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Access to Credit and the Size of the Formal Sector in Brazil

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Abstract

This paper studies the link between credit conditions and formalization in Brazil, as both credit and the rate of formalization have notably increased in the last decade. A firm dynamics model with endogenous formal and informal sectors is developed to quantitatively evaluate how much of the change in corporate credit and the size of the formal sector can be attributed to a reduction in the cost of financial intermediation. The model predicts that the observed reduction in intermediation costs generates an increase in the credit-to-output ratio and in the share of formal workers, in line with the data. It is found that—by affecting the corporate interest rate, the allocation of capital and the entry and exit rates—the change in credit conditions has important effects on firm size distribution and aggregate productivity[1].

Keywords: Financial Structure, Informal Sector, Productivity.

JEL Classification: D24, E26, L11, O16, O17

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1 Introduction

This paper analyzes the link between credit conditions, the level of formalization and firm size distribution. Formalization in Brazil has risen by 21.69 percent since 2001 (from 45.5 percent to 55.37 percent.[2] During the same period, due to favorable international liquidity and a decline in policy controlled interest rates, there has been an improvement in credit conditions for Brazilian firms, evident in the sharp increase in credit to firms over GDP (from 15 percent in 2003 to more than 22 percent in 2008) and a reduction in average interest rates charged on corporate loans.

The Brazilian experience is of particular interest because Brazil is among only a handful of major emerging economies that saw bank lending double (as a share of GDP) during the last decade. Together with structural reforms in the financial sector aimed to reduce the cost of corporate credit and improved access to credit by financial institutions, a period of sound macroeconomic policies contributed to the increase in credit and formalization.[3] For example, during the administrations of President Lula (2003-2010), inflation rates remained low, the government ran a primary surplus on average of 3-4 percent of GDP, net public debt declined steadily, demand for Brazil's exports was strong and large gains occurred in the terms of trade. The aim of this paper is to develop a parsimonious model to study how the increased efficiency of financial institutions and the reduction in their funding costs that resulted from structural reforms, as well as good macroeconomic conditions and credit environment, affected aggregate credit and the rate of formalization.

More specifically, we ask what is the change in the level of corporate credit to GDP and formalization that can be attributed to improvements in the efficiency of financial intermediaries and a reduction in their cost of funding. We answer this question by developing a general equilibrium model of firm dynamics with endogenous entry and exit that incorporates capital financing and bankruptcy decisions. The model allows for the existence of a formal and an informal sector. Entering and operating in the formal sector is costly but allows firms to access credit markets with better commitment and greater efficiency. Financial intermediaries have access to international markets at a risk-free rate but incur a proportional cost when issuing debt. The degree of debt enforcement affects the interest rate that non-financial firms face because there is equilibrium default.

Our quantitative experiment proceeds as follows. We first calibrate a steady state of the model using firm-level data and other relevant aggregate statistics from Brazil in the early 2000s.[4] We also use country-specific institutions based on those reported by the World Bank in its *Doing Business* database. This calibration allows us to pin down technology parameters for non-financial firms and financial intermediaries and determines the benchmark size of the informal sector, the level of credit

[2] The definition of the formal sector is based on the share of workers who contribute to social security as in Catão, Pagés and Rosales (2009).

[3] The paper documents the structural reforms and the changes in credit conditions in the following section.

[4] The data from Brazil include the firm-level survey RAIS, a survey with informal firms ECINF, household survey and detailed information on credit terms to the corporate sector as well as aggregates from different sources. The data and their sources are presented in the following section and in the Data Appendix that accompanies this paper.

and corporate spreads in the economy. Once the model is calibrated, we study the effect of a 37 percent reduction in the cost of funds for financial intermediaries (from 7.5 percent to 4.7 percent) and a 44 percent reduction in the cost of issuing loans (from 5.58 percent to 3.31 percent). These changes are calibrated using Brazilian data from 2003 to 2010 to match the observed reduction in the money market interest rate and overhead costs for financial firms.

The reduction in intermediation costs produces an endogenous response in the level of credit, the firm size distribution and the degree of formalization that is at the center of our paper. More specifically, we find that a reduction in credit costs generates an increase in credit to GDP of approximately 87 percent. The increase in the formal labor force is 45 percent, therefore, as in the data, the model generates sizable increases in the level of credit and the size of the formal sector. An increase in the level of formalization and the better allocation of resources allows the model to generate an increase in measured aggregate TFP of approximately 15 percent and weighted firm-level productivity of about 16 percent.

The intuition for these results is as follows. Changes in intermediation costs have a first order effect on corporate bond prices. This translates into lower default probabilities that in turn increase bond prices even further (the loan spread endogenously decreases by 21.96 percent in the model). This affects firm size distribution through the following channels. First, it induces incumbent firms to change the composition of debt and capital. When interest rates are low, firms' precautionary motive for capital accumulation is reduced and incentives to borrow are stronger. Since firms do not face the need to accumulate capital in order to survive adverse shocks, this increases efficiency in the economy (i.e., firms move closer to their optimal level of capital). Second, it affects the endogenous entry and exit productivity thresholds. Since the value of the firm is higher, it lowers the entry threshold into formalization, increasing the fraction of output produced by formal firms. This affects productivity in different directions. On one hand, lower entry threshold has a negative impact on the average level of productivity of the entrant firm. On the other hand, a larger fraction of output is produced by more productive formal firms. Finally, higher entry also results in stronger competition and higher wages (due to higher aggregate demand for labor) that translates into more exit (with a positive effect on productivity) and a reduction in the average size of the firm. We find that the positive effects on productivity dominate and an increase in aggregate TFP is observed.

To understand the overall results even further, we also analyze one by one the effect of changes in the cost of funds for financial intermediaries and the reduction in the cost of issuing loans. We find that most of the effect on the level of credit is coming from the increase in the level of efficiency of the financial sector (as opposed to changes in their funding costs). Moreover, we uncover an important interaction effect between the level of efficiency and the cost of funds for intermediaries that allows the model to generate the overall change in the size of the formal sector.

Our approach to firm dynamics started with Hopenhayn (1992) and Hopenhayn and Rogerson (1993), and is close to Cooley and Quadrini (2001) who studied the effects of financial constraints

in a similar set-up. The modeling assumptions regarding the informal sector follow the steps of Rauch (1991) and Loayza (1996) where informal activity can be thought of as an optimal response to the economic environment. The treatment of informality and credit frictions follows D'Erasmo and Moscoso Boedo (2012) and D'Erasmo, Moscoso Boedo and Senkal (2012). A related literature on the distributional consequences of frictions in this context started with Restuccia and Rogerson (2008). Important references are Hsieh and Klenow (2009), Guner, Ventura, and Xu (2008), Arellano, Bai, and Zhang (2010) and Buera, Kaboski and Shin (2011). This paper introduces imperfect capital markets, and along that dimension the most closely related papers include Antunes and Cavalcanti (2007) and Quintin (2008).[5] This paper builds upon this literature by analyzing to what extent the observed changes in credit conditions in Brazil can generate the pattern that aggregate credit and the size of the informal sector display.

The relevant empirical literature regarding firm dynamics across countries include Tybout (2000), La Porta and Shleifer (2008), Foster, Haltiwanger, and Krizan (2001), Bartelsman, Haltiwanger and Scarpetta (2009), and Alfaro, Charlton, and Kanczuk (2009). Tybout (2000) and La Porta and Shleifer (2008) are the only ones that report data on firm characteristics in the informal sector, while the other three use different data sources but are focused on firms operating in the formal sector.

The paper is organized as follows. Section 2 presents the relevant facts about the evolution of formality and credit in Brazil during the last decade. Section 3 and 4 present the theoretical model and its equilibrium. Section 5 is devoted to the calibration of the model to the Brazilian data. Section 6 presents the main experiment. Finally, Section 7 concludes.

2 Credit, Formalization and Institutions in Brazil

This section describes the main facts driving our quantitative exercise. A description of the institutional framework and the changes in credit conditions is followed by an analysis of the firm size distribution and the size of the informal sector. Finally, we describe a set of measured institutions that are also important for understanding the link between credit imperfections, informality and productivity.

2.1 Institutional Reforms and Credit Conditions

The role of institutions such as the bankruptcy law shaping economic outcomes has been studied extensively in the empirical literature (see, for example, La Porta et al., 1998, Djankov et al., 2008, and Levine, 1999). The evidence points towards the importance of creditor rights. Developing economies are characterized by lower legal protection of creditor rights as well as inefficient credit markets, and until the early 2000s Brazil was no exception. However, several structural reforms (such as the bankruptcy reform and decline in policy-controlled interest rates) together with favorable international

[5] Antunes and Cavalcanti (2007) and Quintin (2008) study endogenous informal sectors that result from imperfect contract enforcement. Also related, Castro, Clementi and MacDonald (2008) and Erosa and Hidalgo Cabrillana (2008) study the effects of financial contracts in environments with asymmetric information.

liquidity conditions, propelled the increase in corporate credit, especially bank lending, observed during the last decade.

The reforms implemented during this period contributed to the improvement in intermediation efficiency and a large reduction in the cost of credit for non-financial and financial corporations in Brazil. Although many emerging economies experienced rapid credit growth, the experience of Brazil is of particular interest because Brazil is among only a handful of major emerging economies that saw bank lending double (as a share of GDP) from 2000 to 2010.

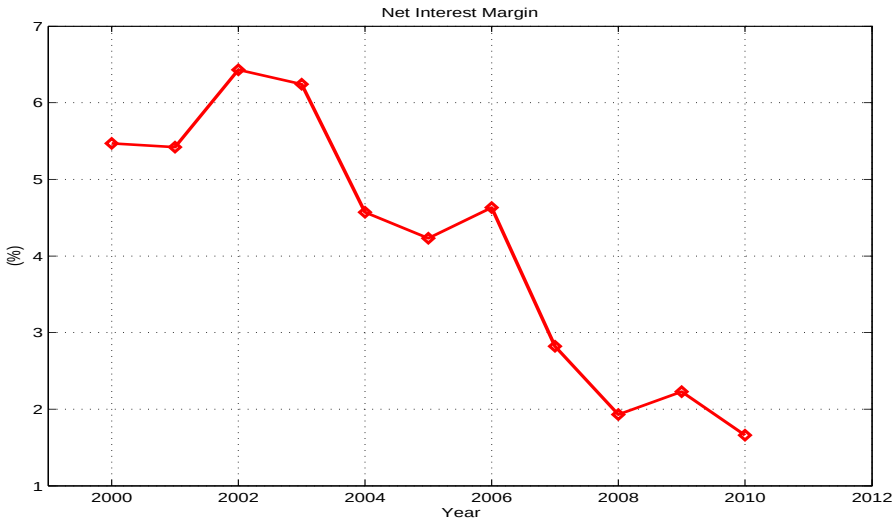
One of the major changes in the institutional environment during the last decade was the change in the Brazilian Bankruptcy Law that provided a significant increase in protection to creditors. The old bankruptcy code in Brazil was enacted in 1945 and had remained largely unchanged until the 2005 bankruptcy law was enacted. Before the reform, creditors had a very low level of protection in Brazil. This characteristic raised the interest rate spread and inhibited the supply of credit. The new bankruptcy law encourages reorganization of claims in a bankrupt entity. In the event of liquidation, the new law rearranges the absolute priority rules in favor of secured creditors. Before the reform, bankruptcies in Brazil took on average 10 years to be resolved, which is roughly three times longer than the time taken in the United States (3 years) and in the Latin American and Caribbean region (3.6 years). This long bankruptcy resolution period reduced the time value of assets and led to greater attrition through depreciation in the value of fixed assets. In summary, the new law provided major protection to creditors and the focus was the improvement of efficiency of the bankruptcy process.[6]

Another important set of financial reforms resulted from a number of bank failures during the late 1990s. As Ter-Minassian (2012) describes, two major programs were implemented: one for private banks (PROER) and another for public banks (PROES). The PROER program provided liquidity to banks in difficulty but assessed to be ultimately solvent. The government provided financial support for the acquisition of failing but salvageable banks and for an orderly unwinding of insolvent ones, created a deposit guarantee fund. The Central Bank acquired powers of supervision and bank resolution. The PROES program mainly focused on closing or privatizing public banks that were not profitable. These programs were fundamental for the increase in efficiency observed in the financial sector in Brazil for the years that followed.

The financial reforms during the last decade also include the improvement of the legislation regulating the realization of collateral for non-performing loans and the liberalization of entry by foreign banks. This increased the level of competition in the financial sector (even though the system remains dominated by relatively few large private and public banks) and drove down credit costs for market participants.

[6] Several major changes that affected the relation between firms and creditors were introduced as part of the new bankruptcy law. For example, secured and unsecured credits are now given priority over tax credits, the distressed firm might be sold (preferably as a whole) before the creditors list is compiled–which speeds up the process and increases firm value–and any new credit extended during the reorganization process is given first priority in the even of liquidation. See Araujo, Ferreira and Funchal (2012) for an exhaustive description of the new bankruptcy law in Brazil.

Figure 1. The Cost of Credit



Note: Net Interest Margin corresponds to the difference between the average lending rate and the average deposit rate. Source Beck and Asli Demirgüç-Kunt (2009) updated in 2012.

The set of financial reforms we described were accompanied by low inflation rates and strong demand for Brazil's exports due to the large gains in the terms of trade observed in this period. These factors also contributed to a better credit environment in general.

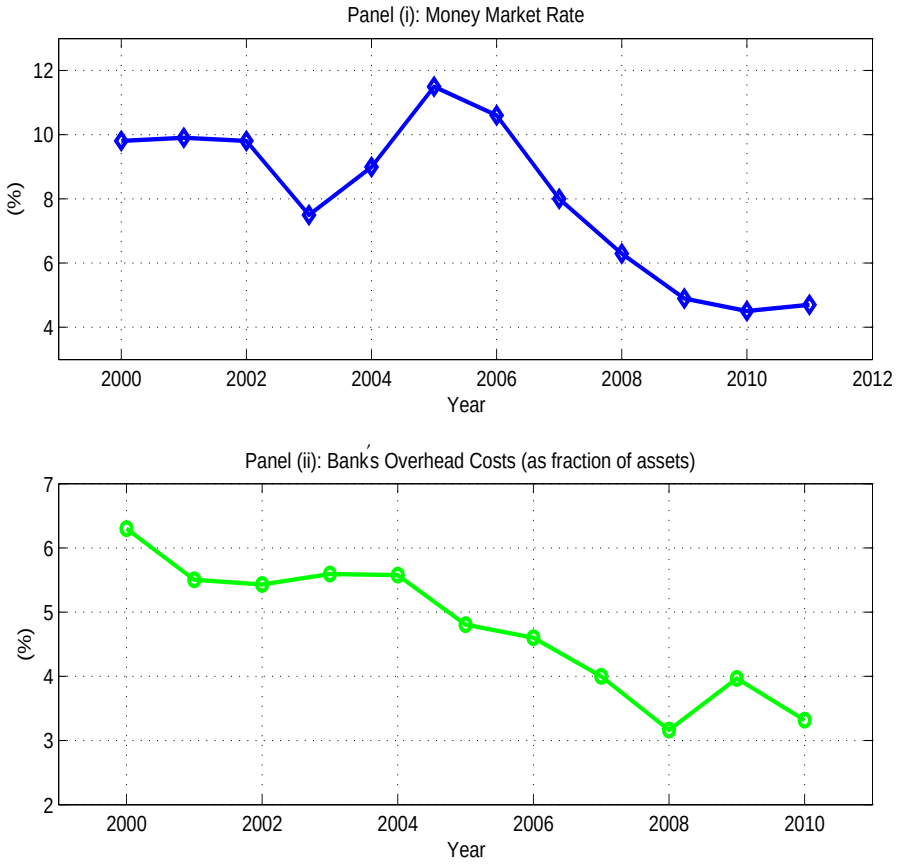
The reduction in intermediation costs were translated into a lower cost of credit for non-financial corporations. We obtained information on the cost of credit from the data on financial structure compiled by Thorsten Beck and Asli Demirgüç-Kunt.[7] We start with the evolution of the interest rate margin (i.e., the difference between the average lending rate and the average deposit rate). Figure 1 shows the reduction in the interest rate margin during 2000-2010.[8]

The figure shows that the reduction in the net interest margin was of more than 75 percent from its peak in 2003 (from 6.43 percent in 2002 to 1.66 percent in 2010) and that there is a significant drop in 2005, the year when the new bankruptcy law was implemented.

Another observable measure of the changes in the structure of the financial sector and the cost of funds for financial intermediaries is the sharp decrease in the real money market interest rate during this period (see Figure 2).[9] We collected data on the nominal money market interest rate and transformed it into real using the consumer price index. Both series are from the International Financial Statistics (IFS).

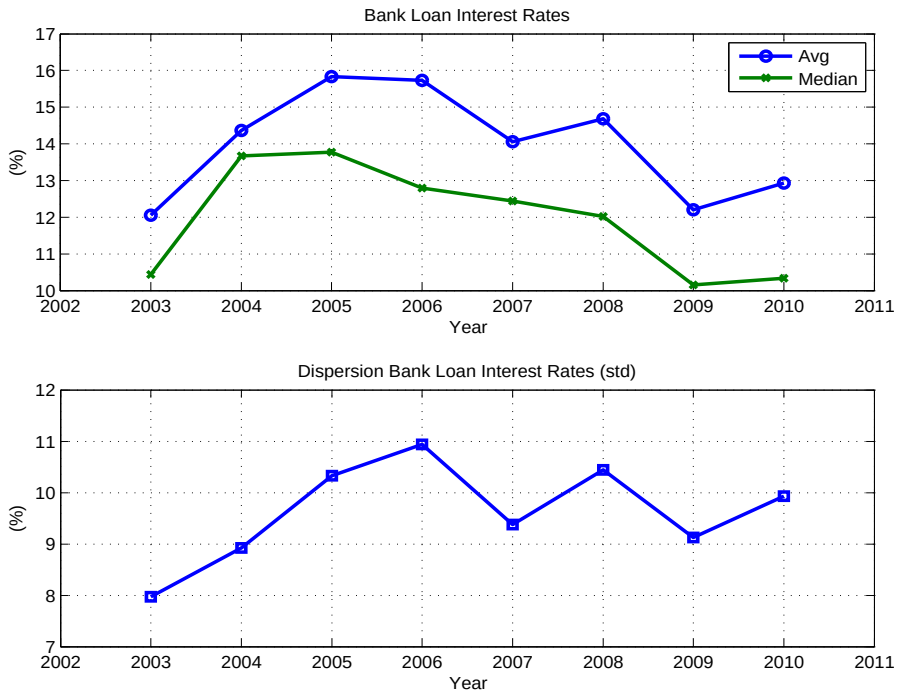
[7] See the New Data version (2012) of the data originally provided in Beck and Asli Demirgüç-Kunt (2009).
[8] See the Data Appendix for sources and definitions as well as a file that contains the data used.
[9] The money market corresponds basically to short-term funds available to banks in everyday operations.

Figure 2. Intermediation Costs



Note: Money Market Interest Rate from IFS data. Overhead costs as a fraction of assets in the financial sector from Financial Structure (2012) data.

Figure 3. Corporate Loan Interest Rates



Source: Brazilian Central Bank (SCR: Sistema de Informacoes de Credito do Banco Central)

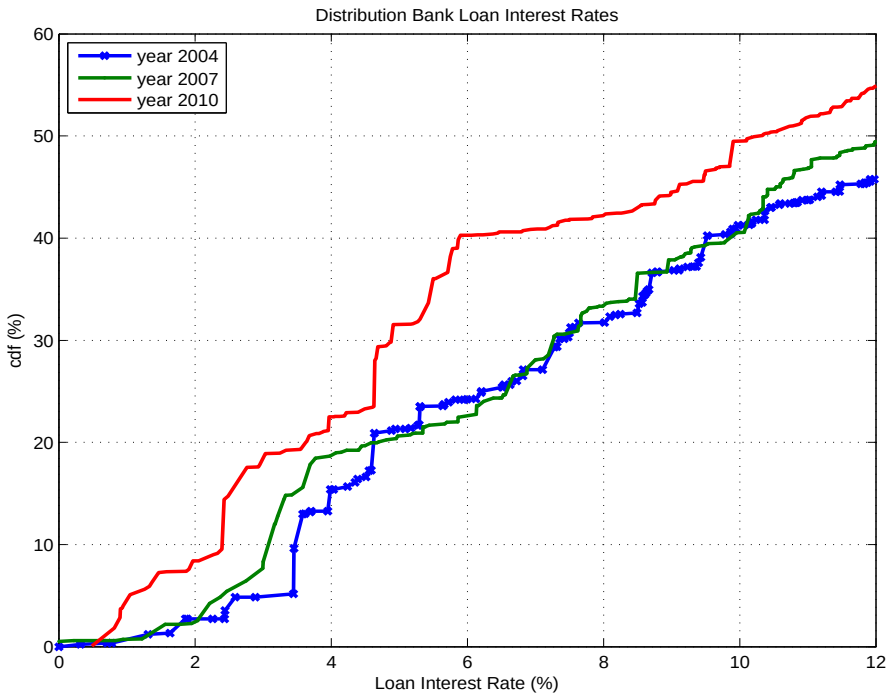
Panel (i) of Figure 2 shows that the cost of funds for the financial sector in Brazil was reduced by almost half in less than 10 years (from approximately 10 percent in 2000 to less than 5 percent in 2010). Another important factor affecting the cost of credit for non-financial corporation is the efficiency level in the financial sector. Panel (ii) of Figure 2 provides additional evidence on the reduction in the cost of accessing credit. This figure presents data on bank overhead costs as a fraction of total assets.These data come from Beck and Demirgüç-Kunt (2009). We observe that overhead costs decreased by 47 percent since the year 2000.

We obtained access to central bank data on bank credit on bank lending to individual firms (Sistema de Informacões de Credito do Banco Central). These data contain very valuable information on loan interest rates and lending amounts at the firm level reported directly from financial institutions.[10] Figure 3 presents the average, the median and the standard deviation of real loan interest rates.[11]

[10] These data are not publicly available. I thank Luis Catão, who provided the data, for allowing me to present this set of summary statistics. These statistics are included in a file that accompanies the Appendix.

[11] All measures presented correspond to loan-weighted measures. To avoid distortions caused by a few outliers, we restrict the sample to $+/-$ 2 standard deviations of the original weighted mean.

Figure 4. Distribution of Corporate Loan Interest Rates



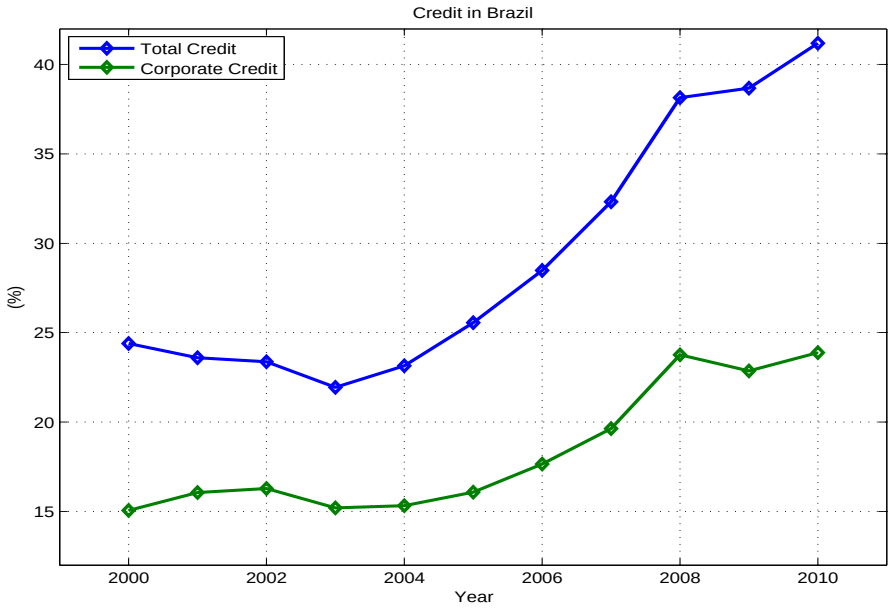
Source: Brazilian Central Bank (SCR: Sistema de Informacoes de Credito do Banco Central)

These data do not show a clear pattern, as do those presented in Figure 1; however, we observe that the average and the median interest rate to corporations decrease after their peak in 2004/2005. Consistent with the aggregate data, the reduction in interest rates is approximately 18 percent for the average and 25 percent for the median. The standard deviation is a useful summary statistic of the dispersion of the observed interest rate distribution and allows us to infer the extent to which financial intermediaries are expanding credit to those at the low end and the high end of the distribution; there seems to be an increase in dispersion during this period. To present more evidence on the change in interest rates, Figure 4 shows the entire distribution for selected years.

We note the increase in the weights on low interest rates when moving from year 2004 to year 2010. For example, year 2010 has approximately 40 percent of the total amount loaned below interest rates of 6 percent, while for year 2004 at the same interest rate the corresponding fraction is around 20 percent.

Together with the reduction in intermediation costs and interest rates, there is a large expansion in credit in Brazil during this period. Funchal and Clovis (2008) find evidence that the use of bank debt increased significantly in the post-bankruptcy reform Brazilian market. Figure 5 presents data consistent with this empirical finding. This figure shows the evolution of total domestic bank

Figure 5. The Evolution of Credit



Source: Catão, Pagés and Rosales (2009).

credit and domestic bank credit to the corporate sector to GDP, two traditional measures of financial deepening.

Figure 5 shows that the ratio of overall credit to the private sector (i.e., including credit to both firms and households) relative to GDP rose dramatically in the period we are analyzing. Credit to the corporate sector experienced a similar expansion, going from 15 percent in 2000 to 24 percent in 2010 (an increase of 58.7 percent).

Before moving into data on informality and then to the model, we would like to provide more information on the link between financial reforms, credit conditions and credit at the firm level. Araujo, Ferreira and Funchal (2012) present evidence on the consequences of the bankruptcy reform. They use a differences-in-differences approach to analyze this event. More specifically, they compare Brazilian firms (the treatment group) to non-Brazilian firms from Argentina, Chile and Mexico (the control group) with respect to the behavior of debt related variables.[12] The source of their data is Economatica, which includes 698 publicly traded firms from 1999 to 2009 (no financial institutions). Of those firms, 338 are Brazilian (the treatment group), and the rest belong to the control group. Table 1 presents their main results. As shown in Table 1, the authors find that the bankruptcy reform generated a considerable increase in the total amount of debt at the firm level as well as a significant

[12] They allow for different firm trends within treatment and control groups to account for the fact that the standard difference-in-difference approach may not consistnetly estimate the average treatment effect due to the assumption of common trends.

Table 1. Effects of the Bankruptcy Reform

	Dep. Variable	
	Total Debt	Cost Debt
Bankruptcy reform	0.1780	-0.1678
s.e.	0.0640	0.0040
Other Controls	Yes	Yes
Observations	3143	2487
R^2	0.09	0.03

Note: Source is Table 2 in Araujo, Ferreira and Funchal (2012). Differences in Difference estimation. Bankruptcy reform dummy takes value one after year 2004. Other controls include Taxes to Total Revenue, Total Assets, Return on Assets, Price-to-Book ratio, Earnings before taxes. The source of the data is Economatica. 698 publicly traded firms from 1999 to 2009 (no financial institutions). 338 firms are Brazilian (the treatment group) and the rest to the control group.

reduction in the cost of credit. More specifically, the estimates indicate that the new bankruptcy legislation generates an increase of 17.8 percent in total debt and a reduction of approximately 16.78 percent in the cost of debt.

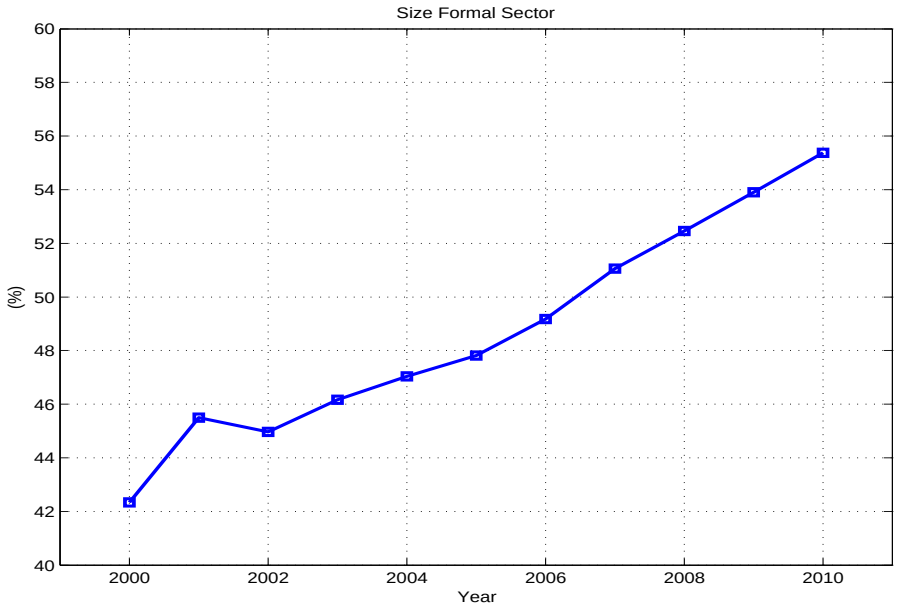
2.2 Formalization and Firm Size Distribution

How does the change in credit conditions affect firm size distribution in Brazil? Credit markets allow for a better allocation of resources. When credit markets improve, capital and labor move closer to the efficient level. An important margin affecting resource misallocation is the level of formalization in the economy. One of the main benefits of formalization is better access to credit, since operating in the formal sector increases access to courts and other types of contract-enforcement mechanisms, and financial institutions are generally not willing to extend loans to firms that lack the proper documentation. Changes in the cost of funds affect not only existing firms by allowing them to expand or to survive larger adverse shocks, but also the number and the size of those firms that decide to start operating in the formal sector. This has important implications, since it affects the dynamics of firm size distribution.

In fact, a dramatic change in the level of formalization was observed in Brazil during this period. Using data from the Brazilian National Institute of Geography and Statistics (IBGE), we present the share of formal workers in the economy (measured as the share of workers that contribute to Social Security). Figure 6 shows that the share of formal workers has increased by more than 21 percent (from 45 percent in 2001 to 55 percent in 2010).

Evidence on the credit channel was also presented in Catão, Pagés and Rosales (2009). They used a difference-in-difference approach applied to household survey data from Brazil to show that

Figure 6. Level of Formalization



Source: Brazilian National Institute of Geography and Statistics (IBGE).

formalization rates increase with financial deepening , especially in sector where firms are typically more dependent on external finance.[13]

The relation between credit and the level of formalization has important effects for the firm size distribution because informal firms tend to be much smaller and unproductive that formal firms. To shed light on the firm size distribution we use two data sources. The first source is the ECINF survey (*Pesquisa de Economia Informal Urbana*), a representative cross-section of small firms (with at most five employees) collected at the national level by the Brazilian Bureau of Statistics (IBGE) in 2003.[14,15] The second source is the universe of formal firms, RAIS (*Relação Anual de Informacões Sociais)*, compiled by the Brazilian Ministry of Labor which requires by law that all formally registered firms report information each year on each worker employed by the firm.[16]

From the ECINF, we can take a close look at the "Micro-Sector" in Brazil. Table 2 presents the distribution of firms with fiver or less workers. This includes formal and informal firms. Table 2

[13] The measure of external finance is the standard Rajan-Zingales (1998) index.

[14] ECINF samples households located in urban areas and seeks to identify the self-employed and employers with up to five employees in at least one work situation. This data set has been used in recent studies by Fajnzylber, Maloney and Montes-Rojas (2011) and Ulyssea (2012), for example. See http://www.ibge.gov.br/home/estatistica/economia/ecinf/2003/default.shtm for more information.

[15] The ECINF offers extensive detail on the main firm and the entrepreneur characteristics of microenterprises such as sector revenues, profits employment size, capital stock and time in business.

[16] In both cases, ECINF and RAIS, we only have access to aggregate information provided in a large set of tables by the original source. See the Data Appendix for a full description of variables used and links to corresponding tables.

Table 2. "Micro-Sector" Firm Size Distribution

"Micro-Sector" Size Distribution		
# of Workers	Fraction of Firms %	CDF %
0	86.60	86.60
1	7.40	94.00
2−3	4.60	98.60
4−5	1.40	100.00

Note: "Micro-Sector" defined as firms with 5 or less employees. Source is ECINF survey, a representative cross-section of small firms (5 or less employees) collected at the national level.

shows that when we look at both formal and informal firms, a considerable mass is allocated in the small bins. More than 80 percent of firms employ no workers, and almost 95 percent employ less than 1 worker.

Using the ECINF and RAIS, we can look at the differences between formal and informal firm size distribution. Table 3 presents formal size distribution from RAIS (i.e., the distribution of registered firms) and informal size distribution from ECINF (i.e., the distribution of unregistered firms). As shown in Table 3, most informal firms employ less than three workers (98.23 percent), the first bin in the distribution of formal firms. IBGE identified 10,525,954 small enterprises in Brazil in 2003, and 98 percent of them were defined as informal (not registered). A large share of formal firms are also concentrated in the small size bins, but there is considerable dispersion in terms of workers per plant/firm.

2.3 Measured Formal Institutions

Besides access to credit, institutions that affect the cost of operating a formal firm are also important determinants of the size of the formal sector and the level of aggregate credit in the economy. These include corporate taxes, entry costs into formalization and labor market costs such as payroll taxes and firing costs. To obtain information on these institutions we use the World Bank *Doing Business* dataset. These data measure the costs, in terms of time and resources, along many dimensions affecting the firm, such as starting a business, getting construction permits, employing workers, obtaining credit, protecting investors, paying taxes, trading across borders, enforcing contracts, and closing a business. Of particular interest are the cost of entering the formal sector, the profit tax rate, the payroll tax rate, the efficiency of the bankruptcy law and firing costs.

We describe how these measured institutions are constructed:[17]

Entry Cost: The cost of entering the formal sector corresponds to the reported "costs of registering

[17] We are interested in values reported in 2003, but we use values for the most recent year when the observation for 2003 is not reported. Since these variables measure long-term institutional arrangements, not having the information for a particular year does not bias the estimates to a large extent.

Table 3. Formal and Informal Firm Size Distribution

Formal Size Distribution		
# of Workers	Fraction of Firms %	CDF %
0-4	69.58	69.58
$4-9$	15.22	84.80
$9-19$	8.06	92.86
$19-49$	4.43	97.29
$49-99$	1.36	98.64
$99-249$	0.82	99.46
$249-499$	0.30	99.76
>499	0.24	100.00
Informal Size Distribution		
# of Workers	Fraction of Firms %	CDF %
0	80.12	80.12
1	12.23	92.35
$2-3$	5.88	98.23
$4-5$	1.77	100.00

Note: Source of Formal Size Distribution is RAIS that collects information on all formally-registered firms. Source for Informal Size Distribution is ECINF survey a representative cross-section of small firms (5 or less employees) collected at the national level.

a business and of dealing with licenses to operate a physical locale." It involves the cost of starting a business as a share of income per capita. The estimate of the entry cost for Brazil is 0.739 of GNI per capita.

Taxes: The tax rate paid on profits by the firms is taken from "Paying Taxes - Profit tax (%)" and the payroll tax corresponds to "Paying Taxes - Labor tax and contributions (%)."[18] The estimated values for Brazil are 22.4 percent and 51.65 percent, respectively.[19]

Bankruptcy costs: The efficiency of the system in the event of default is measured by the share of the asset value of the firm that is lost during bankruptcy. The cost of the system (ϕ), reported as a percentage of the estate's value, includes court fees and the cost of insolvency practitioners, such as legal and accounting fees. The estimated value for Brazil is 9 percent.[20]

Firing Costs: The firing costs are obtained using information on the variable "Firing cost (weeks of wages)." The estimated value of firing one worker equals 88 percent of the worker's annual wage.

3 Environment

This is a standard firm dynamics model based on Hopenhayn (1992) with credit markets as in Cooley and Quadrini (2001). The environment extends the environment of D'Erasmo and Moscoso Boedo (2012) to incorporate firing costs. Time is discrete, and the period is set to one year. There are three types of entities in the economy: firms, lenders and consumers. Firms can operate in one of the two sectors (formal or informal) and produce the consumption and capital goods used in the economy. They are the capital owners and pay dividends to consumers. We analyze a small open economy where lenders have unlimited access to international markets and make loans to non-financial firms. Consumers supply labor to firms and receive their profit net of entry costs. The stationary equilibrium is analyzed.

3.1 Consumers

There is an infinitely-lived representative consumer who maximizes the expected utility:

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\beta^t U(C_t)\right],$$

[18] Because both tax rates are expressed as a function of profits, they need to be adjusted and the labor tax rate expressed as a function of payroll. To do that, the standardized balance sheet and income statements was used to construct the exercise, as explained in Table 1 of Djankov et al. (2010).

[19] Labor and corporate tax rates differ from those presented in Carvalho and Valli (2011). As opposed to the procedure used in the World Bank Doing Business dataset, these authors use the statutory level of taxes. As they explain on page 26, "tax laws in Brazil allow for a great variety of exemptions and usually differentiate tax rates according to taxable bases. As such, they are not concise references for calibration." Note also that the labor tax used by our study incorporates social contributions made by firms.

[20] This parameter corresponds to the costs associated with courts and lawyers' expenses. Since the paper focuses on changes in the financial sector, it is taken as fixed for the quantitative exercise. However, one interesting avenue for future research is the study of how changes in the legal system affect aggregate credit and firm dynamics.

where $\mathbb{E}[\cdot]$ is the expectation operator, C_t is consumption (restricted to be nonnegative) and $\beta \in (0,1)$ is the discount factor. The household is endowed with one unit of labor, which it supplies to firms at the market wage rate w. The consumer is responsible for the creation cost of new firms c_e and consequently owns existing firms in the economy and receives income from the dividends they pay. Finally, the household receives a lump-sum transfer for the total amount of taxes collected.

3.2 Firms and Technology

The unit of production is a single-establishment firm, also understood as a unique investment project. Each project is described by a production function $f(z,k,n)$ that combines productivity z, capital k, and labor n. It is assumed that the production function has decreasing returns to scale. In particular, the production function is defined as $f(z,n,k) = z(k^{\alpha}n^{1-\alpha})^{\gamma}$ with $\alpha \in (0,1)$ and $\gamma \in (0,1)$.

There are two processes for z: *high* (h) and *low* (l). The *high* productivity process is given by

$$\ln(z_{t+1}) = (1-\rho)\ln(\mu_h) + \rho\ln(z_t) + \epsilon_{t+1}$$

with $\epsilon_{t+1} \sim N(0,(1-\rho^2)\sigma^2)$, where σ^2 is the variance of $\ln(z)$, μ_h is the mean, and ρ the autocorrelation parameter of the process. The conditional cumulative distribution of z_{t+1} is denoted by $\eta(z_{t+1}, z_t)$. The use of the *high*-productivity process is restricted to the formal sector. To simplify the exposition of the model, the following two assumptions are made. First, it is assumed that the *low*-productivity process is a constant given by μ_l and restricted to the informal sector. Second, once operating as either formal or informal, firms are not allowed to switch between sectors. These assumptions imply that formal firms will use the *high*-productivity process and that informal firms will use the *low*-productivity process. Other potential possibilities would be to allow firms to switch between sectors and to allow formal firms to use the *low*-productivity process.[21] The two processes will be calibrated to match the size distribution of formal firms and the size of the informal sector. Note that the fraction of firms operating under each process is an endogenous outcome of the model and a function of country-specific frictions.[22]

The assumption of different productivity processes is consistent with the evidence provided by La Porta and Shleifer (2008). They document productivity differences between informal firms and small formal firms at the firm level that range from 100 percent to 300 percent. They also find that these differences are permanent and not the result of informal sector firms operating at a lower scale in order to avoid detection.[23] This is also consistent with the evidence presented in Fajnzylber,

[21] The version of the model that allows for all of these possibilities was computed and calibrated and delivered that, at the calibrated parameters, the dichotomy between sectors and productivity processes arose endogenously. More specifically, a model that allowed informal firms with the *low*-productivity process to switch to the formal sector reproduces the same equilibrium as the benchmark economy.

[22] It is useful to take into account that, since the *high*-productivity process is distributed normally, there is a positive probability of obtaining values of z_t from this process below μ_l.

[23] For example, differences in sales per worker are much higher (two to three times higher) than the average entry cost, implying that it is not just barrier to entry that is the main factor affecting scale, productivity or the decision to

Maloney and Montes-Rojas (2011), who analyze microenterprises in Brazil. They find that 85 percent of the firms that did not have a license made no attempt to regularize at the time of starting up. In contrast, 75 percent of the licensed entrepreneurs did at least try to regularize their firm when they began operating.

Firms maximize expected discounted dividends d:

$$\mathbb{E}\left[\sum_{t=0}^{\infty} R^t d_t\right],$$

at rate R.[24] Firms are created by the consumer paying a cost c_e. Once launched, firms face a technology adoption decision. They draw their initial productivity z_0 in the h process from the distribution $\nu(z_0)$. Draws from this distribution are assumed to be i.i.d across firms. Firms then compare z_0 to μ_l and choose between staying out of the market or operating one of the projects as a formal or informal firm, i.e., the project choice is non-reversible.[25] Unimplemented projects go back into the pool.

There is a random fixed cost of production c_f, measured in units of output, that is i.i.d across firms and over time with distribution $\xi(c_f)$. A firm that does not pay this fixed cost is not allowed to produce. Firms own their capital and can borrow from financial intermediaries in the form of non-contingent debt $b \geq 0$. They finance investment with either debt or internal funds.

If the firm operates in the formal sector, it is subject to a proportional tax on profits τ and a payroll tax τ_w. Creating a formal sector firm requires an entry cost κw. When a formal firm exits, it has to go through a bankruptcy procedure if it defaults on its debt. The bankruptcy procedure has an associated cost equal to a share ϕ of the firm's capital. It is assumed that a formal firm that exits in period t has to pay firing costs equal to $\tau_f w n_t$ where τ_f is the fraction of real wages that the firm has to pay per worker fired.[26] Since in a given period firm exit happens before production has taken place, we make an assumption to accommodate payment of firing costs at this stage. We assume that the labor choice is made in two stages. In the first stage, together with the choice of capital investment,

operate informal. Related to this, they note that in a sample of developing economies approximately 91 percent of registered firms at the time of the survey started as registered firms and do not come from the informal sector. Moreover, Bruhn (2008), Bertrand and Kramarz (2001) and McKenzie and Sakho (2007) present empirical evidence that shows that improvements in entry costs do not lead to the formalization of previously informal firms and only generate the creation of new businesses.

[24] At the stationary equilibrium, the firm's discount factor is constant.

[25] This is consistent with the evidence presented in Atkeson and Kehoe (2007) who argue that manufacturing plants need to be completely redesigned in order to make good use of new technologies.

[26] Note that the model abstracts from formal firms paying firing costs period by period. In a model where firing costs are paid every period, the state space of an in incumbent firm is the following set $\{z_{-1}, k, b, n_{-1}, c_f\}$ where z_{-1} denotes previous productivity, k is current capital, b is the level of debt of the firm, n_{-1} is the number of workers hired last period and c_f is the observed fixed cost. This is a model that incorporates three continuous variables plus the exogenous process for productivity and the fixed cost. Solving this model is computationally challenging and beyond the scope of this project. Since the focus of this paper is on credit frictions we abstract from extending the model in this dimension.

the firm hires a set of workers that we call "advance workers."[27] The amount of workers the firm hires at this stage depends on the firm's choice of capital and the expected value of productivity (conditional on current productivity). It corresponds to the best estimate of the number of workers the firm will utilize in production in the following period. The second stage happens after the realization of the fixed cost. After observing the realized fixed cost, the firm will decide whether to exit or to continue. If the firm exits, it will pay the firing costs on those workers hired in advance, i.e., the "advance workers." Since productivity is highly persistent, the value of "advance workers" will not differ much from actual workers the firm hires when production takes place. If the firm continues, productivity realizes and the firm is allowed to adjust its number of workers to the optimal level at no extra cost if "advance workers" are already in place. In the quantitative exercise, taxes and the costs of formality are set directly from the corresponding measures in the *Doing Business* database as presented in the previous section.

3.3 Credit Markets

Asset markets are incomplete. In each period, firms borrow using only one-period non-contingent debt denoted by b. The credit industry is composed of a continuum of lenders that make loans to formal and informal sector firms. These lenders are risk-neutral and competitive. They have unlimited access to international markets at the risk-free rate r_t. They compete by offering loan contracts to each firm. Because there is perfect competition and full information, prices depend on firms' characteristics, given by their choice of sector (formal or informal), future level of capital, level of borrowing, and current productivity level under each technology. In particular, firms in the formal sector borrow at price $q^f(k_{t+1}, b_{t+1}, z_t)$ and firms in the informal sector borrow at price $q^i(k_{t+1}, b_{t+1})$. Lenders incur a proportional intermediation cost ζ. Without loss of generality we can assume that firms take loans only from one lender.[28]

Consistent with bankruptcy law across countries, we follow the limited liability doctrine. This limits the owner's liability to the firm's capital. In each period, firms can default on their debt. A default triggers a bankruptcy procedure that liquidates the firm. The formal bankruptcy procedure has an associated cost equal to a share ϕ of the firm's capital. The values of the bankruptcy cost ϕ are obtained from the *Doing Business* database. When making a loan to a formal sector firm, lenders take into account that there is limited liability and that they can recover only up the value of capital in case the firm defaults. Because the capital of the informal firm is not legally registered, the recovery rate

[27] The assumption of hiring workers one period in advanced is a standard assumption in the literature on labor adjustment costs at the firm level (see, for example, Hopenhayn and Rogerson, 1993).

[28] The relevant state space that determines the default probability is $\{k_{t+1}, b_{t+1}, z_t\}$ in the case of the formal firm and $\{k_{t+1}, b_{t+1}\}$ in the case of the informal firm. Consistent with bankruptcy procedures and the problem of the firm presented in this paper, firms have the option of defaulting on all of their loans or none of them. Then, the price charged on any debt subcontract b'_s, with $\sum_s b'_s = b'$, must be the price that applies to the single contract of size b'. Consequently, as long as lenders condition their loan price on total end-of-period debt position of a firm, there is a market arrangement in which the firm is indifferent between writing a single contract with one lender or a collection of subcontracts with the same total value with many lenders.

of a loan to an informal sector firm that defaults is assumed to be zero. This assumption follows the evidence presented in Pratap and Quintin (2008), where it is suggested that there is segmentation in financial markets across formal and informal sectors.

3.4 Timing

This section presents the timing of the model. We start with a description of the timing of a formal incumbent, then the informal incumbent and finally the timing of the entrant firm.

The timing of a *formal incumbent* firm is as follows:

1. Period t starts. The relevant state space is $\{z_{t-1}, k_t, b_t\}$ where z_{t-1} denotes productivity operated in $t-1$, k_t is current capital and b_t is the level of debt of the firm. Firms also know the number of "advance workers" that have been hired before.[29]
2. The fixed cost c_f is realized.
3. The firm decides whether to continue or exit.
   (a) If it decides to exit, the firm pays the firing cost of its "advance workers" and chooses whether to exit by default or by repaying its debt.
   (b) If it decides to stay, the level of productivity z_t is realized.
   (c) The firm hires workers n_t for production in period t. It also repays the existing debt b_t, decides the level of capital k_{t+1}, debt b_{t+1} at price $q^f(k_{t+1}, b_{t+1}, z_t)$ and chooses "advance workers" for the following period.
   (d) Profit and payroll taxes are paid.
   (e) Dividends (if any) are distributed.

The timing of an *informal incumbent* firm is similar to that of a formal incumbent, the difference being that informal firms do not pay taxes or firing costs and they face (endogenously) different borrowing costs. It is given by:

1. Period t starts. The relevant state space is $\{\mu_l, k_t, b_t\}$ where μ_l denotes productivity operated in $t-1$, k_t is current capital, b_t is the level of debt of the firm.
2. The fixed cost c_f is realized.
3. The firm decides whether to continue or exit.
   (a) If decides to exit, the firm defaults on its debt and keeps the installed capital.
   (b) The firm hires workers n_t, repays the existing debt b_t, decides the new level of capital k_{t+1} and debt b_{t+1} at price $q^f(k_{t+1}, b_{t+1}, z_t)$.
   (c) Dividends (if any) are distributed.

The timing of a potential *entrant firm* is as follows:

[29] Note that "advance workers" are a function of $\{z_{t-1}, k_t$, so they do not need to be included as part of the state space.

1. The owner of the firm (the consumer) decides whether to pay the entry cost c_e or not.
2. If the entry cost is paid, the firm draws the initial productivity z_0 of the h process from the distribution $\nu(z_0)$.
3. Firms then compare z_0 to μ_l and choose between staying out of the market or operating one of the projects as a formal or informal firm.
4. Depending on this decision, they start as a formal or informal incumbent with no capital and no debt.

4 Equilibrium

The stationary equilibrium of the model is analyzed in this section. In this equilibrium the wage rate, the risk-free rate and the schedule of loan prices are constant. Every equilibrium function depends on the set of loan prices, the risk-free rate, and the wage rate. For ease of exposition, this dependence is not explicitly presented.

4.1 Consumer's Problem

In the stationary equilibrium, all prices and aggregates in the economy are constant. Hence, household maximization implies that the consumer supplies its unit of labor inelastically, $\beta = R$, and that aggregate consumption is:

$$C = w + \Pi + T - E + X, \tag{1}$$

where Π is total dividends from incumbent firms, T is the lump-sum transfer from the income and payroll taxes, E is the aggregate creation cost, and X is the exit value of firms.

4.2 Formal Sector Incumbent

The incumbent firm in the formal sector operating a project with technology h starts the period with capital k, debt b, and previous productivity z_{-1}. Then, the firm draws the fixed cost that is required for continuing the operation, c_f, and decides to either operate the project, exit after repayment of debts, or default and liquidate the firm.

We can define operating revenue $\mathcal{R}^f$ for an incumbent formal firm as follows:

$$\mathcal{R}^f(z,k,c_f) = \max_{n\geq 0} (1-\tau)\left[z(k^\alpha n^{1-\alpha})^\gamma - c_f - w(1+\tau_w)n\right]$$

The first order condition of this problem (in an interior solution) is

$$zk^{\gamma\alpha}\gamma(1-\alpha)n^{(1-\alpha)\gamma-1} = w(1+\tau_w).$$

The solution to this problem provides the optimal labor decision denoted by $n(z,k)$. Knowing z and together with his choice of k', "advance workers" or the best estimate of the number of workers the firm will utilize in production in the following period is equal to $E_{z'|z}[n(z',k')]$.

The value function of a firm when deciding whether to stay or exit is denoted as $W^f(z_{-1},k,b,c_f)$. If it decides to remain in business, it pays c_f and observes the current period's productivity z. The value function of a firm operating in the formal sector is denoted as $V^f(z,k,b,c_f)$. The incumbent solves the following problem

$$W^f(z_{-1},k,b,c_f) = \max\left\{ \int V^f(z,k,b,c_f)d\eta(z|z_{-1}), V^x(z_{-1},k,b,c_f) \right\} \tag{2}$$

where the continuation value is

$$V^f(z,k,b,c_f) = \max_{n,k',b'} d^f + \beta \int W^f(z,k',b',c_f')d\xi(c_f)$$

s.t.

$$d^f = (1-\tau)\left[z(k^\alpha n^{1-\alpha})^\gamma - c_f - w(1+\tau_w)n\right] - k' + (1-\delta)k + q^f(k',b',z)b' - b \geq 0$$

and the exit value is given by

$$V^x(z_{-1},k,b,c_f) = \max\{k - b - \tau_f w E_{z|z_{-1}}[n(z,k)], \max\{0,(1-\phi)k - b - \tau_f w E_{z|z_{-1}}[n(z,k)]\}\}$$

where the zero lower bound comes from the limited liability constraint, the second term corresponds to exit without default where the firm repays the debt and pays the firing costs to "advanced workers" and the third term refers to the exit by default option that incorporates bankruptcy costs.

The solution to problem (2) provides the exit decision rule $\chi^f(z_{-1},k,b,c_f)$ that takes the value of 0 if the firm continues to operate, 1 if the firm decides to default, and 2 if the firm decides to exit after repayment. The optimal capital and debt decision rules for a firm in the formal sector are given by $k'^f(z,k,b,c_f)$ and $b'^f(z,k,b,c_f)$, respectively.

Using the exit and default decision rule of the formal firm, we can define the default probability of a formal firm $p^f(k',b',z)$ as follows:

$$p^f(k',b',z) = \int I_{\{\chi^f(z,k',b',c_f)=1\}} d\xi(c_f),$$

where $I_{\{\cdot\}}$ is the indicator function that takes a value equal to one when the condition in between brackets is true. At a given level of productivity and choices of capital and debt by the formal firm,

the default probability integrates over different values of the fixed cost c_f to capture those states in which the firm finds it optimal to exit by default.

4.3 Informal Sector Incumbent

An incumbent firm in the informal sector, after observing fixed operating cost c_f, can choose to stay active or to exit the market after a default. More specifically, the informal incumbent firm solves the following Bellman equation:

$$W^i(k,b,c_f) = \max\Big\{V^i(k,b,c_f),k\Big\} \tag{3}$$

where the value of remaining in the informal sector is given by

$$V^i(k,b,c_f) = \max_{n,k^{'},b^{'}} d^i + \beta \int W^i(k^{'},b^{'},c_f^{'})d\xi(c_f)$$

s.t.

$$d^i \;\; = \;\; \mu_l(k^{\alpha}n^{1-\alpha})^{\gamma} - c_f - wn - k^{'} + (1-\delta)k + q^i(k^{'},b^{'})b^{'} - b \geq 0$$

The solution to problem (3) provides the exit decision rule $\chi^i(k,b,c_f)$ that takes the value of 0 if the firm continues to operate in the informal sector and 1 if the firm decides to default. The optimal capital and debt decision rules are given by $k'^i(k,b,c_f)$ and $b'^i(k,b,c_f)$.

Similar to the definition of the default probability for a formal firm, we can derive the default probability of an informal firm using the exit decision rules. Specifically, the default probability of an informal firm $p^i(k',b')$ is:

$$p^i(k',b') = \int I_{\{\chi^i(k',b',c_f)=1\}}d\xi(c_f).$$

4.4 Entrants

The value of a potential entrant (net of entry cost) W_e is given by:

$$W_e = \int \max\Big\{W^i(0,0,0), \int \widetilde{V}^f(z,0,0,0)\eta(z|z_0)\Big\}d\nu(z_0) - c_e \tag{4}$$

where $\widetilde{V}^f(z,0,0,0)$ is the value of starting as a formal firm given by

$$\widetilde{V}^f(z,0,0,0) = \max_{k^{'},b^{'}} \widetilde{d}^f + \beta \int W^f(z,k^{'},b^{'},c_f^{'})d\xi(c_f)$$

s.t.

$$\widetilde{d}^f = -w(1+\tau_w)\kappa - k^{'} + q^f(k^{'},b^{'},z)b^{'} \geq 0$$

Effectively, an entrant has no capital, no debt, and the cost of production c_f equals zero. The entrant chooses between projects and sectors. The sector and project adoption decisions are made after paying c_e and observing the productivity level z_0, which affects the conditional distribution from which the first productivity parameter will be drawn. Differences in the volatility of the processes together with differences in initial productivity are going to generate variation in the decisions made by entrants and by potential lenders. That introduces differences in behavior as a function of volatility and contract enforceability. In equilibrium, under free entry, $W_e = 0$ will hold. The solution to problem (4) provides the entry decision rule $\Xi^e(z_0)$ that takes value 0 if the firm decides to enter informal and 1 if the firm decides to enter formal. This will determine the entry productivity threshold to the formal sector z_0^*. More specifically, let z_0^* be the value of initial productivity in the *high* process such that

$$W^i(0,0,0) = \int \widetilde{V}^f(z,0,0,0)\eta(z|z_0^*).$$

Then, since it is possible to show that the value of being in the formal sector is increasing in the level of productivity, the entry decision rule will be $\Xi^e(z_0) = 1$ for $z_0 \geq z_0^*$ and equal to zero otherwise. The solution to this problem also provides capital and debt decision rules $\widetilde{k}'(z,0,0,0)$ and $\widetilde{b}'(z,0,0,0)$ for a firm that starts operating in the formal sector.

4.5 Lenders

Lenders make loans to formal and informal firms while taking prices as given. Profit for a loan b' to a firm in the formal sector with future capital k' and, productivity z is

$$\begin{aligned}\pi^f(k^{'},b^{'},z) &= -q^f(k^{'},b^{'},z)b^{'} + \frac{1-p^f(k^{'},b^{'},z)}{1+r}b' \\ &\quad + \frac{p^f(k^{'},b^{'},z)}{1+r}\min\left\{b', (1-\phi)k' - \tau_f w E_{z|z_{-1}}[n(z,k)]\right\} - \zeta b',\end{aligned}$$

where $p^f(k^{'},b^{'},z)$ denotes the default probability of this borrower defined before.

Profit for a loan b' to a firm in the informal sector with future capital k' is

$$\pi^i(k^{'},b^{'}) = -q^i(k^{'},b^{'})b^{'} + \frac{\left[1-p^i(k^{'},b^{'})\right]}{1+r}b' - \zeta b'$$

where $p^i(k^{'},b^{'})$ denotes the default probability of the informal borrower defined before. In equilibrium, the schedule of prices will adjust so that $\pi^f(k^{'},b^{'},z) = 0$ and $\pi^i(k^{'},b^{'}) = 0$ for all (j,k',b',z), that is, the equilibrium price schedule is given by

$$q^f(k',b',z) = \frac{1-p^f(k',b',z)}{1+r} + \frac{p^f(k^{'},b^{'},z)}{1+r}\frac{\min\left\{b', (1-\phi)k' - \tau_f w E_{z|z_{-1}}[n(z,k)]\right\}}{b'} - \zeta, \quad (5)$$

and

$$q^i(k^{'}, b^{'}) = \frac{\left[1 - p^i(k^{'}, b^{'})\right]}{1 + r} - \zeta.$$

4.6 Definition of Equilibrium

A stationary competitive equilibrium is a set of value functions $\{W^f, W^i, V^f, V^i, \widetilde{V}^f\}$, decision rules (capital, debt, default, exit and sector), a wage rate w, schedule of lending prices $q^f(k', b', z)$ and $q^i(k', b')$, aggregate distributions $\vartheta(k, b, z; M)$ and $\widehat{\vartheta}(k, b, M)$ of firms in the formal and informal sectors, and a mass of entrants M such that:

1. Given prices, firms' value functions and their decision rules are consistent with problems (2), (3) and (4);
2. The free entry condition is satisfied (i.e., $W_e = 0$);
3. Lenders make zero profit for every loan type;
4. The distributions of firms ϑ and $\widehat{\vartheta}$ are stationary;
5. Aggregate consumption satisfies equation (1);
6. The labor market clears (i.e., $1 = \int n^f(z, k) d\vartheta(k, b, z; M) + \int n^i(k) d\widehat{\vartheta}(k, b; M)$).

5 Calibration

This section calibrates the initial steady state of the model. We start with the parametrization of the stochastic process in the model to then explain the calibration procedure. The process for productivity will be discretized to obtain the grid for z and the transition probabilities $\eta(z'|z)$ following the method explained in Tauchen (1986).[30] From the transition matrix $\eta(z'|z)$, the unconditional probability $\eta^*(z)$ is derived. The distribution of initial shocks is set to $\nu(z_0) = \eta^*(z)$. Operating fixed costs are assumed to take values of $\{0, \widehat{c_f}, \infty\}$ and the pdf distribution is denoted by $\xi(0), \xi(c_f), \xi(\infty)$.

To calibrate the model we proceed in two steps. A first set of parameters can be calibrated without the need to solve the model. In a second step, and taking all other parameters as given, a set of parameters is chosen in order to match relevant moments from the Brazilian economy in 2003.[31] The first set contains the following parameters $\{\beta, \alpha, \gamma, \delta, r, \zeta, \rho, \tau, \kappa, \phi, \tau_w, \tau_f\}$. The second set includes the next six parameters $\{\mu_h, \sigma_h, \mu_l, \widehat{c_f}, \xi(0), \xi(c_f)\}$.

We assume that the discount factor $\beta = \frac{1}{1+r}$. We set r to 8.2 percent, the value observed for real money market rate in Brazil in 2003. The intermediation cost ζ is set to 5.58 percent to match the overhead cost over assets in year 2003. The capital share α is set to 1/3, a standard value, and the parameter that controls the degree of decreasing returns γ is set to 0.85, a value based on previous

[30] The number of grid points for z is set to 21.

[31] We select this year because it correspond to the last period before the reduction in credit costs started and also because it is the first year for which we have firm-level data.

estimates of the degree of decreasing returns to scale at the firm level. In particular, $\gamma = 0.85$ as in Restuccia and Rogerson (2008). The depreciation rate δ is set to 7 percent, also a standard value.

The tax structure and the cost of formalization parameters $\{\tau, \tau_w, \tau_f, \phi, \kappa\}$ are computed directly from the values reported in the *Doing Business* database for the Brazilian economy following the procedure explained in D'Erasmo and Moscoso Boedo (2012).[32] They are set as follows: the tax rate $\tau = 0.224$, and $\tau_w = 0.517$; the firing cost $\tau_f = 0.8846$; the bankruptcy cost $\phi = 0.09$; and the entry cost $\kappa = 0.739$.

The autocorrelation of the *high*-productivity process ρ is set to 0.78 as estimated by Ulyssea (2012) using the *Relação Anual de Informacões Sociais* (RAIS), an annual matched employer-employee data set collected by the Brazilian Ministry of Labor.[33] This dataset captures the universe of formal firms in Brazil. This is the same dataset we use to compute the moments of the firm-size distribution. The parameter is in the range of commonly estimated values in the literature.

Six parameters are left for the second step of the calibration process: the mean of the productivity process of the *high* and *low* projects μ_h and μ_l respectively, the volatility of the *high* productivity process σ_h, the operating cost $\widehat{c_f}$ and the associated probabilities $\{\xi(0), \xi(\widehat{c_f})\}$. To obtain values for these parameters, the following seven moments of the Brazilian economy are targeted: (i) the size of the formal labor force (46.16 percent), measured as those workers covered by a pension scheme as reported by Brazilian National Institute of Geography and Statistics (see Figure 6 in the data section); (ii) the average size of formal establishments in Brazil (10.8 workers) using data from RAIS (see Table 3); (iii) the average level of corporate credit to GDP computed using values reported in Catão, Pagés and Rosales (2009), equal to 15.19 percent, as shown in Figure 5; (iv) the average exit rate of formal firms (equal to 12.9 percent) computed by Ulyssea (2010) using data from RAIS ; (v) the average exit rate for "large" formal firms (i.e., formal firms with more than 20 workers), which equals 5 percent, as presented in Bartelsman, Haltiwanger and Scarpetta (2009); (vi) the average age of informal firms, which equals 8.84 years using data from ECINF reported in (Ulyssea, 2010).[34]

Identification of the model parameters is key to performing a sensitive quantitative exercise. In what follows, we explain our identification strategy. Since all the moments generated by the model are a function of all "deep" parameters, it is not possible to associate individual parameters with individual statistics. However, the numerical results suggest that particular moments are more informative for identifying particular parameters or set of parameters. First, the size of the informal sector is informative about μ_l since, everything else equal, this parameter determines the entry threshold to the formal sector and the size of the informal firm. Second, the average size of the formal firm is infor-

[32] We use data from the earliest year available (in most cases 2007). We note that, as one would expect from parameters that reflect institutions at the country level, there is almost no variation over time, so this does not generate an inconsistency with a calibration based on year 2003.

[33] Ulyssea (2012) estimated several values that range between 0.72 and 0.90, and we choose a value in the middle of this range.

[34] The full description of the moments and the sources can be found in the Data Appendix.

mative about μ_h since this parameter determines the average productivity for an incumbent formal firm. Third, the average corporate credit to GDP is informative of σ_h. If productivity is constant and no other shocks are present, firms have an incentive to borrow only until they reach their optimal size. As the volatility of productivity changes, firms' demand for credit is also affected. The demand for credit is a function of the price schedule firms face, and the dispersion of interest rates (a function of the dispersion of default probabilities) is tightly linked with the dispersion of firm productivity. Fourth, the average exit rate is informative of $\hat{c}_f$ since a non-trivial share of firms exit when receiving this shock, and that share is affected by changes in $\hat{c}_f$. Fifth, the average age of informal firms is informative of $\xi(0)$ since, in most cases, informal firms survive when $c_f = 0$ and the age of the firm is directly related to the probability of exit. In particular, it is possible to show that the average age of an informal firm is equal to $[1/\Pr(\text{survival informal})] = [1/\Pr(\text{exit informal})] \approx [1/(1-\xi(0))]$. Finally, the average exit rate of "large" firms is informative of $\xi(\widehat{c_f})$ since large firms exit only with probability $[1 - \xi(\widehat{c_f}) - \xi(0)]$.

The only parameter left to calibrate is the entry cost c_e. Once this parameter is set the equilibrium of the model can be computed (i.e., we can obtain the equilibrium wage w, the equilibrium mass of entrants M and the equilibrium schedule of prices $q^f(k', b', z)$ and $q^i(k', b')$ to clear the labor market, to satisfy the free entry condition and to satisfy the zero profit condition of financial intermediaries). However, since it is very hard to obtain information to identify the cost of entry, the calibration strategy follows the seminal work of Hopenhayn and Rogerson (1993). In particular, the wage rate is normalized to 1 and used to find the value of c_e that, in equilibrium, satisfies the free entry condition with equality. Note that this also implies deriving endogenously the equilibrium mass of entrants M and the menu of prices $q^f(k', b', z)$ and $q^i(k', b')$ that clear the labor market and satisfy the zero profit condition for financial intermediaries.

Table 4 presents the parameters of the model.[35]

Table 5 presents the targeted moments in the data and the model. Table 5 shows that the model approximates the targeted moments relatively well.

After the calibration exercise is done, we test the model in different dimensions. In particular, we ask how the distribution of operating establishments generated by the model compares with that of Brazil. We start with the distribution of firms in what is denominated the "micro-sector," i.e., firms with up to five employees. Data are from ECINF, which includes the universe of firms in the "micro-sector." Table 6 shows that the model approximates the "Micro-Sector" distribution considerably well. As in the data, most firms employ no workers or only one worker (80.59 percent in the model vs. 86.6 percent in the data). About 90 percent of firms in the "Micro Sector" in the model are informal (compared to 87 percent in the data). Since informal firms are very small, with 0 or 1 workers (both in the model and in the data), this results in the distribution observed in Table 6.

[35] The wage rate and the equilibrium mass of entrants are presented in Table 8 below. The equilibrium menu of prices is presented in Figure 7.

Table 4. Model Parameters

Parameter		Value	Target
Discount factor	β	0.93	$1/(1+r)$
Capital share	α	0.33	Capital Share Standard
Returns to scale	γ	0.85	Returns to Scale
Depreciation	δ	0.07	Capital Depreciation
Risk free rate	r	0.08	Real Interest Rate
Autocorrelation	ρ	0.92	Autocorrelation Prod. RAIS
Prof. Tax	τ	0.22	Profit Tax *Doing Business*
Labor Tax	τ_w	0.52	Labor Cost *Doing Business*
Firing Cost	τ_f	0.88	Firing Cost *Doing Business*
Bankruptcy Cost	ϕ	0.09	Bankruptcy Cost *Doing Business*
Formal Entry Cost	κ	0.74	Entry Cost *Doing Business*
Intermediation Cost	ζ	0.06	Overhead Cost Brazil
Entry Cost	c_e	1.03	Equilibrium Condition
Avg Productivity l process	μ_l	1.349	Size Formal Sector (46.16%)
Avg Productivity h process	μ_h	2.961	Avg. Size Formal Firm (11.69)
Dispersion h process	σ_h	0.048	Avg. Corporate Credit to GDP (15.19%)
Med. Fixed Cost (%)	$\hat{c}_f$	0.358	Avg. Exit Rate Formal Sector (12.9%)
Prob. Low Fixed Cost	$\xi(0)$	0.872	Avg. Age Informal Firms (8.84 years)
Prob. Med Fixed Cost	$\xi(\hat{c}_f)$	0.091	Exit Rate Large Formal Firms (5.0%)

Table 5. Targeted Moments

Moment	Data	Model
Size Formal Sector %	46.16	46.15
Avg Size Formal Firm	11.69	11.18
Avg. Corporate Credit to GDP %	15.20	16.80
Avg. Exit Rate Formal Sector	12.90	11.58
Avg. Age Informal Firms (in years)	8.84	7.69
Avg. exit rate “large” formal firms %	5.00	4.70

Table 6. "Micro-Sector" Firm Size Distribution

	Data %		Model %	
# of Workers	Frac. Firms	CDF	Frac. Firms	CDF
0	86.6	86.60	80.59	80.59
1	7.4	94.00	18.39	98.98
2−3	4.6	98.60	0.22	99.21
4−5	1.40	100.00	0.80	100.00

Note: "Micro-Sector" corresponds to firms with 5 or less employees. Source is ECINF survey, a representative cross-section of small firms (5 or less employees) collected at the national level.

We can now look at the distribution across the formal and informal sectors. Using data from RAIS and ECINF, Table 7 presents the distribution of firms conditional on whether firms operate in the formal or the informal sector.

The model does a good job of generating the right distributions of operating establishments in the formal and informal sector, with some caveats. In the formal sector, it generates the right number of establishments with less than nine employees, but misses at the very low end of the distribution (less than five employees) and at the very top (firms with more than 99 workers).[36] Table 7 shows that the model is right on target for the distribution of informal establishments.

As additional tests of the model, we show in Table 8 below that the model also captures the first and second moments of the distribution of corporate spreads. The average corporate spread in the model is 12.48 percent, versus 14.37 percent in the data. The cross-sectional standard deviation of corporate spreads in the model is 5.08 percent, compared to 7.96 percent in the data.

6 Experiment: Reducing the Cost of Credit

The objective of this paper is to analyze the effects of the reduction in credit costs on the size of the firm, the amount of credit in the economy and the level of formality. The experiment can be interpreted as a counterfactual experiment where we measure the effects of reducing r and ζ to the observed values in 2010 and measure the steady state to steady state effect. A summary of our experiment can be described as follows. First, we calibrated the model to the Brazil economy. In this case, we normalize $w = 1$ to then iterate on the set of loan prices $q_j^f(k', b', z)$ and $q^i(k', b')$ until lenders

[36] A different entry process into the formal sector can correct this problem. One alternative is to assume that firms receive a signal of their initial productivity before entering, as opposed to an initial draw from the productivity distribution. If the correlation of the signal and the initial productivity is lower than that used for the productivity process, firms that originally invested a large amount of capital can find themselves with low productivity and hiring a small amount of workers in the initial period. Another alternative is to assume that the demand for new firms depends on the time the firm has spent in the market. A final option is to incorporate a detection probability when firms are in the informal sector. When detected firms are forced to formalize, that would move a set of small firms to the formal sector, generating an increase in the 1-4 bin. The analysis of these alternatives is beyond the scope of this paper.

Table 7. Firm Size Distribution

Formal Size Distribution	Data %		Model %	
# of Workers	Frac. Firms	CDF	Frac. Firms	CDF
0-4	69.58	69.58	24.85	24.85
4−9	15.22	84.80	39.99	64.84
9 −19	8.06	92.86	32.09	96.93
19 −49	4.43	97.29	3.06	99.99
49 −99	1.36	98.64	0.01	100.00
99 −249	0.82	99.46	0.00	100.00
>249	0.54	100.00	0.00	100.00
Informal Size Distribution	Data %		Model %	
# of Workers	Frac. Firms	CDF	Frac. Firms	CDF
0	80.12	80.12	81.34	81.34
1	12.23	92.35	18.66	100.00
2−3	5.88	98.23	0.00	100.00
4−5	1.77	100.00	0.00	100.00

Note: Source of Formal Size Distribution is RAIS that collects information on all formally-registered ï¬rms. Source for Informal Size Distribution is ECINF survey a representative cross-section of small firms (5 or less employees) collected at the national level.

make zero profit on each contract and to find the mass of potential entrants M that clears the labor market and the value of entry cost c_e that satisfies the zero entry condition. Next, we adjust the credit market condition parameters r, ζ to the values observed in 2010 ($r = 4.7$ percent and $\zeta = 3.31$ percent, respectively), and iterate on the wage rate w and loan prices $q^f(k', b', z)$ and $q^i(k', b')$ until lenders make zero profits and the zero entry condition is satisfied (given c_e obtained in the benchmark economy). Finally, the mass of entrants M adjusts to clear the labor market. We start by presenting results on the most relevant aggregates to then explain the effects on the firm size distribution.

Table 8 presents how the main aggregates are changed from the benchmark to the equilibrium with lower costs of credit. As in the data, after a reduction in credit costs (i.e. $\{\downarrow r, \downarrow \zeta\}$), the model generates a rise in corporate credit to GDP and the size of the formal sector. Both the increase in credit to GDP and the size of the formal sector are larger than in the data. In particular, the increase in credit in the model is around 87.89 percent, whereas in the data it is 57.21 percent. Moreover, the increase in the formal labor force is 45.07 percent in the model, versus 19.95 percent observed in the data. One possible explanation for the overshoot is the fact that we are comparing steady state with steady state, whereas in the data firms might not expect the reduction in the cost of credit (and the implied size of credit to GDP and formal sector) to be permanent at the level observed in 2010.

Table 8. Aggregate Results Reducing the Cost of Credit

	Data %			Model %		
	2003	2010	Δ	Benchmark	$\{\downarrow r, \downarrow \zeta\}$	Δ
Corp. Credit to Output	15.19	23.88	57.21	16.80	31.57	87.89
Formal Labor Force	46.16	55.37	19.95	46.15	66.95	45.07
TFP	-	-	-	1.62	1.86	15.40
Output Per Worker	13.85	15.97	15.31	2.31	2.81	21.64
Capital Per Worker	36.37	37.85	4.07	2.95	3.46	17.32
Avg Spread (%)	14.37	12.93	-10.02	12.48	9.74	-21.96
Std. Dev Spread (%)	7.96	9.92	24.62	5.08	5.69	12.01
Avg Size Formal Firm	11.69	12.95	10.76	11.18	10.18	-8.94
Mass Entrants	-	-	-	0.12	0.10	-22.03
Wage rate w	-	-	-	1.00	1.12	12.03
Entry/Exit Rate Formal	12.9	-	-	11.58	13.89	19.95

Note: Output per worker and Capital per worker in the data computed from Penn World Table. Values in $1,000's$. In the case of these variables, only the change is comparable with the model counterpart due to the model normalization.

Table 8 also shows that the reduction in credit costs has important aggregate productivity effects. In order to compute total factor productivity in the model and the data, we follow the cross-country studies such as Klenow and Rodríguez-Clare (1997) or Hall and Jones (1999). They compute the following equation.

$$TFP = \frac{Y}{K^{\alpha} H^{(1-\alpha)}},$$

where Y denotes aggregate output, K denotes aggregate capital, H denotes some aggregate for labor (usually adjusted for human capital) and α is the capital share. We do exactly the same in the model, where aggregate output is the sum across both formal and informal establishments, aggregate capital is the sum of capital across establishments in both sectors and our aggregate measure of labor equals one. Aggregate productivity (TFP) in the model increases more than 15 percent. The increase in productivity generates an increase in output per worker of about 21.64 percent, and an increase of 17.32 percent is observed in capital per worker.

Once the costs of credit are reduced, the value of creating a firm increases, generating an increase in the entry rate (+ 19.95 percent). This results in an increase in the wage rate (12.03 percent). This is necessary to clear the labor market, since at the original wage rate aggregate demand for labor exceeds aggregate supply. The increase in wages, together with the reduction in credit costs, induces firms to substitute away from workers into capital. This results in the observed reduction in the average size of the formal firm in Brazil as opposed to the increase observed in the data. We note here that the experiment provides a counterfactual where the cost of credit is reduced using the benchmark

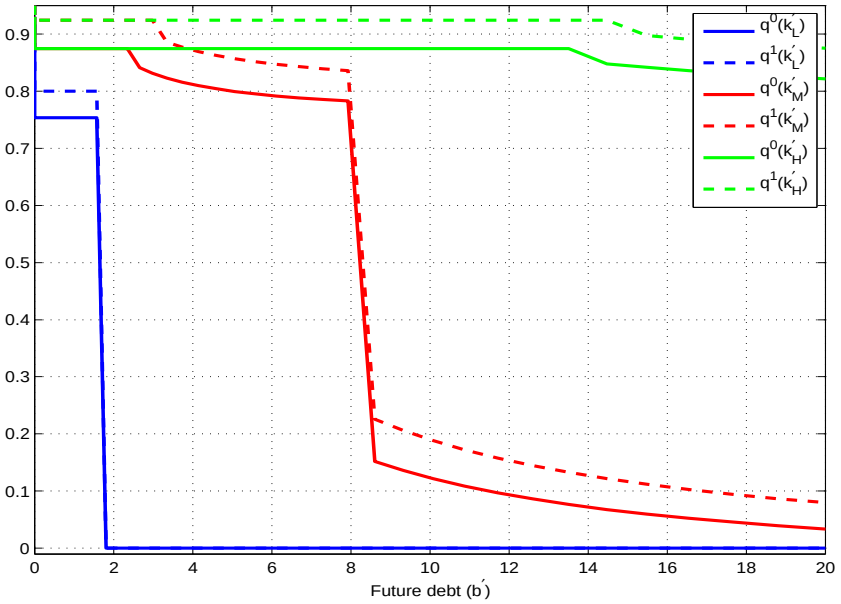
economy as starting point. In the data, other factors such as changes in trade costs and labor regulations (not studied in this paper) affected the size of the formal firm in Brazil. Moreover, there was a change in the way that RAIS data (our data for formal firms) were collected when comparing the year 2003 to 2010. More specifically, by the year 2006, reference companies and other organizations were classified according to version 1.0 of the NCEA (National Classification of Economic Activities). In 2007, with the objective of maintaining international comparability, and to equip the country with a classification of economic activities updated with the changes in the production system of the company, version 2.0 of the NCEA (National Classification of Economic Activities) went into effect. The methodology for identification of active units has also been completely redesigned from the reference year 2007 onwards. Unlike previous years, the new selection criteria take into consideration not only completing the declaration of RAIS and research base year, but also a range of other indicators of economic activity of the unit.

6.1 Firm-Level Effects

Changes in the cost for financial intermediaries have a first order effect on the prices that firms pay for borrowing. This translates into lower default probabilities that in turn reduce bond prices even further. This affects the firm size distribution mainly by three channels: first, it induces incumbent firms to hold a different composition of debt and capital. Second, it affects the entry and exit thresholds. By reducing the entry threshold (since the value of the firm is higher) it reduces the average productivity level of the entrant firm. However, higher entry also results in a higher level of competition and higher wages that translate into more exit. The latter effect also impacts the share of firms producing in the informal sector (those with lower productivity). This has an extra effect on labor demand and the level of efficiency in the economy. We start by describing the effect on prices to then present the effects on the distribution of debt, capital and labor. We then show how the entry threshold is affected to finally present the productivity composition in each economy.

Figure 7 presents the schedule of prices in the benchmark case (denoted by q^0) and the economy with lower r and ζ (denoted by q^1) as a function of b' for different levels of capital $k' \in \{k_L, k_M, k_H\}$ (i.e., k' taking a low, medium and high value from the equilibrium distribution). Bond prices are decreasing in debt levels and capital, since the default probability and the expected recovery for lenders is decreasing in debt and capital. The higher default probability is translated into higher interest rates. Importantly, this figure shows that bond prices are lower (i.e., interest rates are higher) in the benchmark economy than in the case with lower r and ζ for every combination of capital and debt levels. This effect allows firms to borrow more (as we will show below) in the case with lower r and ζ. As firms increase their borrowing level bond prices increase. However, as was noted in Table 8, the average spread decreases by 21.96 percent, so the effect of higher bond prices (everything else equal) dominates.

Figure 7. Bond Prices Formal Firm: Benchmark vs $\downarrow \{r, \zeta\}$



As Table 8 showed, when r and ζ are reduced there is an increase in the aggregate credit to output ratio of 87.89 percent. When bond prices are higher, the value of capital as a buffer stock against negative productivity shock is reduced (i.e., a lower precautionary motive). That is, firms can sustain lower levels of capital since it is cheaper to attain the optimal level of investment by borrowing in financial markets (this is also reflected in the lower average size of the formal firm). Figure 8 shows the distribution of the debt to capital ratio in both economies. This figure shows that debt to capital ratios are considerably lower in the benchmark economy. The median firm in the benchmark case has a debt to output ratio around 0 percent. On the other hand, the median firm in the economy with lower $\{r, \zeta\}$ sustains a debt to output ratio that is close to 35 percent.

Changes in portfolio composition also have important effects on the size of the firm (in terms of workers). Figure 9 shows the distribution of capital and labor in both economies. The shift in the distribution of capital (displayed in Panel (i)) together with the increase in wages (+12 percent) translates into reduction in labor demand for each firm (Panel (ii)). The median firm in the formal sector in the benchmark economy holds approximately 27 units of capital and hires nine workers in the benchmark case. The median firm in the counterfactual economy holds approximately 19 units of capital (a 29 percentreduction) and hires about six workers (a 30 percent reduction).

To take a closer look at the "Micro-Sector" (firms with 5 or less workers) that represents the largest share of firms in the economy, Table 9 displays how the distribution of firms for these type of firms is affected. Recall that the "Micro-Sector" includes formal and informal firms. Table 9 shows that there is an increase in the share of firms in the smallest bin (those with no workers) and also an

Figure 8. Dist. b/k Ratio: Benchmark vs $\downarrow \{r, \zeta\}$

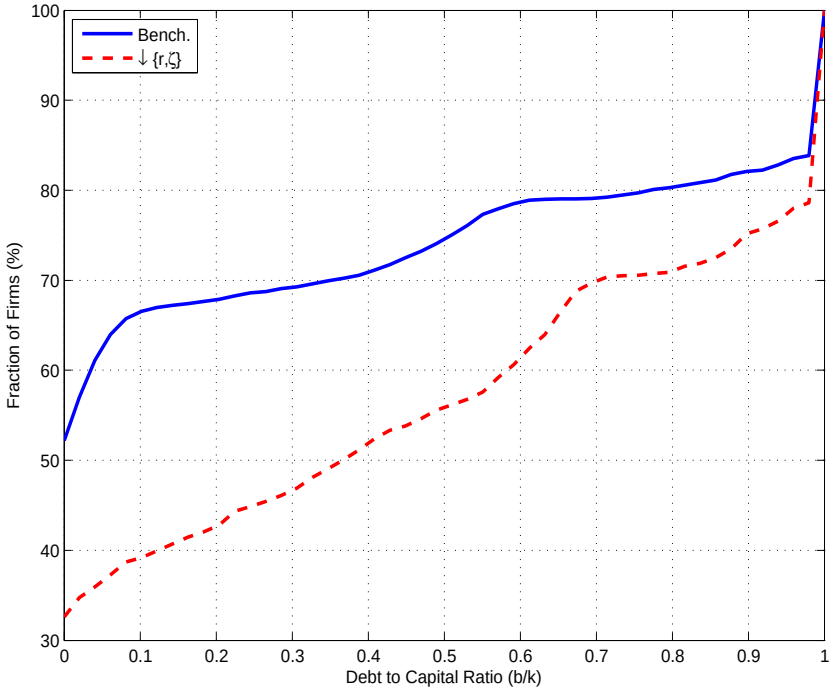


Figure 9. Dist. of Capital and Labor: Benchmark vs $\downarrow \{r, \zeta\}$

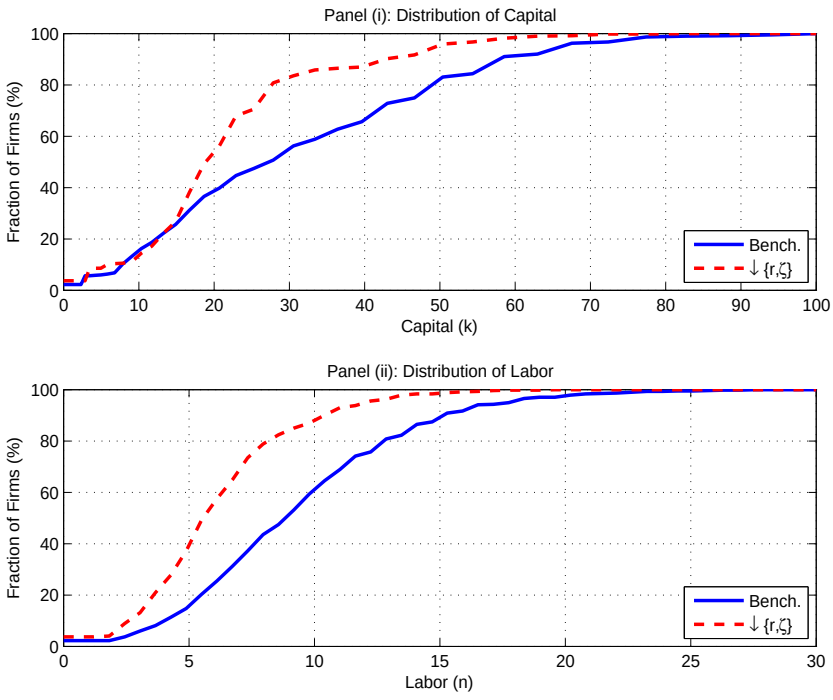


Table 9. "Micro-Sector" Size Distribution: Benchmark vs $\downarrow \{r, \zeta\}$

	Benchmark %		$\{\downarrow r, \downarrow \zeta\}$ %	
# of Workers	Frac. Firms	CDF	Frac. Firms	CDF
0	80.53	80.53	92.32	92.32
1	18.38	98.91	0.04	92.36
2−3	0.32	99.23	2.66	95.02
4−5	0.77	100.00	4.98	100.00

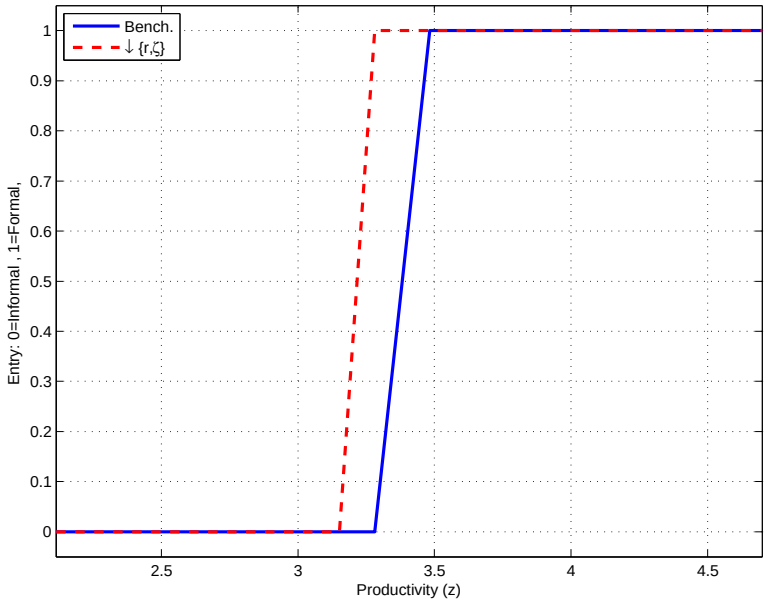
Table 10. Firm Size Distribution: Benchmark vs $\downarrow \{r, \zeta\}$

Formal Size Distribution	Benchmark %		$\{\downarrow r, \downarrow \zeta\}$ %	
# of Workers	Frac. Firms	CDF	Frac. Firms	CDF
0-4	24.85	24.85	35.67	35.67
4−9	39.99	64.84	58.61	94.28
9 −19	32.09	96.93	5.53	99.81
19 −49	3.06	99.99	0.19	100.00
49 −99	0.01	100.00	0.00	100.00
Informal Size Distribution	Benchmark %		$\{\downarrow r, \downarrow \zeta\}$ %	
# of Workers	Frac. Firms	CDF	Frac. Firms	CDF
0	81.34	81.34	100.00	100.00
1	18.66	100.00	0.00	100.00
2−3	0.00	100.00	0.00	100.00
4−5	0.00	100.00	0.00	100.00

important increase in the share of firms with four and five workers. The general equilibrium effect, which results in a larger wage, induces informal and formal firms to hire fewer workers. The increase in the smallest bin is mostly due to changes in the labor demand of informal firms. On the other hand, the change in the largest bin is due to changes in the labor demand of formal firms that were not included in the "Micro-Sector" before but are after the change in credit conditions.

To understand these results better, we now study the distribution of formal and informal firms individually. Table 10 presents the distribution of formal and informal firms. Table 10 shows that labor demand is affected in both the formal sector and the informal sector. In the formal sector, the share of firms in the $0-4$ worker and $4-9$ worker bins increases by approximately by 50 percent. The share of firms in other size bins are reduced with the largest reductions in the $9-19$ and $19-49$ bins. The increase in wages and the reduction in bond prices also impact the informal size distribution. Only very small firms remain active in this sector.

Figure 10. Entry Threshold: Benchmark vs $\downarrow \{r, \zeta\}$



6.1.1 Firm-Level Productivity

Changes in the cost of credit impact the firm size distribution via changes in both the entrant's and incumbent's level of productivity. Figure 10 presents the entry threshold to the formal sector (i.e., the value of z_0^* in each case as defined in the solution to the entrant's problem). Two factors affect the entry threshold in opposite directions. An increase in the wage rate reduces firm profitability increasing the threshold. The reduction in loan prices increases the value of the firm and the entry threshold moves down. As shown in Figure 10, the last factor dominates and results in an entry threshold to the formal sector that is 5.82 percent lower. This smaller entry threshold results in higher entry rates. The higher level of entry also results in higher exit rates, increasing the productivity level of incumbent firms (the "cleansing effect"). The effect of lower productivity of entrants is dominated by the "cleansing" effect, resulting in a shift to the right of the distribution of firm productivity. Figure 11 shows precisely the distribution of firm-level productivity in the formal sector in both economies. It is evident from Figure 11 that productivity in the formal sector increases after the reduction in credit costs. To understand the total effect on aggregate productivity (TFP) of reducing the cost of credit, we need to understand how production is allocated across firms of different productivity and incorporate the informal sector into the analysis. Figure 12 presents the distribution of aggregate production (for the entire economy) as a function of firm-level productivity.

Figure 12 shows that production is allocated more efficiently when credit costs are lower. The distribution of production shifts to the right when comparing the benchmark case versus the economy with lower $\{r, \zeta\}$. An important factor generating this result is the share of firms operating in the

Figure 11. Productivity Distribution Formal Sector: Benchmark vs $\downarrow \{r, \zeta\}$

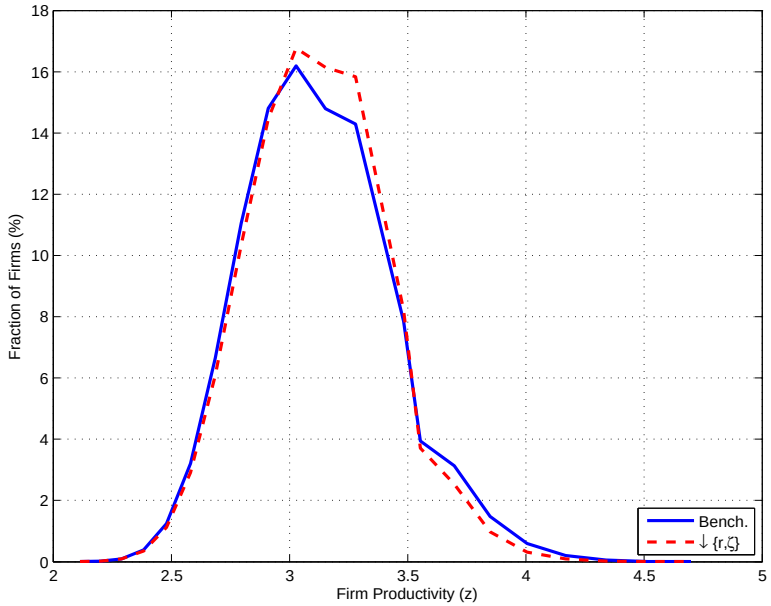


Figure 12. Distribution of Production (both sectors): Benchmark vs $\downarrow \{r, \zeta\}$

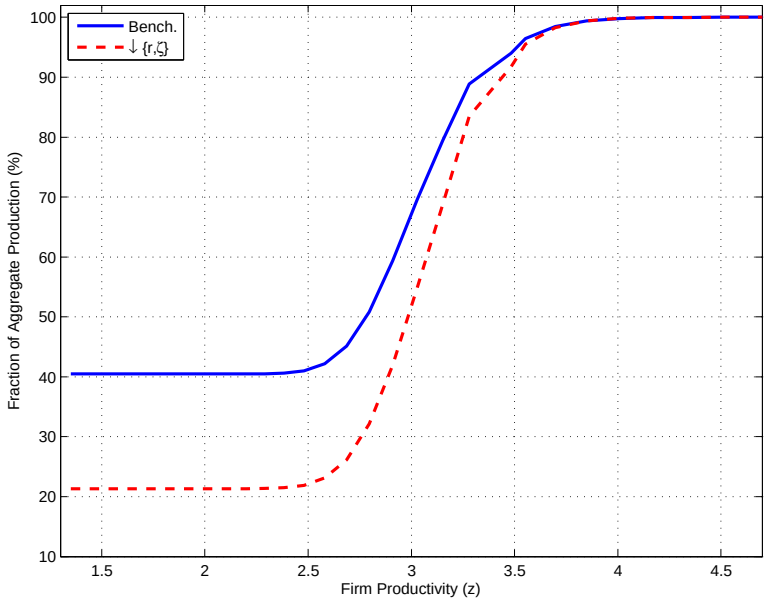


Table 11. Firm Productivity Decomposition

Group	$\widehat{z}$	Ω	$\overline{z}$	$cov(z_s, \omega_s^f)$
Benchmark	2.407	0.373	3.0908	0.035
$\downarrow \{r, \zeta\}$	2.771	0.213	3.0904	0.067

informal sector. The share of formal firms increases in the counterfactual economy by almost 37 percent. The reduction in productivity in the formal sector due to the lower entry threshold is more than compensated by this effect, increasing aggregate TFP.

To explore this effect even further we use a decomposition of weighted average plant-level productivity originally proposed by Olley and Pakes (1996), which has also been by, for example, Bartelsman, Haltiwanger and Scarpetta (2008):

$$\widehat{z} = \int z_s \omega_s ds = \Omega \mu_l + (1 - \Omega)[\overline{z} + cov(z_s, \omega_s^f)]$$

where $\widehat{z}$ is the average of plant level productivity weighted by output share, Ω is the informal share of output, ω_s are the output shares of each establishment, ω_s^f are the output shares of each establishment in the formal sector, and $\overline{z}$ is the un-weighted mean productivity in the formal sector. Therefore, output weighted productivity can be decomposed into three terms. First is the effect of informal activity given by Ω, and then the formal weighted productivity, which can be decomposed into the unweighted average of firm-level productivity plus a covariance between output share and productivity. The covariance captures allocative efficiency within the formal sector because it reflects the extent to which firms with higher-than-average productivity have a greater market share. Table 11 displays the values of this decomposition for both economies.

We observe that the value of output-weighted productivity correlates with our value of aggregate TFP. As the cost of credit decreases, the value of $\widehat{z}$ increases (+15 percent). This effect is generated by an important shift into the formal sector (the share of informal output decreases by 42 percent) and by a better allocation of resources in the formal sector (evidenced by the 91 percent increase in the $cov(z_s, \omega_s^f)$ term).

6.2 Decomposing the Effect of r and ζ

Our main quantitative experiment consisted of analyzing the effects of a joint reduction in r and ζ. If one takes Brazil as a small open economy, one can think of changes in r to be outside the set of factors the government can control and changes in ζ as being a function of government policies. For this reason, it is important to understand the source of the aggregate effects. We perform a counterfactual experiment where we change one parameter at a time and compare it to the final joint result. Table

Table 12. Decomposing the effects of r and ζ

	only $\{\downarrow \zeta\}$	only $\{\downarrow r\}$	$\{\downarrow r, \downarrow \zeta\}$
Corp. Credit to Output	1.98	1.31	1.88
Formal Labor Force	0.90	0.91	1.45
Output Per Worker	1.03	1.02	1.22
	1.03	1.02	1.17
TFP	1.02	1.01	1.15
Avg Spread (%)	1.13	0.67	0.78
	1.25	1.26	1.12
Avg Size Formal Firm	1.12	1.15	0.91
	1.17	1.12	0.78
Wage rate w	1.04	1.03	1.12
Entry/Exit Rate Formal	1.02	1.00	1.2

Note: Values are relative to benchmark case.

12 presents the results of these experiments. All values are reported as a share of the values in the benchmark economy.

Table 12 shows that most of the effect on the level of credit is coming from a reduction in ζ (the proportional cost of generating a loan). Reductions in the risk-free interest rate r generate an increase in credit that is only 1/3 of the overall effect.[37] The intuition can be found in equations (5) and (**??**). A change in ζ has a first order effect on prices q^f and q^i, while changes in r affect prices q^f and q^i weighted by the corresponding default probability. This is reflected in the observed average spread. The model generates a higher spread consistent with higher borrowing when only ζ changes, as opposed to a lower spread when r is lower.

Interestingly, we observe in Table 12 that there is an interaction effect between ζ and r that allows the model to generate the overall change in the size of the formal sector. When ζ and r change individually there is a reduction in the size of the formal sector. Both a lower ζ and a lower r are needed to make the model move in the direction observed in the data. We can understand this result by noting that informal firms also have access to credit (at prices q^i), and changes in ζ and r also change their menu of prices. When only one of the parameter changes, all firms have access to better credit terms and demand more workers (reflected in higher wages). The increase in the wage rate reduces the incentives to enter the formal sector, increasing the entry threshold, and this results in a smaller formal sector. This is also evident in the larger size of the formal firm when ζ and r change individually. When both ζ and r change together the effect of better credit terms dominates

[37] Recall that the percent change in ζ and r are approximately similar (44 percent and 37 percent, respectively), ζ goes from 5.58 percent to 3.31 percent and r goes from 7.5 percent to 4.7 percent.

the increase in the wage rate and the formal sector increases. Consistent with this, the change in the entry rate when both ζ and r change is larger than the sum of the individual changes.

7 Conclusion

This paper develops a firm dynamics model with endogenous formal and informal sectors to quantitatively evaluate how much of the change in corporate credit and the size of the formal sector can be attributed to an increase in the efficiency of the financial sector (measured as a reduction in the cost of funds for financial intermediaries and an increase in their efficiency in extending loans).

The quantitative exercise shows that, as a response to the changes in the financial sector, the model generates an increase in credit to GDP of 87.89 percent, paired with an increase in the size of the formal labor force of 45.07 percent. This is consistent with what was observed in the data for the same period in Brazil. The increase in the level of formalization and the better allocation of resources induce an increase in measured aggregate TFP of 15.40 percent and weighted firm-level productivity of 16 percent. To understand the overall results even further, we analyze the changes in the financial sector one by one. Interestingly, we find that most of the effect on the level of credit is coming from the increase in the level of efficiency of extending loans (as opposed to changes in their funding costs). Moreover, the experiments show that effects in terms of the size of the formal sector are not additive, since there is an important interaction effect between the level of efficiency and the cost of funds for intermediaries that allows the model to generate the overall change.

This model shows that changes in the cost of credit are important to generate an increase in the size of the formal sector, the amount of credit and aggregate productivity. One possible avenue for future research is the study of the optimal size and timing of the structural reforms affecting financial intermediaries. Moreover, important institutions that affect the cost of formality (such as the cost of entry and the level of taxes) interact with the cost of credit since they affect the incentives to enter and to exit by repayment or default. The extent to which changes in credit conditions are effective depends on whether these institutions are also reformed or not. The analysis of joint reforms is another interesting line for future research.

8 References

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9 Data Appendix

This section provides a description of the variables used in the paper and their sources. A set of files that contains every variable used in the paper and that can be made public accompanies this appendix. First, an Excel file Brazil_IDB_all_data.xls that contains all the aggregate variables (cost of credit, size of formal sector, credit data, institutions data, as well as the distribution of informal firms). Second, a second set of Stata files from RAIS (our sample of formal firms) in the file Brazil_RAIS_data.zip. Finally, the set of tables from ECINF (our sample of small firms that contains information on formal and informal firms) in the file Brasil_ECINF_tables.zip

The variables and its sources used are the following (a definition accompanies the data object when needed).

1. Net Interest Margin
    - Definition: Accounting value of bank's net interest revenue as a share of its interest-bearing (total earning) assets.
    - Source: Beck and Demirgüç-Kunt (2009).
    - Note: See World Bank's website for full data set.
2. Real Money Market Interest Rate
    - Definition: Interest Rates, Money Market Rate
    - Source: International Financial Statistics
    - Note: The nominal rate is converted to real using the consumer price index, also from IFS.
3. Bank Overhead Costs
    - Definition: Value of a bank's overhead costs as a share of its total assets.
    - Source: Beck and Demirgüç-Kunt (2009).
    - Note: See World Bank website for full data set.
4. Corporate loan interest rates (median, average, distribution)
    - Definition: Koan interest rate. Data spans all nationwide banking lending to individual firms above a minimum thresh-old of R$5,000. These data contain information on interest rates and respective lending amounts at the firm level.
    - Source: Central Bank of Brazil (BACEN).
    - Note 1: Micro Data not publicly available. Aggregates included in annex Excel file.
    - Note 2: The nominal rate is converted to real using the consumer price index.
5. Total domestic bank credit to GDP
    - Definition: Total Domestic Bank Credit
    - Source: Catão, Pagés and Rosales (2009) using data of Brazilian Planning Ministry Research Institute (ipeadata.gov.br)

6. Domestic Bank Credit to the corporate sector to GDP

    - Definition: Domestic Bank Credit to the corporate sector
    - Source: Catão, Pagés and Rosales (2009) using data of Brazilian Planning Ministry Research Institute (ipeadata.gov.br)

7. Formal Size Distribution

    - Source: RAIS *Relocao Anual de Informacoes Sociais*
    - Note 1: Compiled by the Brazilian Ministry of Labor, which requires by law that all formally registered firms report information each year on each worker employed by the firm.
    - Note 2: Micro data not available. We use aggregate tables reported in the IBGE website and summary statistics reported in cited papers. I provide a set of stata files and do files derived from aggregate tables that I used to compute the distribution of firms reported in the paper (see Brazil_RAIS_data.zip)
    - Note 3: Tables of interest (1996-2010) can be found in "Cadastro Central de Empresas" (Central Register of Enterprises, CEMPRE):
      http://www.sidra.ibge.gov.br/bda/pesquisas/cempre/default.asp
    - The Central Register of Enterprises (CEMPRE) is formed by companies and other organizations and their local units formally constituted, registered in the National Register of Legal Entities. The update occurs annually from the annual economic surveys of IBGE, in the areas of Industry, Trade, Construction and Services, and administrative records.

8. Informal Size Distribution

    - Source: ECINF survey (*Pesquisa de Economia Informal Urbana*)
    - Note 1: This data is a representative cross-section of small firms collected at the national level by the Brazilian Bureau of Statistics (IBGE) in 2003. ECINF samples households located in urban areas and seeks to identify the self-employed and employers with up to five employees in at least one work situation.
    - The ECINF offers extensive detail on the main firm and the entrepreneur characteristics of the micro-enterprises such as sector revenues, profits employment size, capital stock and time in business.
    - Note 2: IBGE does not provide access to the micro data but provides a large set of descriptive tables that can be found in
      http://www.ibge.gov.br/home/estatistica/economia/ecinf/2003/default.shtm under "Tabelas Completas."
    - Note 3: I provide the table with the distribution of informal firms in the Excel file that accompanies this appendix, and I also provide a zip file with the full set of tables (see Brazil_ECINF_tables.zip).

9. Measured Institutions: Taxes (profit and payroll), entry cost formal sector and firing costs

- *Entry Cost:* The cost of entering the formal sector corresponds to the reported "costs of registering a business and of dealing with licenses to operate a physical locale." It involves the cost of starting a Business measured in time and the cost of starting a business as a fraction of income per capita.[38] The estimate of the entry cost for Brazil is 0.739 of GNI per capita.
- *Taxes:* The tax rate paid on profits by the firms is taken from "Paying Taxes - Profit tax (%)" and the payroll tax corresponds to "Paying Taxes - Labor tax and contributions (%)." Because both tax rates are expressed as a function of profits, they need to be adjusted and the labor tax rate expressed as a function of payroll. To do that, the standardized balance sheet and income statements was used to construct the exercise, as explained in Table 1 of Djankov et al. (2010). The estimated values for Brazil are 22.4 percent and 51.65 percent, respectively.
- *Firing Costs:* The firing costs are obtained using information on the variable "Firing cost (weeks of wages)." A year corresponds to 52 weeks, so the estimated value of firing one worker equals 88 percent of the worker's annual wage.
- *Bankruptcy costs:* The efficiency of the system in the event of default is measured by the fraction of the asset value of the firm lost during bankruptcy. The cost of the system (ϕ), reported as a percentage of the estate's value, includes court fees and the cost of insolvency practitioners, such as legal and accounting fees. The estimated value for Brazil is 9 percent.
- Source: *Doing Business* dataset, World Bank. The complete data set can be found at http://www.doingbusiness.org/custom-query

[38] Following D'Erasmo and Moscoso Boedo (2012), the time cost is translated to monetary units by assuming that one worker has to be employed full time in order for the firm to go through the entry process.