Dispersion in Financing Costs and Development

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Very preliminary. Please do not circulate.

Abstract

We study how dispersion in financing costs and financial contract enforcement affect entrepreneurship, firm dynamics and economic development in an economy in which financial contracts are imperfectly enforced. We use employee-employer administrative linked data combined with data on financial transactions of all formal firms in Brazil to show how interest rate spreads vary with firm size, age and loan characteristics, such as loan size and loan maturity. We present a model of economic development based on a modified version of Buera, Kaboski, and Shin (2011) which are consistent with those facts and provide evidence on the effects of financial reforms on economic development. Eliminating dispersion in financing costs leads to more credit and higher output due to cheaper credit for productive agents with low assets. Moreover, abstracting from heterogeneity in interest rate spreads understates the impacts of financial reforms that improve the enforcement of credit contracts.

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1 Introduction

One of the striking features of the credit market is the sizable gap between lending and deposit rates. For instance, according to the International Financial Statistics, the average interest rate spread (lending minus deposit rate) is approximately 0.7 percent in Japan, 3 percent in the United States, 5 percent in Italy, 10 percent in Uruguay and 40 percent in Brazil. Banerjee (2003) also shows that there is extreme variability in the interest rate charged by lender for similar loan transactions within the same economy,[1] such that richer entrepreneurs borrow more and pay lower rates of interest. In Section 2, we use the Brazilian Public Credit Register[2] (CIS - Credit Information System, managed by Central Bank of Brazil) and combine it with Brazil's linked employer-employee administrative data set (RAIS - Relação Anual de Informações Sociais) to understand how loan interest rates and size vary depend on firm characteristics. We show that even controlling for loan type, loan maturity, a credit risk index and sectorial fixed effects and location fixed effects, the loan interest rate and the volume of credit vary considerably with firm characteristics, such as firm size and age. In particular, young and small firms pay higher loan interest rate than old and large firms. For instance, a firm with 300 employers will pay in interest rates approximately 3 percentage points less than a firm with 30 employers and 5.5 percentage points less than a firm with 3 employers, even controlling for loan size, loan maturity, firm age, sector of production and other characteristics.

In this paper, we investigate the effects of dispersion in the cost of financial intermediation on entrepreneurship, firm dynamics and economic development in an economy in which financial contracts are imperfectly enforced. We build a general equilibrium model with heterogeneous agents and endogenous occupational choice similar to the one of Buera, Kaboski, and Shin (2011). In each time period, agents can choose to be either workers or entrepreneurs, as in Lucas (1978). Agents are heterogenous in their ability as entrepreneurs and in each period they face a positive probability of drawing a new entrepreneurial ability from an invariant Pareto distribution. The occupational decision of the agents is also restricted by their initial wealth and two credit market frictions. First of all, financial intermediaries are competing

[1] See also Banerjee and Duflo (2010) and Gilchrist, Sim, and Zakrajsek (2013).

[2] This is a confidential loan level data set, which covers all the credit operations in Brazil since January 2004 and contains information on loan amount, loan type, loan maturity and interest rates.

to lend to each entrepreneur and their monitoring technology is decreasing in the entrepreneur's net worth, such that competition implies that loan interest rates will be decreasing in the entrepreneur's initial asset level. This endogenously generates a dispersion in the interest rate spread by firm size. In addition, there is limited enforcement of financial contracts and borrowers who renege their obligations face a cost proportional to their output net of wage payments. Then the capital of each entrepreneur depends on her net worth and project profitability. Therefore, both the loan size and the loan interest rate are jointly determined, which is a fact emphasized by Banerjee (2003).

We calibrate and estimate the model to be consistent with key firm level characteristics of the Brazilian economy, such as firm size, exit and entry rates. We also endogenously match the relationship between loan interest rate spread and firm size, as observed in the Brazilian micro level evidence. We then study how financial frictions affect firm dynamics, such as firm growth, entry and exit. In addition, we investigate the quantitative aggregate effects of the two financial frictions. We show that they produce very different aggregate effects. Enforcement of financial contracts has a larger aggregate impact on output (for a similar increase in the level of credit) than intermediation costs. This is because when the enforcement of financial contracts increases then entrepreneurs can borrow more for a given interest rate, and this affects mainly more productive entrepreneurs who are credit constrained and can now grow at a faster rate. When intermediation costs decrease, then this affects all entrepreneurs who are borrowing and those who can now borrow at a lower rate. This also increases production but the credit is not mainly allocated to the most productive entrepreneurs who are constrained.

This paper is related to a large literature on the effects of financial frictions on entrepreneurship and economic development, such as Antunes, Cavalcanti, and Villamil (2008), Banerjee and Moll (2010), Buera, Kaboski, and Shin (2011), Buera and Shin (2013), Erosa (2001), Greenwood, Sanchez, and Wang (2010), Midrigan and Xu (2014), Moll (2014), among others. We differ from these papers in these two following ways. First of all, most of the papers in this literature either consider only one type of financial friction or when there is a spread between the loan and the deposit rate such spread does not vary within the same economy. The only exception is Greenwood, Sanchez, and Wang (2010). They model the financial contract in detail and show how the monitoring technology can endogenously generate dispersion in interest

Table 1: Simple correlations. Source: RAIS and CIS.

	Loan	Spread	# Workers
Loan	1.0000		
Spread	-0.2790	1.0000	
# Workers	0.4078	-0.1425	1.0000

rates. However, they abstract from self-financing, which is a key feature in our modeling strategy. In addition, we use Brazilian administrative firm level data combined with data on financial transactions of firms to endogenously estimate model parameters that are consistent with firm dynamics and loan characteristics observed in the Brazilian economy.

2 Data

We use two main data sets in the empirical analysis. First, we use RAIS (Relação Anual de Informações Sociais)), which is a matched employer-employee data set. We observe the firm's sector, location, number of workers, wage bill and workers' characteristics. The data runs from 2005-2015. All the information is at the firm level and the firm is identified by its tax identifier, which makes it possible to link it to other data sets such and the CIS (Credit Information System), which is data from the Brazilian Central Bank (BCB). It covers all the credit operations since January 2004 and contains information on loan amount, loan type, loan maturity and interest rates, as well as a credit score for the firm given by the bank making the loan. Here we provide some very preliminary results. In this preliminary analysis we use only data for working capital loans for an unknown month within the 2012-2015 period. We have data on size (number of workers), wage bill, loan size and interest rate spread.

Table 1 presents simple correlations of three variables: loan size, interest rate spreads and firm size measured by the number of workers. We can observe that there is a negative correlation between firm size and loan interest rate spread.

Table 2 regresses the loan that the firm got versus its size and size squared. Column (1) reports the regression for the entire sample of firms. Column (2)

Table 2: Loans and firm size

	(1) loan	(2) loan	(3) ln_loan	(4) ln_loan
size	1519.0***	2756.7***	0.00490***	0.0386***
	(37.48)	(62.30)	(56.22)	(68.88)
size2	-0.107***	-5.821***	-0.000000454***	-0.000138***
	(-16.80)	(-21.06)	(-33.19)	(-39.53)
_cons	70782.2***	32085.8***	10.15***	9.729***
	(21.97)	(47.31)	(1464.46)	(1132.07)
N	48630	47767	48630	47767
R^2	0.032	0.174	0.063	0.132

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

uses a trimmed sample in which the top percentiles of size and loan are dropped. We notice that the relationship is increasing and concave: larger firms get bigger loans, but at a decreasing rate. Columns (3) and (4) repeat the exercises of (1) and (2) but use the logarithm of the loan size instead. The same type of pattern remains.

Table 3 reports the regression results of the interest rate spread the firm paid on its loan versus the firm size measured by the firm number of employees. Column (1) uses the entire sample. Column (2) restricts for those firms with spread lower than 100%. Column (3) drops firms from the top percentile of size. Columns (4) uses both restrictions: spread lower than 100% and trims the top percentile of firm size. Clearly, the loan interest rate spread is negatively related to firm size. If we use column (4), then a firm with 100 employers will pay an interest rate spread that will be approximately 16 percent lower than a firm with 10 employees.

Table 3: Spreads and firm size

	(1) spread_agg	(2) spread_agg	(3) spread_agg	(4) spread_agg
size	-0.0385***	-0.0208***	-0.410***	-0.165***
	(-21.06)	(-28.10)	(-33.33)	(-32.89)
size2	0.00000375***	0.00000197***	0.00156***	0.000533***
	(13.06)	(16.96)	(20.81)	(17.59)
_cons	37.88***	29.68***	42.21***	31.49***
	(260.36)	(487.52)	(218.76)	(389.64)
N	48630	45134	48143	44650
R^2	0.009	0.018	0.032	0.040

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3 The Model

3.1 Environment

The economy is populated by a continuum of infinitely lived individuals. Time is discrete and infinite ($t = 0, 1, 2, ...$). There is one good that can be used for consumption or investment. Agents can be workers or entrepreneurs.

3.1.1 Endowments

In each period individuals are endowed with initial wealth, a, and they can be either a worker or an entrepreneur. Entrepreneurs create jobs and manage their labor force, n. Each individual is endowed with a talent for managing, z, drawn from an invariant Pareto distribution function $\Gamma(z) = 1 - \left(\frac{z_m}{z}\right)^{\zeta}$ with $z \geq z_m$. With probability $\rho_z \in [0, 1]$ individuals keep the same talent from period t to period $t+1$, and with probability $1-\rho_z$, individuals will draw a new talent for managing from distribution $\Gamma(z)$. Agents accumulate assets and are distinguished by their assets and ability as entrepreneurs (a, z).

3.1.2 Preferences

Individuals derive utility from consumption, c_t, and preferences are represented by:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t u(c_t) \right], \tag{1}$$

where $\beta \in (0,1)$ is the subjective discount factor, and E_0 is the expectations operator conditional on information at $t = 0$. The period utility is assumed to take the following form:

$$u(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}, \ \sigma > 0. \tag{2}$$

3.1.3 Technology

Managers in the entrepreneurial sector operate a technology that uses labor, n, and capital, k, to produce a single consumption good, y, that is represented by

$$y = f(z; k, n) = z^{\theta}(k^{\alpha} n^{1-\alpha})^{1-\theta}, \quad \theta, \ \alpha \in (0,1). \tag{3}$$

Managers can operate only one project. Entrepreneurs finance part of their capital through their own assets, and part by borrowing from financial intermediaries. Entrepreneurs incur a fixed-cost χ to operate in every period.

Entrepreneurs face financial frictions. Agents have two options in which to invest their assets:

- Financial Intermediaries: Agents can competitively rent capital to financial intermediaries (banks) and earn an endogenously determined interest rate, r.
- Own business: Agents can use their own wealth as part of the amount required to operate a business. They might borrow the remaining capital they require from a bank at interest rate $\tilde{r}$.

3.2 Financial intermediaries

There is a continuum of financial intermediaries who are competing to lend to each entrepreneur. The cost of raising capital is r. There is a monitoring cost associated with making a loan $l = k - a$ for an entrepreneur who has collateral a. We denote this cost by

$$\phi(l, a) = \phi_0 l + \phi_1 \left(\frac{l}{a}\right), \quad \text{with} \quad \phi_0 \geq 0, \quad \text{and } \phi_1 \geq 0.$$

If the lender does not incur this cost, the borrower could break the financial contract without any cost; otherwise, borrowers will incur a cost, which is described below.

Since lenders compete for each loan, then:

$$\tilde{r}l = rl + \phi_0 l + \phi_1 \left(\frac{l}{a}\right) \implies \tilde{r}(a) = r + \phi_0 + \phi_1 \left(\frac{1}{a}\right). \tag{4}$$

The spread between the loan rate $\tilde{r}(a)$ and the deposit rate would be decreasing in the level of collateral, a.

There is a commitment and limited liability problem in the credit market. Borrowers cannot commit *ex-ante* to repay. Those who default on their debt incur a cost η proportional to the output produced net of labor costs.

Agents with sufficient resources and managerial ability to become entrepreneurs choose the level of capital and number of employees to maximize profit subject to a technological constraint and a credit market incentive constraint, i.e.,

$$\pi(a, z) = \max_{n,k \geq 0} z^{\theta}(k^{\alpha} n^{1-\alpha})^{1-\theta} - wn - \tilde{r}(a)(k - a) - ra - \chi, \tag{5}$$

subject to the credit market incentive constraint

$$\begin{aligned} z^{\theta}(k^{\alpha} n^{1-\alpha})^{1-\theta} - wn - \tilde{r}(a)(k - a) - ra - \chi \geq \\ (1 - \eta)(z^{\theta}(k^{\alpha} n^{1-\alpha})^{1-\theta} - wn) - ra - \chi. \end{aligned} \tag{6}$$

We can then rewrite the incentive compatibility constraint as:

$$k \leq a + \frac{\eta(z^{\theta}(k^{\alpha} n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}(a)}. \tag{7}$$

Both the loan size and the loan interest rate are jointly determined, which is a fact emphasized by Banerjee (2003). They are outcome variables which are jointly determined by primitive variables, such as the net worth of the borrower, the intermediation cost technology, and the financial friction related to a commitment and limited liability problem.

3.3 Optimal Decisions

Let $V^w(a,z)$ and $V^e(a,z)$ be the value for individual (a,z) to become a worker or an entrepreneur, respectively. The occupational choice of an individual (a,z) is described by the following value function

$$V(a,z) = \max\{V^w(a,z), V^e(a,z)\}. \tag{8}$$

This defines the policy function $o(a,z)$ such that $o(a,z) = 1$ if the individual becomes an entrepreneur and zero otherwise. The value function of being a worker is defined by the following Bellman equation:

$$V^w(a,z) = \max_{c,a' \geq 0}\{u(c) + \beta E_{z'}[V(a',z')|z]\}, \tag{9}$$

subject to

$$c + a' = w + (1 + r - \delta)a. \tag{10}$$

Analogously, the value of becoming an entrepreneur is given by:

$$V^e(a,z) = \max_{c,a' \geq 0}\{u(c) + \beta E_{z'}[V(a',z')|z]\}, \tag{11}$$

subject to

$$c + a' = \pi(a,z) + (1 + r - \delta)a. \tag{12}$$

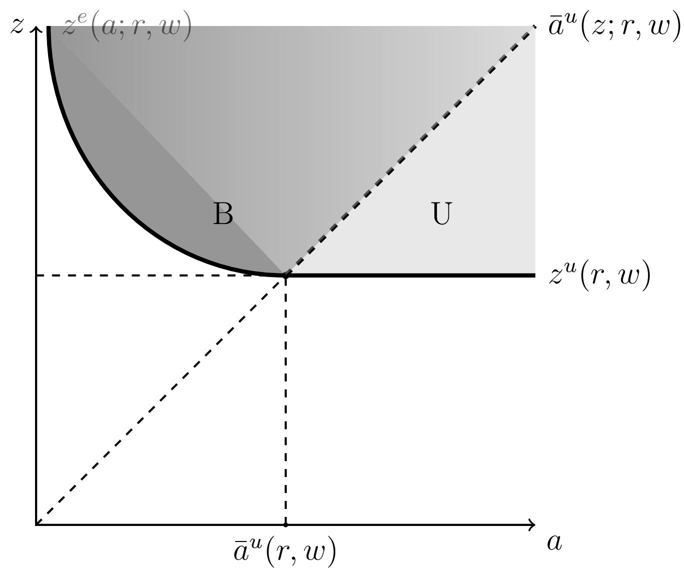
Figure 1 shows occupational choice in (z,a) space for this economy for a given wage rate and interest rate r and two levels of the enforcement variable η. Appendix A contains the formal proof of the two graphs presented in Figure 1. Figure 1 (a) shows the case of perfect enforcement, such that $\eta = 1$, but in which financial intermediation is still costly and there exists a positive spread rate $\tilde{r}(a) - r > 0$. The light gray shaded area (region U) displays the measure of agents who are unconstrained entrepreneurs, such that their initial wealth a is more than sufficient to operate a business such that their optimal capital stock is below their initial wealth, $k^u(z,r,w) \leq a$. Agents with entrepreneurial ability and wealth lying in this region produce at their optimal scale, and they all have the same marginal productivity of rented inputs employed in production. Among these entrepreneurs there is no misallocation of capital. Without any financial friction, all agents represented by a pair (z, a) lying above the dotted line $z^u(r, w)$ would become an entrepreneur producing at their optimal scale. But with costly intermediation this is not the case. The line defining the occupational choice is represented by the solid line $z^e(a; r, w)$. The dark gray shaded area (region B) represents the entrepreneurs who are borrowers. They are paying different loan interest rates, depending on their initial net worth a. Consequently, they produce at very different levels of marginal productivity of capital. Agents with a pair (z, a) close to the dotted line $\bar{a}^u(r, w, z)$ are borrowing less and have a marginal productivity of capital that is close to the rental price of capital. Agents far from this line are borrowing more and producing at a higher marginal productivity of capital. Notice that intermediation costs affect not only the misallocation of capital at the intensive margin, but they also affect the allocation of talent since agents with a pair (z, a) such that $z^u(r, w) \leq z \leq z^e(a; r, w)$ do not become entrepreneurs due to such costs.

Figure 1 (b) displays the case in which the enforcement of financial contracts are imperfect, such that $\eta < 1$. Region U still represents the measure of unconstrained entrepreneurs. Region B corresponds to entrepreneurs who are borrowers. Agents with a pair (z, a) in region B which is close to the dotted line $\bar{a}^u(z; r, w)$ are unconstrained borrowers such that the incentive compatible constraint of financial contracts is not biding. Such agents produce with a marginal productivity of capital similar to the loan rate, which varies with their initial net worth. As we get closer to the solid line $z^e(a; r, w)$, then the incentive compatible constraint binds and entrepreneurs will be producing with a marginal productivity of capital that is above the loan rate they face. Imperfect enforcement of financial contracts affect also the allocation of talent, since the line $z^e(a; r, w)$ becomes steeper when this constraint starts to bind at $\bar{a}^c(r, w)$, and the measure of entrepreneurs decrease.

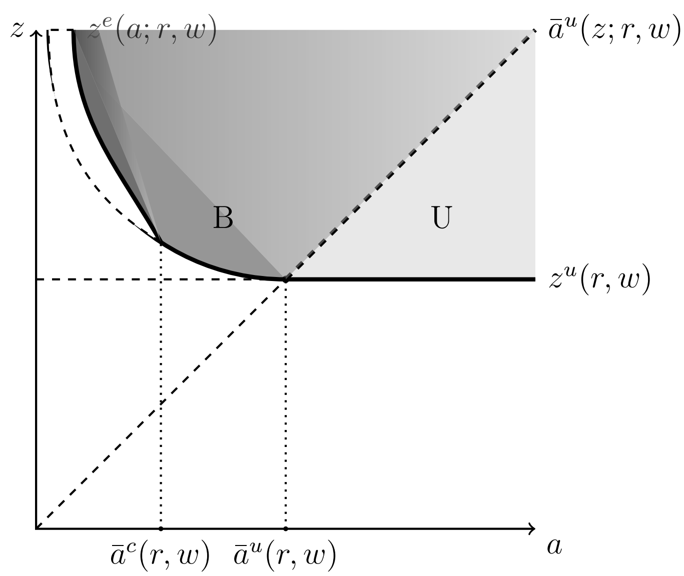
3.4 Competitive equilibrium

Let $H(a, z)$ denotes the joint endogenous distribution of wealth a and entrepreneurial ability z. We will now characterize the recursive stationary competitive equilibrium. Given prices, w and r, individuals' policy rules for occupational choice $o(a, z)$, consumption $c(a, z)$, and assets $a'(a, z)$ are associated to optimal value function $V(a, z)$. Similarly, given prices entrepreneurs will choose labor $n(a, z)$, and capital input, $k(a, z)$ to maximize profits subject to the technology and enforcement constraints. The output of each entrepreneur is denoted by $y(a, z)$. Financial intermediaries maximise prof-

Figure 1: Light gray shaded area shows the measure of agents who are unconstrained entrepreneurs. Dark gray shaded area shows the measure of agents who are not constrained borrowers. The white area below the curve $z^e(a;r,w)$ represents the measure of agents who are workers.



(a) Full enforcement, $\eta = 1$.



(b) Imperfect enforcement, $\eta < 1$.

its. They compete to each loan such that the loan rate is given by $\tilde{r}(k-a,a)$. We also have that all markets clear, such that

$$K = \int k(a,z)o(a,z)H(da,dz) = \int aH(da,dz), \quad (13)$$

$$\int n(a,z)o(a,z)H(da,dz) = \int (1-o(a,z))H(da,dz), \quad (14)$$

$$\int c(a,z)H(da,dz) + \delta K = \int y(a,z)o(a,z)H(da,dz). \quad (15)$$

Finally, the joint distribution of assets and entrepreneurial ability, $H(a,z)$, is stationary:

$$H(a,z) = \rho_z \int_{\{(\tilde{a},\tilde{z})|a'(\tilde{a},\tilde{z})<a,\tilde{z}<z\}} H(d\tilde{a},d\tilde{z}) + (1-\rho_z) \int_{\{(\tilde{a},\tilde{z})|a'(\tilde{a},\tilde{z})<a\}} \Gamma(z)H(d\tilde{a},d\tilde{z}). \quad (16)$$

4 Quantitative Analysis

In order to solve the model numerically, we must assign values to the model parameters. The model period is set to 1 year. There are ten structural parameters to discipline. A full calibration targeting Brazilian data has not been implemented yet. For now, the parameters are set to usual values:

- Preferences: the discount factor β is set to 0.96 and the coefficient of relative risk aversion σ to 2, standard values in the literature.
- Technology: the Cobb-Douglas parameter α (the exponent of capital) is set to $1/3$; the depreciation rate δ is set to 0.05, which corresponds to 5% per year. The span of control parameter θ is set to 0.1.
- Stochastic process: the distribution of productivity shocks is characterized by two parameters: ρ and ζ. These are taken from Buera, Kaboski, and Shin (2011) such that $\rho = 0.85$ and $\zeta = 4.15$.
- Financial sector: the monitoring cost function has two parameters: ϕ_0 controls the mean spread and ϕ_1 controls the dispersion with the borrower's assets. Set ϕ_0 to 0 in the benchmark. The parameter ϕ_1 will be a free parameter in the benchmark exercise. The enforcement constraint is characterized by the parameter η, which will be another free parameter.

Table 4: Benchmark and Improved Financial Sector

	Benchmark	$\phi_1 = 0$	$\eta \uparrow$
% Entrepreneurs	25.8	29.3	19.2
GDP	1.00	1.25	1.34
Credit/GDP	0.542	1.99	1.98
Average Spread	3.41	0.0	3.46
Max Spread	5.12	0.0	5.44
Min Spread	3.0	0.0	3.0
Average Leverage	0.44	2.32	2.88
Average Firm Size	2.80	2.33	4.34
Max/Min Firm Size	2.83	1.97	2.28
Wage	1.00	1.32	1.16

The wage w is determined to clear the labor market in equilibrium. As for the interest rate r, we assume that this is a small open economy and set $r = 0.02$.

Selected moments for the benchmark economy are reported in Table 4. Around one quarter of the individuals in the economy consists of entrepreneurs. The Credit/GDP ratio is 0.54. The average spread paid by entrepreneurs that borrow is 3.41%. Some entrepreneurs, however, pay considerably more for their credit as the maximum spread is higher than 5%. The average leverage ratio stands at 0.44. In this example economy, firms are heterogenous in size, but modestly so: the largest firm has 2.8 times more employees than the smallest firm.

Now, consider running the following thought experiment. Suppose there is no monitoring costs to financial intermediaries. To operationalize this, set $\phi_0 = \phi_1 = 0$. In this world, the interest rate for credit operation will equal the deposit rate and the spread will thus be equal to 0. The results for this economy are reported in the second column of Table 4. First, note that GDP increases by 25%. More individuals choose to be entrepreneurs and their share rises to 29.3%. Without monitoring costs, credit is cheaper for all those who choose to be entrepreneurs. With cheaper financing, the Credit/GDP ratio increases to almost 2, which represents approximately 3.7 times the benchmark value. Accordingly, leverage increases 5-fold. Average firm size declines somewhat as cheaper credit helps smaller firms more. Large firms tend to have a high level of assets and thus already paid low spreads in the benchmark economy.

There is one more parameter that affects credit in this economy: the enforcement parameter η, which controls the collateral constraint. So, consider improving the enforcement technology; i.e. increasing η. To make the experiments comparable, we engineer a rise in η such that the Credit/GDP ratio is the same as in the zero-spread economy: 1.98. The results for this experiment are reported in the third column of Table 4. First, GDP increases by even more than in the previous exercise and is now 34% higher than in the benchmark economy. One difference is that the share of entrepreneurs decreases. The average spread increases slightly and the maximum spread also rises. This experiment helps particularly high productivity agents that have low level of assets. The average size of firms increase relatively to the benchmark.

One more thing to note regarding both counterfactuals in Table 4 is that the wage increases relative to the benchmark. As financing is cheaper in both alternative scenarios, with a constant wage, more agents would choose to become entrepreneurs. In order to guarantee that the labor market clears, the wage must rise to incentivize some agents to choose to be workers.

Another alternative scenario is to consider a world in which the spread is positive, but is constant across all borrowers. In order to implement this, set $\phi_1 = 0$ and $\phi_0 > 0$. In order to make this counterfactual comparable to the benchmark, set $\phi_0 = 0.0341$, the average spread in the benchmark economy. That is, all borrowers will pay a spread of 3.41%, regardless of their leverage. The results for this experiment are reported in the second column of Table 5. GDP is 4% higher than in the economy with dispersion in financing costs. Note that the share of entrepreneurs increases slightly and so does the Credit/GDP ratio. Though the average spread is the same, by construction, firms that were paying higher prices for credit now have access to cheaper financing. This is particularly important for high productivity and low asset agents. Leverage then goes up.

In the previous scenario, though the spreads were kept at the same level as in the benchmark economy, credit was more abundant in the economy. An alternative counterfactual is to set a constant level for the spread that is consistent with the same Credit/GDP ratio as in the benchmark economy. This is done in Table 6. First note that output declines slightly. This happens because credit is more expensive now. Note, however, that the maximum spread paid in this economy is still a bit lower than in the benchmark. This leads some high productivity and low asset agents to become entrepreneurs,

Table 5: Benchmark and Constant (Fixed) Spread

	Benchmark	$\phi_1 = 0$ and $\phi_0 > 0$
% Entrepreneurs	25.8	27.3
GDP	1.00	1.04
Credit/GDP	0.542	0.74
Average Spread	3.41	3.41
Max Spread	5.12	3.41
Min Spread	3.0	3.41
Average Leverage	0.44	0.69
Average Firm Size	2.80	2.61
Max/Min Firm Size	2.83	2.00
Wage	1.00	1.04

which leads their share to increase slightly. Again, in order to guarantee that the labor market clears, the wage rate rises.

We can also improve the enforcement technology using this economy as a new benchmark. This is done in Table 7. For comparison purposes, we engineer a hike in η to generate the same rise in the Credit/GDP ratio found in the similar exercise reported in Table 4. Though not reported, the parameter η had to be increased further in this experiment in order to generate the same rise in Credit/GDP. In this experiment, output rises (but less so than in the experiment with dispersion in financing costs). The share of entrepreneurs declines, but less so than in the experiments with varying spreads.

5 Conclusion

In this paper, we investigate the effects of dispersion in the cost of financial intermediation on entrepreneurship, firm dynamics and economic development in an economy in which financial contracts are imperfectly enforced. We calibrate and estimate the model to be consistent with key firm level characteristics of the Brazilian economy, such as firm size, exit and entry rates. We then study how financial frictions affect firm dynamics, such as firm growth, entry and exit. In addition, we investigate the quantitative aggregate effects of the two financial frictions. We show that they produce very different aggregate effects. Enforcement of financial contracts has a larger

Table 6: Benchmark and Constant (Higher) Spread

	Benchmark	$\phi_1 = 0$ and $\phi_0 > 0$
% Entrepreneurs	25.8	26.7
GDP	1.00	0.98
Credit/GDP	0.542	0.543
Average Spread	3.41	4.61
Max Spread	5.12	4.61
Min Spread	3.0	4.61
Average Leverage	0.44	0.50
Average Firm Size	2.80	2.60
Max/Min Firm Size	2.83	2.24
Wage	1.00	1.02

Table 7: Constant Spread and Better Enforcement

	$\phi_1 = 0$ and $\phi_0 > 0$	Higher η
% Entrepreneurs	26.7	22.6
GDP	0.98	1.27
Credit/GDP	0.543	1.98
Average Spread	4.61	4.61
Max Spread	4.61	4.61
Min Spread	4.61	4.61
Average Leverage	0.50	3.62
Average Firm Size	2.60	3.33
Max/Min Firm Size	2.24	2.01
Wage	1.02	1.19

aggregate impact on output (for a similar increase in the level of credit) than intermediation costs. This is because when the enforcement of financial contracts increases then entrepreneurs can borrow more for a given interest rate, and this affects mainly more productive entrepreneurs who are credit constrained and can now grow faster. When intermediation costs decrease, then this affects all entrepreneur who are borrowing and those who can now borrow at a lower rate. This also increases production but the credit is not mainly allocated to the most productive entrepreneurs who are constrained.

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A Mathematical Appendix

Consider the problem of an entrepreneur (a, z). Let $d \leq a$ be the amount of assets entrepreneurs use in their business, and let l be loans, such that $k = d + l$. Clearly, since $\tilde{r} > r$ for all finite a, then if $l > 0$, then $d = a$. The problem of the entrepreneur can be rewritten as

$$\pi(a, z) = \max_{n,d,l \geq 0} z^{\theta}((d+l)^{\alpha} n^{1-\alpha})^{1-\theta} - wn - \tilde{r}l - rd - \chi, \tag{17}$$

subject to

$$l \leq \frac{\eta(z^{\theta}((d+l)^{\alpha} n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}(a)}, \quad \text{with} \quad \tilde{r} = r + \phi_0 + \frac{\phi_1}{a}, \tag{18}$$

$$d \leq a. \tag{19}$$

The Lagrangean associated to this problem is:

$$L = z^{\theta}((d+l)^{\alpha} n^{1-\alpha})^{1-\theta} - wn - \tilde{r}l - rd - \chi + \lambda[\frac{\eta(z^{\theta}((d+l)^{\alpha} n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}} - l] + \mu[a-d]$$

The Kuhn-Tucker conditions are:

$$\frac{\partial L}{\partial n} = \left((1-\theta)(1-\alpha)\frac{y}{n} - w\right)\left(1 + \lambda\frac{\eta}{\tilde{r}}\right) \leq 0, \; n \geq 0, \; \frac{\partial L}{\partial n} n = 0, \tag{20}$$

$$\frac{\partial L}{\partial d} = (1-\theta)\alpha\frac{y}{k}\left(1 + \lambda\frac{\eta}{\tilde{r}}\right) - r - \mu \leq 0, \; d \geq 0, \; \frac{\partial L}{\partial d} d = 0, \tag{21}$$

$$\frac{\partial L}{\partial l} = (1-\theta)\alpha\frac{y}{k}\left(1 + \lambda\frac{\eta}{\tilde{r}}\right) - \tilde{r} - \lambda \leq 0, \; l \geq 0, \; \frac{\partial L}{\partial l} l = 0, \tag{22}$$

$$\mu[a-d] = 0, \tag{23}$$

$$\lambda[\frac{\eta(z^{\theta}((d+l)^{\alpha} n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}} - l] = 0. \tag{24}$$

Case 1: If $0 < d < a$, then $\mu = 0$ and $\lambda = 0$. Therefore:

$$(1-\theta)(1-\alpha)\frac{y}{n} = w, \; (1-\theta)\alpha\frac{y}{k} = r, \quad \text{and} \quad (1-\theta)\alpha\frac{y}{k} < \tilde{r}.$$

It can be shown that

$$k^u(r, w; z) = z\left((1-\theta)\left(\frac{\alpha}{r}\right)^{1-(1-\alpha)(1-\theta)}\left(\frac{1-\alpha}{w}\right)^{(1-\alpha)(1-\theta)}\right)^{\frac{1}{\theta}},$$

$$n^u(r,w;z) = z\left((1-\theta)\left(\frac{\alpha}{r}\right)^{\alpha(1-\theta)}\left(\frac{1-\alpha}{w}\right)^{1-\alpha(1-\theta)}\right)^{\frac{1}{\theta}},$$

$$y^u(r,w;z) = z\left((1-\theta)\left(\frac{\alpha}{r}\right)^{\alpha}\left(\frac{1-\alpha}{w}\right)^{1-\alpha}\right)^{\frac{1-\theta}{\theta}},$$

and

$$\pi^u(r,w;z) = \theta y^u(r,w;z) - \chi.$$

Therefore, $\pi^u(r,w;z) \geq w$ defines a treshold ability level $z^u(r,w)$ given by

$$z^u(r,w) = \left(\frac{w+\chi}{\theta}\right)\left(\frac{1}{(1-\theta)}\left(\frac{r}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha}\right)^{\frac{1-\theta}{\theta}},$$

such that for all agents with $k^u(r,w;z) < a$, and $z \geq z^u(r,w)$ agents are entrepreneurs. Notice that $z^u(r,w)$ is independent of a. Since $k^u(r,w;z)$ is linear related to z, we can define $\bar{a}^u(r,w,z)$ and all agents with $z > z^u(r,w)$ and $a > \bar{a}^u(r,w)$ are unconstrained entrepreneurs.

Case 2: If $d = a > 0$ and $l = 0$, then $\mu > 0$ and $\lambda = 0$. Consequently:

$$(1-\theta)(1-\alpha)\frac{y}{n} = w,\ (1-\theta)\alpha\frac{y}{k} = r+\mu, \text{ and } (1-\theta)\alpha\frac{y}{k} < \tilde{r}.$$

It can be shown that

$$k^{nb}(r,w;z) = a,$$

$$n^{nb}(r,w;z) = \left(z^{\theta}(1-\theta)\frac{(1-\alpha)}{w}a^{\alpha(1-\theta)}\right)^{\frac{1}{1-(1-\alpha)(1-\theta)}},$$

$$y^{nb}(r,w;z,a) = z^{\theta}\left(a^{\alpha}\left(z^{\theta}(1-\theta)\frac{(1-\alpha)}{w}a^{\alpha(1-\theta)}\right)^{\frac{1-\alpha}{1-(1-\alpha)(1-\theta)}}\right)^{1-\theta},$$

and

$$\pi^{nb}(r,w;z,a) = (1-(1-\alpha)(1-\theta))y^c(\tilde{r},w;z,a) - ra - \chi.$$

Condition $\pi^{nb}(r,w;z) \geq w$ defines a treshold ability level $z^b(\tilde{r},w;a)$ given by

$$z^{nb}(r,w,a) = \left(\frac{w+\chi+ra}{1-(1-\alpha)(1-\theta)}\right)^{\frac{1-(1-\alpha)(1-\theta)}{\theta}}\left(\frac{1}{(1-\theta)}\frac{w}{1-\alpha}\right)^{\frac{(1-\alpha)(1-\theta)}{\theta}}\frac{1}{a^{\frac{\alpha(1-\theta)}{\theta}}},$$

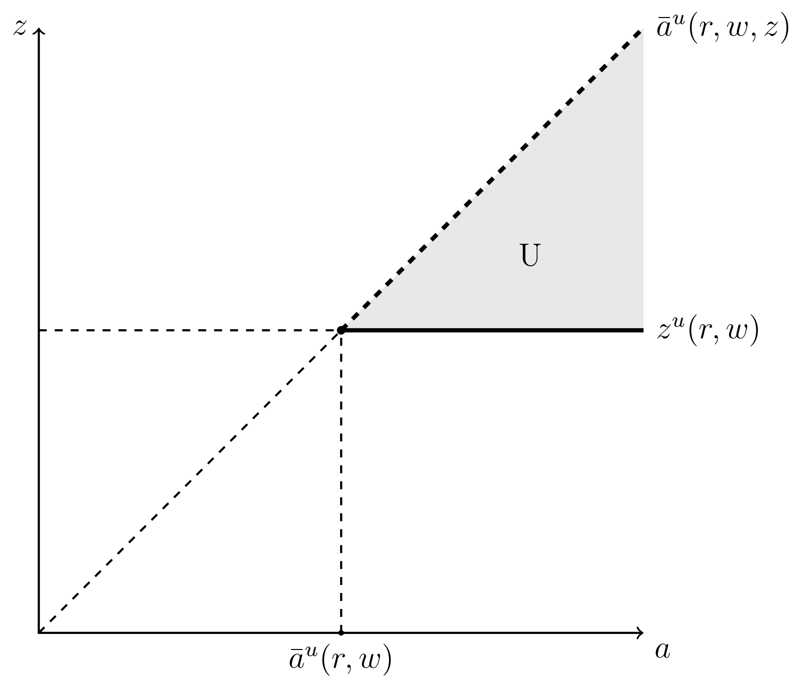

Figure 2: Case 1: $k^u(r, w) \leq a$. Light gray shaded area shows the measure of agents who are unconstrained entrepreneurs.

such that for all agents with $k^{nb}(r,w;z) = a$, and $z \geq z^{nb}(r,w,a)$ agents are entrepreneurs. Observe that $\lim_{a\to 0} z^{nb}(r,w,a) = \infty$. It can be shown that

$$sign\left(\frac{\partial z^{nb}(r,w,a)}{\partial a}\right) = sign\left(\theta r a - \alpha(1-\theta)(w+\chi)\right).$$

Notice that since $(1-\theta)\alpha\frac{y}{a} = r + \mu$, then

$$sign\left(\frac{\partial z^{nb}(r,w,a)}{\partial a}\right) = sign\left(-\mu a\right).$$

This is negative, as long as $\mu > 0$. Therefore as $a \to \bar{a}^u(r,w)$, then $z^{nb}(r,w,a) \to z^b(r,w)$.

Case 3: If $d = a > 0$ and $0 < l < \frac{\eta(z^\theta((a+l)^\alpha n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}}$, then $\mu > 0$ and $\lambda = 0$. Consequently:

$$(1-\theta)(1-\alpha)\frac{y}{n} = w,\ (1-\theta)\alpha\frac{y}{k} = r + \mu, \quad \text{and} \quad (1-\theta)\alpha\frac{y}{k} = \tilde{r}.$$

It can be shown that

$$k^b(\tilde{r},w;z) = z\left((1-\theta)\left(\frac{\alpha}{\tilde{r}}\right)^{1-(1-\alpha)(1-\theta)}\left(\frac{1-\alpha}{w}\right)^{(1-\alpha)(1-\theta)}\right)^{\frac{1}{\theta}},$$

$$n^b(\tilde{r},w;z) = z\left((1-\theta)\left(\frac{\alpha}{\tilde{r}}\right)^{\alpha(1-\theta)}\left(\frac{1-\alpha}{w}\right)^{1-\alpha(1-\theta)}\right)^{\frac{1}{\theta}},$$

$$y^b(\tilde{r},w;z) = z\left((1-\theta)\left(\frac{\alpha}{\tilde{r}}\right)^{\alpha}\left(\frac{1-\alpha}{w}\right)^{1-\alpha}\right)^{\frac{1-\theta}{\theta}},$$

and

$$\pi^b(\tilde{r},w;z) = \theta y^b(\tilde{r},w;z) + (\tilde{r} - r)a - \chi.$$

Therefore, given that $\tilde{r} = r + \phi_0 + \frac{\phi_1}{a}$, the inequality $\pi^b(\tilde{r},w;z) \geq w$ defines an ability level $z^b(\tilde{r},w;a)$ given by

$$z^b(r,w,a) = \left(\frac{w+\chi-\phi_0 a-\phi_1}{\theta}\right)\left(\frac{1}{(1-\theta)}\left(\frac{r+\phi_0+\frac{\phi_1}{a}}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha}\right)^{\frac{1-\theta}{\theta}},$$

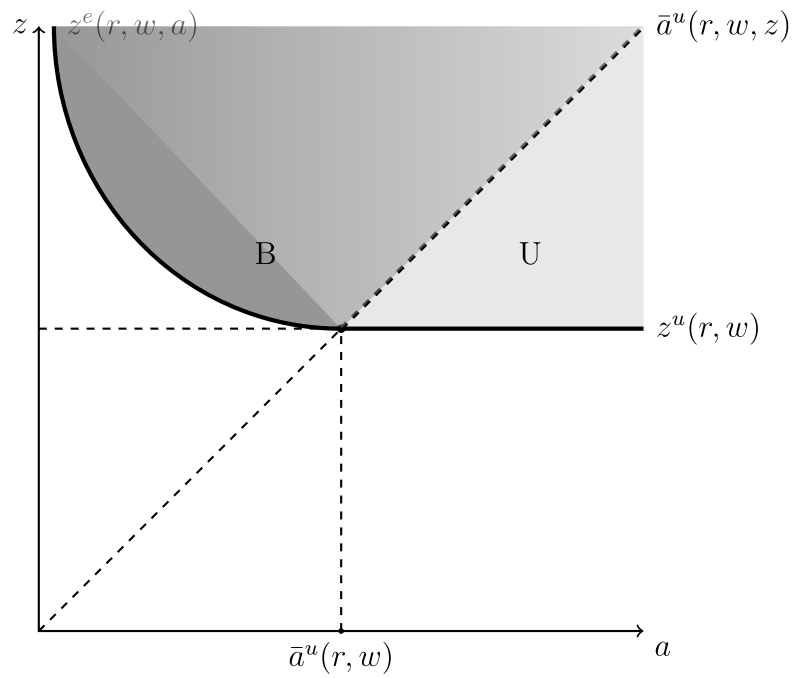

Figure 3: Cases 2 and 3: $k^u(r,w) < a$ and $0 \leq k - a < \frac{\eta(z^\theta((a+l)^\alpha n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}}$. Light gray shaded area shows the measure of agents who are unconstrained entrepreneurs. Dark gray shaded area shows the measure of agents who are not constrained borrowers.

such that for all agents with $a < k^b(\tilde{r}, w; z) < \frac{\eta(z^\theta((a+l)^\alpha n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}}$, and $z \geq z^b(r,w,a)$ agents are entrepreneurs. Observe that $\frac{\partial z^b(r,w,a)}{\partial a} < 0$, and $\lim_{a \to 0} z^b(r,w,a) = \infty$.

Cases 2 and 3 imply that for all $a \in [0, \bar{a}^u(r,w)]$, there will be a productivity level $z^e(r,w,a) = \max\{z^u(r,w), \min(z^{nb}(r,w,a), z^b(r,w,a))\}$ such that $z^e(r,w,\bar{a}^u(r,w)) = z^u(r,w)$, $\frac{\partial z^e(r,w,a)}{\partial a} < 0$, and $\lim_{a \to 0} z^b(r,w,a) = \infty$. In addition, whenever $z \geq z^e(r,w,\bar{a}^u(r,w))$, then the agent is an entrepreneur.

Case 4: If $d = a > 0$ and $l = \frac{\eta(z^\theta((a+l)^\alpha n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}}$, then $\mu > 0$ and $\lambda > 0$. Consequently:

$$(1-\theta)(1-\alpha)\frac{y}{n} = w, \; (1-\theta)\alpha\frac{y}{k}\left(1 + \lambda\frac{\eta}{\tilde{r}}\right) = r + \mu, \;\; \text{and} \;\; (1-\theta)\alpha\frac{y}{k}\left(1 + \lambda\frac{\eta}{\tilde{r}}\right) = \tilde{r} + \lambda.$$

Given that the amount of capital is constrained, it must be the case that $(1-\theta)\alpha\frac{y}{k} > \tilde{r}$. The labor first-order condition yields:

$$n(w;k^c,z) = \left(\frac{(1-\alpha)(1-\theta)z^{\theta}}{w}\right)^{\frac{1}{1-(1-\alpha)(1-\theta)}} (k^c)^{\frac{\alpha(1-\theta)}{1-(1-\alpha)(1-\theta)}},$$

where k^c solves

$$k^c = a + \frac{\eta(z^{\theta}((k^c)^{\alpha}n(w;k^c,z)^{1-\alpha})^{1-\theta}) - wn(w;k^c,z)}{\tilde{r}}.$$

This equation defines

$$k^c = k^c(\tilde{r},w;z,a), \quad \text{with} \ \frac{\partial k^c}{\partial a} > 0, \ \frac{\partial k^c}{\partial z} > 0.$$

The derivatives can be checked using the Implicit Function Theorem. We have that

$$y^c(\tilde{r},w;z,a) = \left(z^{\theta}k^c(\tilde{r},w;z,a)^{1-\theta}\left(\frac{(1-\theta)(1-\alpha)}{w}\right)^{(1-\alpha)(1-\theta)}\right)^{\frac{1}{1-(1-\alpha)(1-\theta)}}$$

and

$$\pi^c(\tilde{r},w;z,a) = (1-(1-\alpha)(1-\theta))y^c(\tilde{r},w;z,a) - \tilde{r}k^c - \chi.$$

Condition $\pi^c(\tilde{r},w;z,a) \geq w$ defines a threshold ability level $\bar{z}^c(r,w;a)$, which is decreasing in a as long as $\lambda > 0$. We can show that $\lim_{a\to 0}\bar{z}^c(r,w;a) = \infty$. Observe that when $\lambda = 0$ and $l = \frac{\eta(z^{\theta}((a+l)^{\alpha}n^{1-\alpha})^{1-\theta}-wn)}{\tilde{r}}$, then for agents who are indifferent to be entrepreneurs or workers, we have that $\bar{z}^c(r,w;a) = \bar{z}^b(r,w;a)$. This defines a value $\bar{a}^c(w,r)$, such that whenever $a < \bar{a}^c(w,r)$ and $\bar{z}^b(r,w;a) \leq z \leq \bar{z}^c(r,w;a)$, the leverage constraint is binding. For such agents, then $l = \frac{\eta(z^{\theta}((a+l)^{\alpha}n^{1-\alpha})^{1-\theta}-wn)}{\tilde{r}}$ and $\lambda > 0$, and $\bar{z}^c(r,w;a) > \bar{z}^b(r,w;a)$, in order to compensate for the low capital used. Therefore for any $\bar{z}^b(r,w;a) \leq z \leq \bar{z}^c(r,w;a)$ and $a < \bar{a}^c(w,r)$, the occupational choice is restricted by the leverage ratio. This is shown in the figure below.

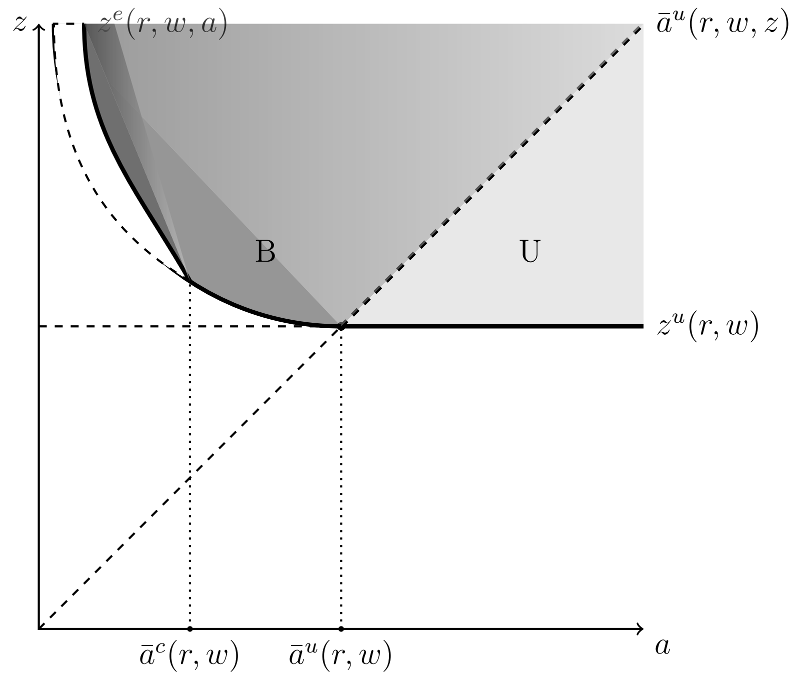

Figure 4: Cases 4: $k^u(r,w) < a$ and $k - a = \frac{\eta(z^\theta((a+l)^\alpha n^{1-\alpha})^{1-\theta} - wn)}{\tilde{r}}$. Light gray shaded area shows the measure of agents who are unconstrained entrepreneurs. Dark gray shaded area shows the measure of agents who are not constrained borrowers.