Performance of an economy with credit constraints, bankruptcy and labor inflexibility

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Abstract

We present a static general equilibrium model of an economy with agents with heterogenous wealth and endogenous credit constraints due to moral hazard. Credit constraints give rise to inefficiencies which are larger if wealth is distributed more unequally. We show that increases in the loan recovery rate improve the efficiency of the economy and raise the equilibrium interest rate. We also determine the sensitivity of the economy to the wealth distribution, and how this response depends on the loan recovery rate. We examine these results in an open economy, where interest rate increases are translated into inflows of capital due to improvements in loan recovery.

The previous results are compounded if the economy faces labor inflexibilities, so smaller increases in inequality lead to productive inefficiencies and to lower wages. We simulate our model economy to determine the importance of these effects.

Keywords: Credit constraints, wealth distribution, efficiency.

JEL Class.: G38, E44, D53.

1 Introduction

In this paper, we examine the economic costs induced by credit constraints in a model where agents are endowed with different amounts of capital. We study the effect of inequality in the distribution of capital on the performance of the economy, as well as the response of the economy to improvements in creditor rights and to reductions in the fixed set-up cost of establishing firms.

The importance of credit constraints on the performance of an economy is an important empirical issue. The evidence shows that firm's investment is correlated with changes in the net worth of firms (Hubbard [1998]), which is not predicted by models without credit constraints. In cross country regressions, La Porta, Lopez-de Silanes, Shleifer, and Vishny [1998] have shown that the extent of creditor rights affects the development of the financial sector of countries. In addition, credit constraints affect the response to crises, as shown in macro models such as the one developed by Aghion, Bacchetta, and Banerjee [2004] and specially Kiyotaki and Moore [1997], among many others.[1] The ability of an economy to withstand shocks without a significant degradation of its performance is a significant advantage. It has also been observed by Bergoeing, Kehoe, Kehoe, and Soto [2002] that the quality of bankruptcy procedures i.e., the ability to recover loans to distressed firms affects the speed of recovery from a shock. For example, Araujo and Funchal [2006] provides a model of bankruptcy and credit constraints that shows that the quality of legal protection for creditors in bankruptcy leads to more efficient outcomes and reduces fraud.

In our model, a continuum of entrepreneurs own heterogenous amounts of mobile capital stocks. This mobile capital must be combined with one unit of capital specific to each entrepreneur. In order to form firms, entrepreneurs must also pay a fixed set up cost. Given the prevailing interest rate, there is an optimal amount of capital for a firm. Entrepreneurs that do not have sufficient capital must obtain loans in the market. The problem is that borrowers can be tempted to abscond with the loan (as in Burkart and Ellingsen [2004]), with a recovery rate that depends on the quality of distressed credit legislation. This implies that entrepreneurs with small amounts of capital will be excluded from the loan market and will lose their specific capital, while other entrepreneurs will receive smaller than optimal loans. In general, this implies that, since specific capital is not pledgable, the economy will not take full advantage of its productive capability.

In this simple model we find that improvements in the recovery rate (as well as reductions in the setup cost) increase the demand for capital and thus lead to a higher interest rate. This is a consequence both of allowing more agents access to the credit market as well as by allowing credit-constrained agents with suboptimal loans to get closer to the optimal capital

[1] See Love, Preve, and Sarria-Allende [2005] for a complete review of the literature.

stock. The result is increased efficiency of the economy.[2]

We are also interested in the effect of redistributions of wealth among agents. We focus on the effects of Mean Preserving Spreads (MPS) becuse they isolate the effects of credit constraints on performance, since a MPS can affect the economy only through the credit constraints. An analysis that compares distributions according to stochastic dominance would need to consider changes in the aggregate wealth, which has effects economic performance independently of credit constraints. In this context, we define a capital robustness parameter that describes the capacity of an economy to resist wealth redistributions without a negative impact. If an MPS shifts some agents to the left of this parameter, they become credit constrained, the economy-wide interest rate falls and the economy becomes less efficient. By implication, if a financial crisis increases the dispersion in the net worth of firms, this explains the empirical observation of Love et al. [2005] that the provision of trade credit collapses for years after a financial crisis, and that the performance of the economy falls.

The capital robustness parameter decreases with improvements in the loan recovery rate, implying that as the recovery rate improves, the economy becomes more resistant to MPS, without incurring efficiency losses. In the limit, when loans are totally recoverable, there are no credit constrained agents and a mean zero shock to the distribution of capital has no effect on the economy (level shocks to wealth would have an effect).[3] Thus, the model can explain the observation in Galindo and Micco [2004], that increases in the loan recovery rate reduce the volatility of the economy. Another property of the model that is verified empirically is that improvements in the loan recovery rate increase the penetration of credit in the economy, as observed in Araujo and Funchal [2006].

To this simple economy we add labor by making all agents , i.e. all potential entrepreneurs, owners of one unit of labor and, further, that firms require one unit of labor to operate (this is a simple way of imposing inflexibility in the labor market, in this case, the difficulty in firing excess employees). In this richer model we recover the main results of the previous model: an improvement in the recovery rate increases the efficiency of the economy and raises the interest rate by increasing the demand for capital, and an increase in the inequality of capital endowments lowers the interest rate. Moreover, our restriction to a fixed amount of labor per firm means that firms cannot adjust employment to decreases in the amount of capital, so the credit constraints bite harder and the economy becomes more sensible to redistributions. This shows that labor inflexibility leads to more firms that are unable to get loans or that are credit constrained after a redistribution of wealth. Therefore, the fall in the demand for labor due to an MPS is larger than if labor employment were flexible, and in turn, this has

[2]These effects occur in a closed economy. In a small open economy this translates into inflows of capital in order to keep the interest rate in equilibrium with the outside world.

[3]We also examine the possibility of international capital movements and show that changes in the loan recovery rate lead to inflows and outflows of capital as well as real effects on output.

a stronger negative effect on wages.

We simulate the model in order to examine the importance of the credit constraints in the presence of shocks with non-homogenous effects. In the simulations, the effects of falling loan recovery rates can be substantial, both as effects on the equilibrium interest rates as well as on aggregate output. Output can be cut by almost half when the loan recovery rate goes from a Norwegian rate (80%), to a Brazilian rate (20%).[4]

Since our model is a static general equilibrium model, it cannot incorporate bankruptcy in the normal sense. However, the fact that entrepreneurs with viable projects cannot find funding and that this leads to the loss of their specific capital makes their situation analogous to the bankruptcy caused by illiquidity, and it generates social costs that are analogous to those of bankruptcy. There are several differences between our paper and the macroeconomic literature on credit constraints: first, we consider these costly "bankruptcies" and not only credit constraints; second, because we analyze heterogenous shocks to initially homogenous agents and because we concentrate on the microeconomic aspects of credit constraints and bankruptcy, while avoiding the complications of dynamic analysis.

The analysis of this paper focusses on the credit rationing and economic activity, and its closest analogue is chapter 13 in Tirole [2006], which studies similar issues with a somewhat different approach. An important distinction is that we analyze credit constraints that arise in the mechanism described in Burkart and Ellingsen [2004], which allows us to focus on the important question of the effects of changing the level of legal protection of creditors. An important paper that studies the effects of distribution and efficiency in a dynamic setting is Aghion and Bolton [1997]. Holmstrom and Tirole [1997], examines credit constraints in a general equilibrium setting, with heterogenous agents; however, we examine different issues.

Another line of research that is related to the topic of this paper lies in studying efficiency in bankruptcy procedures as in the papers of Bebchuk [1988], Bebchuk [2001], Aghion, Hart, and Moore [1992], Hart [2000], and Hart, La Porta, Lopes-de Silanes, and Moore [1997], among others. Araujo and Funchal [2006] has a descriptive analysis of bankruptcy procedures in Brazil and other LA countries.

2 The model

2.1 The Basic Setup

Initially we examine a simple one-period model with no role for labor.[5] We divide this'period into four stages (see figure 1. In the first stage, a continuum of agents indexed by $z \in [0, 1]$ are born, each endowed with one unit of specific capital and different amounts of mobile capital

[4]We do not claim these results are realistic, but that serve to show the magnitude of the effects.

[5]Section 3 extends the model to deal with labor.

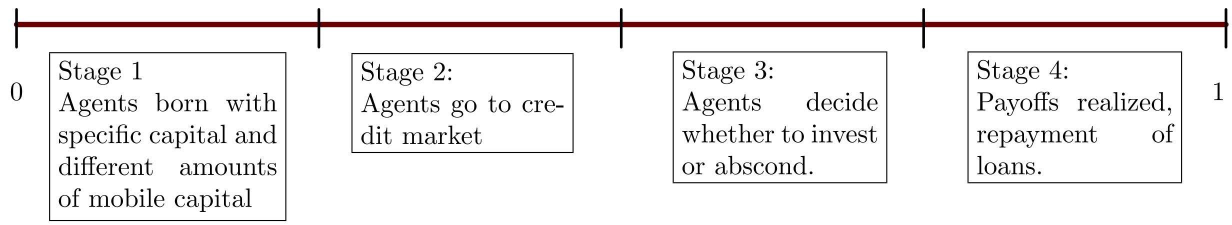

Figure 1: Time line of the model

or wealth. Specific capital cannot be transferred, sold or used independently of the agent, and can be interpreted as knowledge of the market, of clients or some other characteristic that is not easily transferred to other entrepreneurs or firms. During the second stage agents go to the credit market either to borrow or to loans funds. In the third stage the agents can decide whether to invest their own capital plus any loans in a firm that uses her specific capital, or can elect to abscond with the loan and mobile capital. In the final stage profits from firms are realized and repayment of loans takes place.

In the third stage, agents who choose to invest combine their specific capital with mobile capital (their own plus any loans) and become entrepreneurs. Agents that do not receive loans may decide not to operate their business and can loan their mobile capital instead, losing the services of their specific capital.

At birth, each agent z is endowed with K_z units of observable mobile capital, ordered by to z.[6] We denote by Γ the cumulative distribution function of mobile capital among the population of agents, which is assumed to be continuously differentiable on $[K_m, K^m]$.

There is only one good produced in this economy, with $x = f(K), f' > 0, f'' < 0, f(0) = 0, f'(0) = +\infty$. We assume that due to the existence of fixed specific capital, there are decreasing returns to mobile capital. Entrepreneurs are price takers in both the capital and output markets; the output price is normalized to 1, and the price of capital (interest rate) is denoted by r. Agents try to maximize their utility from consumption which is $U(c_z) = c_z$. Agents who become entrepreneurs maximize:

$$U(c_z) = c_z = \pi(K_z + D_z) + (1 + r)K_z, \quad z \in [0, 1],$$

where $\pi(K_z + D_z) = f(K_z + D_z) - (1 + r)(K_z + D_z) - \Theta$; are the profits of the firm owned by entrepreneur z, where D_z are the amounts loaned or borrowed by agent z, and $\Theta > 0$ is the fixed cost of operating a firm, paid out of its output.[7]

[6]So that if $z > z'$, $K_z > K_{z'}$.

[7]We assume that the supply of credit is inelastic, but we could have just as easily have introduced an initial period 0 as in chapter 13 in Tirole [2006] to derive an elastic supply of credit. The main results of the paper are not altered by a credit supply function that increases with the interest rate, though the magnitude of the effects is smaller.

In a perfect credit market with an interest rate r, all entrepreneurs would operate their firms, since this is the only way to take advantage of their specific capital. All entrepreneurs, no matter how small their initial mobile capital stock, would be able to get loans to achieve the optimal capital stock K^*:

$$f'(K^*) = f'(K_z + D_z) = 1 + r.$$

Access to the capital market is limited because entrepreneurs cannot commit to invest all available resources into the project. The demand for loans originates in agents who do not have the optimal mobile capital stock K^*, while loans derive from agents who own more than that amount of mobile capital. Loans are limited by moral hazard. In particular, entrepreneurs may use (part of) the available capital –their own capital as well as the loan they receive– to finance non-verifiable personal consumption. Following, the literature (see Hart [1995]), we refer to such opportunistic behavior as diversion.

The crucial assumption of the model is that loans are limited by moral hazard. Following Burkart and Ellingsen [2004], we assume that output and sales revenue are verifiable and can therefore be pledged to outside investors, yet the investment decisions are non-contractible. Thus, entrepreneurs enjoy project returns only after paying all their obligations. In contrast, diverted resources can be enjoyed in full and are only repaid to the extent that creditor rights are enforced. Following Burkart and Ellingsen [2004] (also Tirole [2001]), we assume that when an entrepreneur diverts, the legal system is able to recover only a fraction $1 - \phi$ of the amount diverted, with $0 < \phi < 1$.[8] We can interpret an increase in $1 - \phi$ as an improvement in the efficiency of the bankruptcy system. In case of diversion, the diversion is total: it never pays for an agent to divert partially (it is an all-or-nothing option). The reason is that diversion yields a marginal return of ϕ on the assets, but any invested funds must return at least $(1 + r) > \phi$, since otherwise the entrepreneur has employed more than the optimum amount of capital.

As we have mentioned, here is an optimal amount of mobile capital per firm, but a credit constrained entrepreneur may need to operate its firm using a lower than optimal capital stock.[9] Thus the model differentiates between entrepreneurs that are unconstrained, those that are allowed to obtain credit but not as much as they require and finally, those that do not have access to the credit market and have to loan their capital stock. Thus there are two types of constrained agents: those entrepreneurs who do not operate their firms at the efficient level and those that cannot use their specific capital.

In our setting, diversion can be considered as fraudulent bankruptcy, which is never

[8]Alternatively, we can consider diverted resources as less useful in providing utility benefits for the entrepreneur than legally obtained resources.

[9]Implicitly we have assumed that there is such a large cost of monitoring loan compliance that financial institutions cannot arise in this economy.

observed in equilibrium. We do observe, however, agents who cannot get loans and decide not to use their specific capital voluntarily, losing it, while lending their mobile wealth. These agents are experiencing a voluntary "bankruptcy", which is costly, but a consequence of their inability to obtain loans.

$$\underbrace{f(K_z + D_z) - (1+r)D_z - \Theta}_{\pi(K_z+D_z)+(1+r)K_z} \geq \phi(K_z + D_z), \tag{1}$$

for $D_z > 0$. The left hand side of the condition corresponds to the utility received by the entrepreneur who does not divert, while the right hand side corresponds to utility received if he does, considering that a fraction $1-\phi$ of the loan is recovered by the lender. In effect, this means that a positive loan must have a marginal return of at least $(1 + r + \phi)$, a term that will become important in the analysis that follows. In particular this means that whenever $\phi > 0$, positive loans require that the firms have economic rents, which means that there are no loans if there are constant returns to scale.[10] Under perfect recovery, i.e. $\phi = 0$, we are back in the standard competitive equilibrium, with no credit constraints.

2.1.1 Preliminary results

We can define two important levels of capital stock. First, the smallest capital stock that allows loans to be made, K^d. Entrepreneurs with lower levels of mobile capital stock prefer to close down their firms (losing their specific capital) and lending their mobile capital. Second, the smallest level of capital K^r such that the entrepreneur is able to obtain loans leading to the optimal capital stock, i.e., the smallest level of capital that allows an entrepreneur to not be credit constrained.

In order to determine K^r, we redefine the auxiliary function

$$\psi(K, D) \equiv f(K + D) - (1 + r)D - \Theta - \phi(K + D)$$

which will be useful in defining the default level of capital stock and the maximum allowable debt for credit constrained entrepreneurs. To see this, note that credit constrained entrepreneurs will always get as much credit as they are allowed to have, because the marginal cost of credit is $1+r$, while to the left of K^*, the return to mobile capital is higher than $1+r$. Hence, for all credit constrained agents (i.e. with $K \in [K^r, K^d]$), we have $\psi(K_z, D) = 0$. However, we need an additional condition to characterize the pair (K^d, D^d). The additional condition is that the debt corresponding to K^d is optimal for that level of capital stock, i.e., $\Psi_2(K, D) = f'(K + D) - (1 + r) - \phi = 0$. Thus we obtain the following definitions:

[10] Under constant returns to scale, on the other hand, loans are unneeded, since all firms are equally profitable.

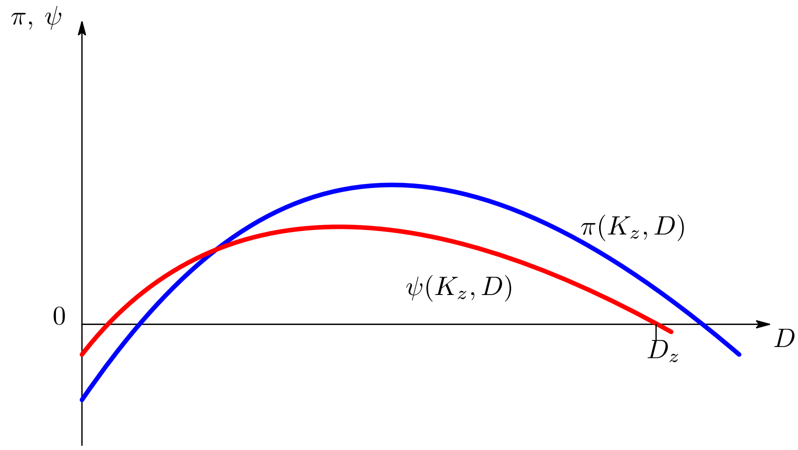

Figure 2: The functions $\pi(K_z, D)$ and $\psi(K_z, D)$ as a function of D.

Definition 1

1. *For any feasible pair of the exogenous variables ϕ, Θ, there is one pair of capital stock and debt (K^d, D^d) that satisfies $\psi(K, D) = \psi_2(K, D) = 0$ and these are the default capital stock and its associated debt.*[11]

2. *K^r that satisfies*
$$\pi(K^*) + (1 + r)K^r = \phi K^* \tag{2}$$
is the smallest capital stock that allows an entrepreneur to get a loan that allows it to produce at the efficient capital stock K^*.

See figure 2 for the two functions π and ψ and the determination of D_z for a given value of K_z. The following lemma collects some results characterizing the range where loans are possible.

Lemma 1

1. *Entrepreneurs with $K_z \in [K^d, K^*)$ receive strictly positive loans.*

2. *Entrepreneurs with $K > K^*$ supply capital to the market.*

3. *The maximum potential loan increases with z if $K_z > K^d$. The maximum effective loan increases with z for $K_z \in [K^d, K^r]$ and decreases thereafter.*

4. *An entrepreneur with $K_z \in (K^d, K^r]$ gets the maximum loan possible.*

5. *An entrepreneur who is unable to get a loan (i.e., with $K_z < K^d$) prefers to fold his company (losing his specific capital) and loan his mobile capital.*

[11] We use subscripts to indicate partial derivatives.

Proof The first and second part are reformulations of the definitions, except for the strict positivity of loans. This last is due to the fact that, the two conditions that define (K^d, D^d) do not hold at $D^d = 0$, except in a set of measure zero in parameter space.

For the third part, define the function g such that $D \equiv g(K)$ is the solution to $\psi(K, D) = 0$. Total differentiation of the IC constraint $\psi(K_z, D) = 0$ leads to:

$$\psi_1 + \psi_2 \frac{\partial D_z}{\partial K_z} = 0,$$

Note that from (5), we have $\psi_1 > 0$ and $\psi_2 < 0$ (because at (K^d, D^d) we have $\psi_2(K+D) = 0$ and $f'' < 0$). Thus we have that $dD/dK_z = g' = -\psi_1/\psi_2 > 0$ for all z. However, if $K_z > K^r$, the optimal debt is $D_z < g(K)$. Even though the firms are potentially able to borrow ever larger amounts, their demand for loans decreases and becomes negative beyond K^*, proving the third and fourth part.

Finally, consider an agent z who is unable to get a loan. This means that for all $D > 0$, $\psi(K_z, D) < 0$. In particular, for $D = 0$, $\psi(K_z, 0) < 0$. Hence

$$\pi(K_z) = f(K_z) - (1+r)K_z - \Theta < f(K_z) - \phi K_z - \Theta = \psi(K_z, 0) < 0$$

because $\phi < 1 < 1 + r$, so the agent prefers to close down a firm that cannot get a loan. ∎

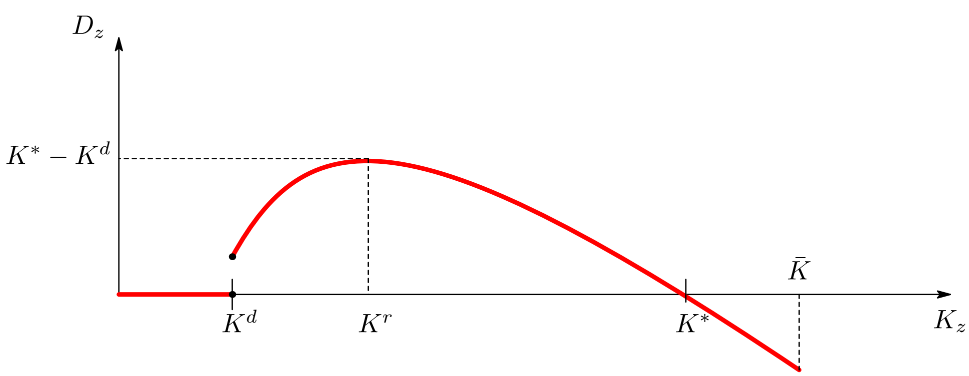

Figure 3: Maximum loan and mobile capital stocks

The last part of the lemma shows that if a firm is ineligible for loans, it is best to shut it down and start loaning the mobile capital, even at the cost of losing the services of specific capital. This means that the economic loss caused by agents ineligible for loans is analogous to the social loss caused by bankruptcies. In costly bankruptcy, a firm fails because of liquidity problems, even though it would be viable if it obtained credit. The losses are caused by the destruction of specific capital tied to the firm. In our model, an entrepreneur who is excluded from the credit market because of liquidity problems would be viable if it obtained credit, and this inability leads to the loss of specific capital. In this sense, the model includes all the features of bankruptcies.

The lemma shows that loans as a function of K_z, are as shown in figure 3. In particular, note that there is a smallest allowable loan which is strictly positive. finally, figure 4 shows how much mobile capital an entrepreneur will command as a function of his own capital stock.

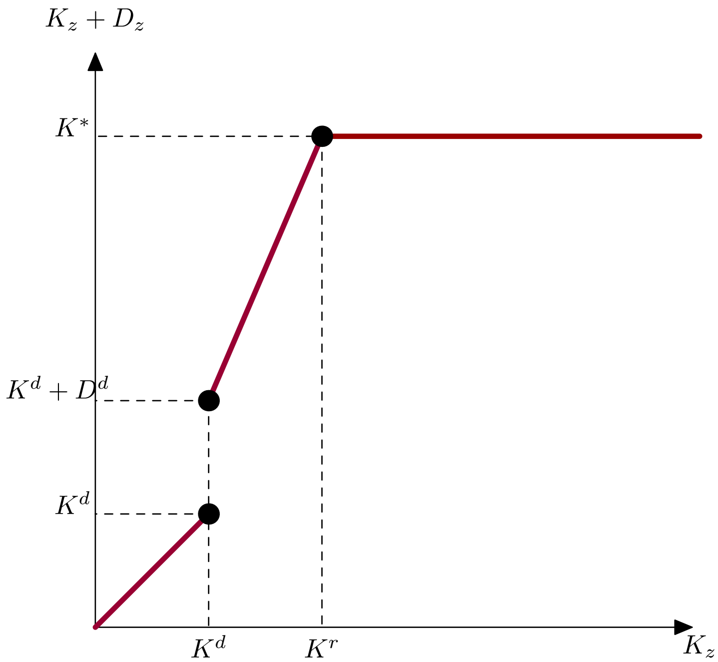

Figure 4: Capital commanded as a function of own capital.

2.1.2 Equilibrium

The equilibrium of this economy occurs when the supply equal the demand for capital. The supply of capital in this economy is

$$\mathcal{S} = \int_{K_m}^{K^m} K_z d\Gamma(K_z) = \bar{K} \tag{3}$$

where $\int_0^{K^m} dG(K_z) = 1$. The demand for loans is given by:

$$\mathcal{D} = \int_{K^d}^{K^r} (K_z + D_z) d\Gamma(K_z) + \int_{K^r}^{K^m} K^* d\Gamma(K_z) = \int_{K^d}^{K^r} (K_z + g(K_z)) d\Gamma(K_z) + K^*(1 - \Gamma(K^r)) \tag{4}$$

We can proceed to define the equilibrium of this economy:

Definition 2 *For a given distribution of mobile capital among agents* $K_z = \Gamma(z)$*, with* $E_z(\Gamma) = \bar{K}$*, an equilibrium is characterized by* (r, K^*, K^d) *such that:*[12]

1. $f'(K^*) = (1 + r)$*, where* K^* *is the optimal mobile capital stock.*
2. *Entrepreneurs maximize profits. To do this, they either demand (subject to (1)) or offer loans. Some entrepreneurs may decide to close their firms.*
3. *The capital market equilibrium condition* $\mathcal{S} = \mathcal{D}$*.*

Note that in this economy there is no trade in goods, but there are loan payments. Since K^* and K^d depend continuously on r, so do the integrals, and therefore, by Brower's theorem, there is an equilibrium to this economy. The equilibrium is unique, since the demand function is downwards sloping in r, as we show in the appendix.

Lemma 2 *The demand for capital is downwards sloping in* r*.*

Proof see appendix.

The following proposition shows some basic properties of the model:

Proposition 1

1. *Any economy such that the distribution of capital stock satisfies* $\Gamma(K^r) = 0$ *(i.e., no agent owns less than* K^r*) has* $K^* = \bar{K}$ *and therefore the economy has the same interest rate and total production as an homogenous economy.*
2. *If* $\Gamma(K^r) > 0$*, the economy is less efficient, the capital stock is higher* $K^* > \bar{K}$ *and the interest rate is lower than in the homogenous economy* $r < f'(\bar{K})$*.*
3. *If we restrict ourselves to distributions of capital stock such that* $\Gamma(K^r) = 0$ *(no credit constrained agents),* $dK^r/d\phi > 0$*.*[13]
4. *If an economy has a distribution of capital* Γ' *which is a mean preserving spread (MPS) of* Γ *characterized by* (r, K^r, K^*)*, and* $\Gamma(K_z) < \Gamma(K_z)$*,* $\forall K_z < K^r$ *then* $r' \leq r$ *and* $K^{*'} \geq K^*$*.*

Proof

1. Since agents either get or make loans that lead them to attain K^*, they reproduce the homogenous economy, which has $K^* = \bar{K}$.

[12] Note that K^r can be obtained from $\pi(K^*) + (1 + r)K^r = \phi K^*$.

[13] We will extend this result later.

2. If some agents are credit constrained, the equilibrium condition $\mathcal{D} = \mathcal{S}$ and equation (4) show that, since $K_z + g(K_z) < K^*$ we must have $K^* > \bar{K}$ and also that $r < f'(\bar{K})$.

3. From the definition of K^r given by (2), $\pi(K^*) + (1+r)K^r = \phi K^*$. By part 1 of this proposition the interest rate (and thus K^* is constant) is constant for all distributions of capital stock that satisfy $\Gamma(K^r) = 0$. Hence , total differentiation of (2) leads to $dK^r/d\phi = K^*/f'(K^*) > 0$.

4. Consider two economies with distributions separated by a mean preserving spread. Three cases may occur:

   - The two economies have $\Gamma(K^r) = 0$, in which case the equilibrium in both reproduces the homogenous economy.
   - If the first economy has a distribution such that $\Gamma(K^r) > 0$, but $\Gamma(K^d) = 0$, the MPS implies that there are more credit constrained agents (or they are more constrained than in the original distribution), so the demand for credit tends to fall. Since the net demand for credit of the wealthier agents decreases, equilibrium can only be achieved by a fall in the interest rate.
   - In the case where the original distribution has $\Gamma(K^d) > 0$, the argument is identical to the previous one with the difference that the effects are larger, since the mean preserving spread implies that more agents might be unable to obtain credit and that these same agents now supply their capital to the market (since they cannot operate their firms and go bankrupt). This tends to increase the supply and reduce the demand for credit, leading to lower interest rates and higher K^*.

∎

An obvious consequence of the previous results is:

Corollary 1 *If an economy has a distribution of capital Γ' which is a mean preserving spread (MPS) of Γ characterized by (r, K^r, K^*), and $\Gamma(K_z) < \Gamma(K_z)$, $\forall K_z < K^r$ then the economy is less efficient, i.e., it has a smaller gross output.*[14]

This important result implies that we can characterize K^r as a measure of the *robustness* of the economy. In an economy with a higher value of K^r, the probability of an MPS which reduces the output of the economy is higher. Note that we focus on mean preserving spreads

[14]The effect on net output is ambiguous and depends on the size of fixed costs Θ. In chapter 13 of Tirole [2006] the effect of an MPS on efficiency is ambiguous, but for different reasons. In the case of fixed investment this is due to the fact that that the threshold for loans is exogenous; and in the case of variable investment to the linear functional form of profits as a function of investment.

because these can only act on the economy through a credit constraint. The smaller K^r is, the larger the variance of the means preserving distributions which have no effects on the economy. Moreover, the proposition shows that that robustness increases with an increase in the recovery rate $1-\phi$, i.e., better recovery rates on loans increase the scope of redistribution with no effect on the economy i.e., it increases the robustness of the economy.

There are some other points that are worthy of note. First, there are various types of losses due to an increase in the variance of the distribution of the capital stock: i) In the range $[K^d, K^r]$, it is due to the inefficient assignment of capital due to credit constraints, ii) in the range $[0, K^d]$, it is due to the fact that some firms close down and the entrepreneurs lose their specific capital, which exacerbates the previous misallocation effects, and iii) for agents which are unconstrained, because it raises the level of the efficient capital stock above its undistorted value.

Second, observe that unconstrained agents can borrow at rate r, whereas the implicit marginal cost of a loan for a constrained agent in $1+r+\phi$, which increases in ϕ. Finally, note that the credit constraint enhances the effect of the ine

2.2 Comparative statics: changes in the underlying parameters: Θ and ϕ

We have shown the effects of changes in the distribution of mobile capital. The following results concern the effect of changing the underlying parameters in the model, in particular the fixed cost F and the recovery rate ϕ. In particular this last variable tells us about the effects of more efficient loan recovery procedures on the capacity of the economy to adapt to an MPS.

The response to changes in the underlying variables can be determined by comparative statics. Since:

$$\begin{aligned}
\psi_1(K^d, D^d) &= f'(K^d + D^d) - \phi > 0 \\
\psi_2(K^d, D^d) &= f'(K^d + D^d) - (1+r) - \phi = 0 \\
\psi_{21}(K^d, D^d) &= f''(K^d + D^d) \\
\psi_{22}(K^d, D^d) &= f''(K^d + D^d)
\end{aligned} \tag{5}$$

we obtain the comparative static effects from the following expressions (where we have omitted the superscript d to simplify the notation):

$$\begin{bmatrix} f'(K+D)-\phi & 0 \\ f''(K+D) & f''(K+D) \end{bmatrix} \begin{bmatrix} dK/dv \\ dD/dv \end{bmatrix} = \begin{bmatrix} -d\psi/dv \\ -d\psi_1/dv \end{bmatrix}, \quad v = \Theta,\ \phi$$

Noting that $\Delta = f''(K+D)(f'(K+D)-\phi) < 0$, that $-d\psi/d\Theta = 1 + D(dr/d\Theta)$, $-d\psi_1/d\theta =$

$dr/d\Theta$ and that $-d\psi/d\phi = (K+D)+D(dr/d\phi)$, $-d\psi_1/d\phi = 1+dr/d\phi$, and using Cramer's rule, we have that

Lemma 3 *The effects of a change in the fixed cost Θ and the recovery rate ϕ on the default capital stock and default loan are:*

$$\frac{dK^d}{d\Theta} = \frac{1+D(dr/d\Theta)}{f'(K+D)-\phi} \tag{6}$$

$$\frac{dD^d}{d\Theta} = \frac{[(dr/d\Theta)(f'(K+D)-Df''(K+D)-\phi)]-f''(K+D)}{(f''(K+D)(f'(K+D)-\phi)} \tag{7}$$

$$\frac{dK^d}{d\phi} = \frac{(K+D)+D(dr/d\phi))}{f'(K+D)-\phi} \tag{8}$$

$$\frac{dD^d}{d\phi} = \frac{(f'(K+D)-\phi)(1+dr/d\phi)-((K+D)+D(dr/d\phi))f''(K+D)}{f''(K+D)(f'(K+D)-\phi)} \tag{9}$$

There are direct and indirect effects at play on the default capital stocks and loan level. The indirect effect occurs because the change in an exogenous variables changes the equilibrium interest rate in this economy. These effects will allow us to examine the response of the economy to the changes in F and ϕ. To see this, note that the supply of credit is fixed, so a fall in demand will necessarily lower the equilibrium interest rate in a closed economy.

Proposition 2 *An increase (fall) in the fixed cost Θ or in the appropriation rate ϕ will lower (raise) the equilibrium interest rate, so long as $K^r \geq K_m$.*

Proof Consider the market equilibrium condition:

$$\mathcal{D} = \int_{K^d}^{K_r} (K_z + g(K_z))d\Gamma(K_z) + \int_{K^r}^{K^m} K^* d\Gamma(K_z) = \bar{K}$$

Suppose the change in one of the parameters $v = \Theta,\ \phi$ does not alter the interest rate $(dr/dv = 0)$, then, after simplifying:

$$\frac{d\mathcal{D}}{dv} = -(K^d + g(K^d))\frac{dK^d}{dv} + \int_{K^d}^{K^r} \frac{dg(K_z)}{dv} d\Gamma(K_z) \tag{10}$$

but both (6) and (8) imply that the first term is negative for $v = \Theta, \phi$ if $K^r \geq K_m$ (otherwise, since $K^d < K^r < K_m$ the marginal effect is zero). Now, from the definition of $g(K_z)$, we have (using $dr/dv = 0$):

$$\frac{dg(K_z)}{d\Theta} = \frac{1}{[f'(K_z + g(K_z)) - (1+r) - \phi]} < 0$$
$$\frac{dg(K_z)}{d\phi} = \frac{K_z + g(K_z)}{[f'(K_z + g(K_z)) - (1+r) - \phi]} < 0$$

because the denominator is zero at (K^d, D^d) and negative for higher K_z. Hence the integral in (10) is negative for $v = \Theta, \phi$ and therefore $d\mathcal{D}/dv < 0,\ v = \Theta, \phi$ (under our assumption that $dr/dv = 0$ and so long as $K^r > K_m$), and since the supply of capital remains constant, the only possible way to recover the equilibrium is that the interest rate falls with increases in both Θ and ϕ.[15][16] ∎

In the following results we assume that $K^r \geq K_m$, in order to simplify the exposition.[17] The following corollary is immediate:

Corollary 2 *The efficient mobile capital stock K^* increases with declines in the loan recovery rate $1 - \phi$ and with increases in the fixed cost of starting a firm Θ.*

The intuition behind the result is that as the recovery rate falls, lenders tend to exclude more agents from the credit markets (from (8), $dK^d/d\phi > 0$), and to lend less to those they still lend. As the potential demand for loans falls, the interest rate also falls and the are fewer firms that that are able to attain the efficient capital stock, since they need more owner's capital. Similar reasoning applies to increases in the fixed cost F. The following result shows that:

Lemma 4 *An increase in F or in ϕ then the total capital used in the smallest firm grows, i.e.,*

1. $d(K^d + D^d)/d\Theta > 0$
2. *If $1 + (dr/d\phi) > 0$ holds, then $d(K^d + D^d)/d\phi > 0$.*

Proof The proof consists of adding up equations (6) and (7) for part 1 of the lemma and parts (8) and (9) for part 2 ∎

In what follows, we will assume that $1+(dr/d\phi) > 0$, i.e., the direct effect of the change in the recovery rate on the minimum capital stock that allows loans exceeds the indirect effect

[15] Note that if $K^r \leq K_m$, there are no constrained agents, so the increase in Θ or ϕ has no effect.

[16] If the supply of capital were elastic (as in chapter 13 of Tirole [2006]) and fell when the interest rate declined, the effect would be smaller, but would remain. The decline in the supply of capital in in response to the fall in the interest rate would reduce the impact of reduced demand for loans.

[17] Otherwise we need the qualifier: "if $K^r < K^d$, there is no effect" in all the propositions.

due to the fall in the interest rate in response to the lower level of activity in the economy. This implies that all the derivatives in (6)–(9) are positive.

An important result of this section is the dependence of the robustness parameter on the recovery rate.

Proposition 3 *An improvement in the recovery rate (i.e. a decrease in ϕ) lowers the robustness parameter and therefore improves the resistance of the economy to income redistributions.*

Proof From the definition of the robustness parameter (2):

$$\pi(K^*) + (1+r)K^r = \phi K^*$$

we get, by total differentiation with respect to ϕ,

$$K^r \frac{dr}{d\phi} + (1+r)\frac{dK^r}{d\phi} = K^* + \phi\frac{dK^*}{d\phi}$$

where we have used the fact that $d\pi(K^*)/dK^* = 0$. Rewriting:

$$(1+r)\frac{dK^r}{d\phi} = K^* + \frac{dr}{d\phi}\left(\phi/f'' - K^r\right) > 0$$

Where the sign comes from the fact that proposition 2 implies that $dr/d\phi < 0$, and since $f'(K^*) = 1 + r$, we have $dK^*/d\phi = (1/f''(K^*))dr/d\phi > 0$. ∎

Note that there are three sources of inefficiency after an increase in ϕ or F:

1. Since K^d increases, more firms close down and the associated specific capital disappears.
2. Firms are more credit constrained than before and therefore use less efficient capital labor ratios.
3. Similarly, firms that are not credit constrained use too much capital.

Another interesting issue is the penetration of credit in the economy as a function of the loan recovery rate $1-\phi$. The aggregate amount of loans can be written as the surplus capital of agents who have more than the optimal capital stock K^*:

$$\mathcal{D} = \bar{K} - \int_{K^*}^{K^m} K^* d\Gamma(K_z) \tag{11}$$

Then

$$\frac{d\mathcal{D}}{d\phi} = \frac{dK^*}{d\phi}\Gamma(K^*)K^* - \frac{DK^*}{d\phi}\left(1 - \Gamma(K^*)\right)$$

which implies that:

Corollary 3 *If* $\Gamma(K^*) < 1/(1+K^*)$, *an increase in the recovery rate* $1-\phi$ *increases the penetration of credit in the economy.*

because $dK^*/d\phi = (dK^*/dr)(dr/d\phi) > 0$. While this result is interesting, most economies are reasonably open to capital flows, so the results of section 2.4 are more appealing for the study of this empirical regularity.

Another interesting feature of the closed economy is that a worsening of the recovery rate leads to the concentration of profits among fewer and richer entrepreneurs. The fact that profits are restricted to fewer agents is a direct consequence of the fact that under our maintained assumption $1 + dr/d\phi > 0$, equation (8) shows that K^d is an increasing function of ϕ. Furthermore, in the appendix we show the following important result:

Proposition 4 *A decrease in the loan recovery rate* $1-\phi$ *leads to profits that are more concentrated, i.e., there is a value of capital* $K^* > \hat{K} > K^d$ *such that all entrepreneurs with* $K > \hat{K}$ *experience an increase in their profits, while profits fall for the remaining entrepreneurs (those with* $K \in [K^d, \hat{K}]$*).*

This implies that the inequality of wealth increases when the loan recovery rate falls.

2.3 Simulations

Since the complexity of the general equilibrium effects makes it difficult to estimate the importance of the effects described in the last section, we simulate an economy in order to obtain estimates of these effects. We use a production function $f(K) = AK^\alpha$, $0 < \alpha < 1$. The parameter settings in the figures are $A = 1.75$, $\alpha = 0.5$, $\Theta = 0.6$, and the distribution is a uniform distribution in $[0, 1]$.

In the simulation, for each value of ϕ, the program creates a grid of potential equilibrium interest rates. For each of these potential equilibria, the demand for capital is constructed using (4). For this, the interval $[K^d(r), K^r(r)]$ is computed (by solving the conditions of Definition 1) and then divided into a grid. At each point in the grid, the nonlinear equation $\Psi(K, D) = 0$ is solved for D, and then $(K + D)$ is evaluated, weighed by the distribution of capital (we have also used the Pareto distribution in simulations) and these points are used to estimate the first integral in (4). Next, we add the the second integral in (4). The value obtained for that interest rate is compared to the supply of capital in the economy and if the difference is smaller than a predefined threshold value, that is taken to be the equilibrium interest rate for that value of ϕ. We also compute the aggregate gross production of the economy at that value of ϕ.

The first set of simulations describes the response to changes in the loan recovery rate, and show that the effects of a degradation of creditor rights can be substantial, and represent more that 50% of the output of the economy as we move in the range between perfect credit

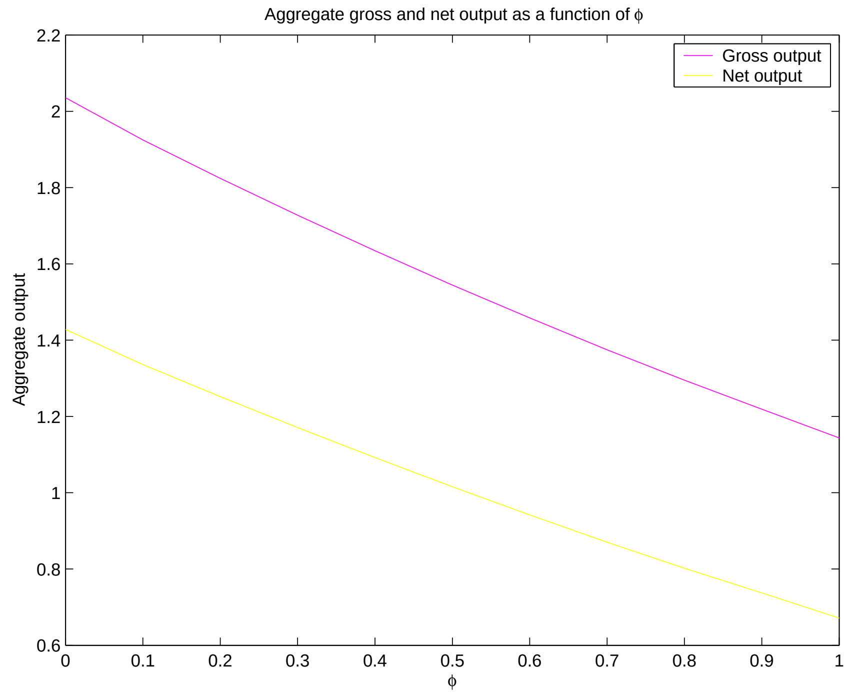

Figure 5: General equilibrium effects of a change in the loan recovery rate: output

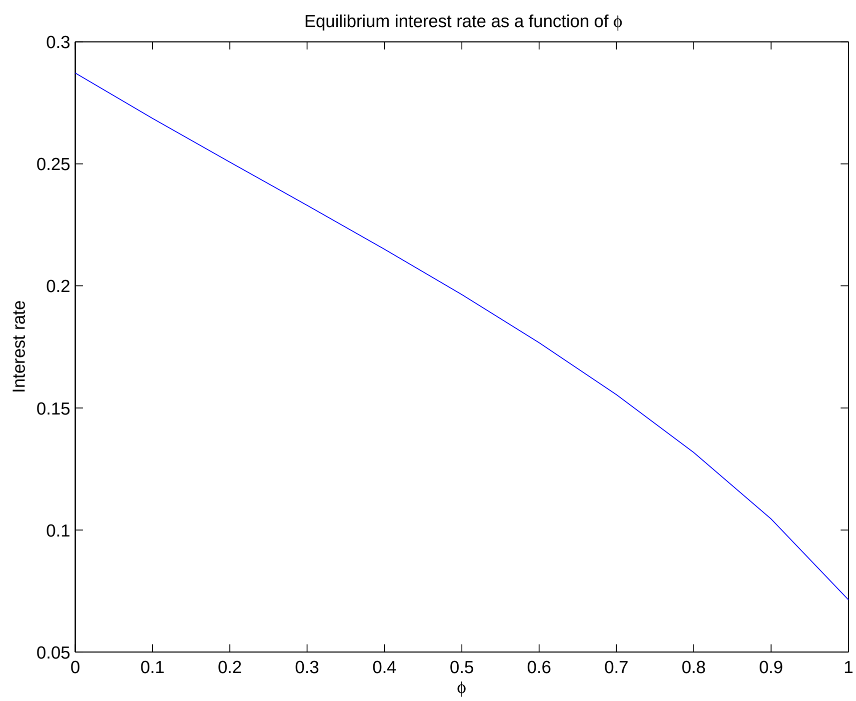

Figure 6: General equilibrium effects of changes in the loan recovery rate: interest rate

recovery to no recovery, as can be seen in figure 5.[18] Similarly, the effect on the interest rate is substantial, reducing the rate from more than 35% to less than 10% as the demand for loans falls because potential borrowers find it difficult to obtain loans, given the credit constraint induced by a low loan recoverability ratio, as shown in figure 6.

2.4 Capital movements

The results of section 2.2 on page 12 can be translated to a small open economy. Consider the case of a small open economy, where interest rates are set in the rest of the world (ROW) and the adjustment proceeds by changes in the aggregate capital stock in the economy. Changes in the recovery rate or in the fixed cost will be reflected in inflows or outflows of mobile capital. Noticing that in the proof of proposition 2 we used the fact that at constant r, an increase in ϕ or in Θ led to a decreased demand for mobile capital, it is clear that:

Corollary 4 *In a small open economy, a reduction (increase) in the recovery rate or an increase in the fixed costs of firms leads to an outflow (inflow) of capital.*

Moreover, if Γ *is the distribution of mobile capital in an economy and another economy has an MPS* Γ'*, with* $\Gamma(K_z) < \Gamma'(K_z)$, $\forall K_z < K^r$*, then the economy with* Γ' *has a smaller capital stock due to outflows of capital to the rest of the world.*

Even though the optimal capital stock K^* remains constant (since the interest rate us fixed), the other sources of inefficiencies caused by the increased ϕ or Θ remain: an increase in the number of firms that are credit constrained ($dK^r/dv > 0,\ v = \Theta, \phi$), a reduction in the amount of credit available to credit constrained firms and an increase in K^d, i.e., the number of entrepreneurs that decide not to operate their specific capital i.e., no to start firms.[19]

When we consider the penetration of credit in the open economy, note that in the expression for credit penetration (11), K^* is fixed, because the interest rate is fixed, but $\bar{K}$ is not because an increase in ϕ leads to an outflow of capital. Hence we immediately have the following result which explains the positive relationship between credit penetration and legal protection for creditors of figure 7:

Corollary 5 *An improvement in the loan recovery rate raises the penetration of credit in the economy.*

There is some evidence for the effect of legal protection since the work of La Porta et al. [1998]. According to Araujo and Funchal [2006], the empirical evidence suggests that strong

[18] It is remarkable that even when $\phi = 1$, i.e., no recovery of absconded loans, the loan market may not disappear, since sufficiently profitable projects will still be funded if agents have sufficient capital.

[19] These results can be derived directly from equations (6)–(9) under the assumption that $dr/dv = 0,\ v = \Theta, \phi$.

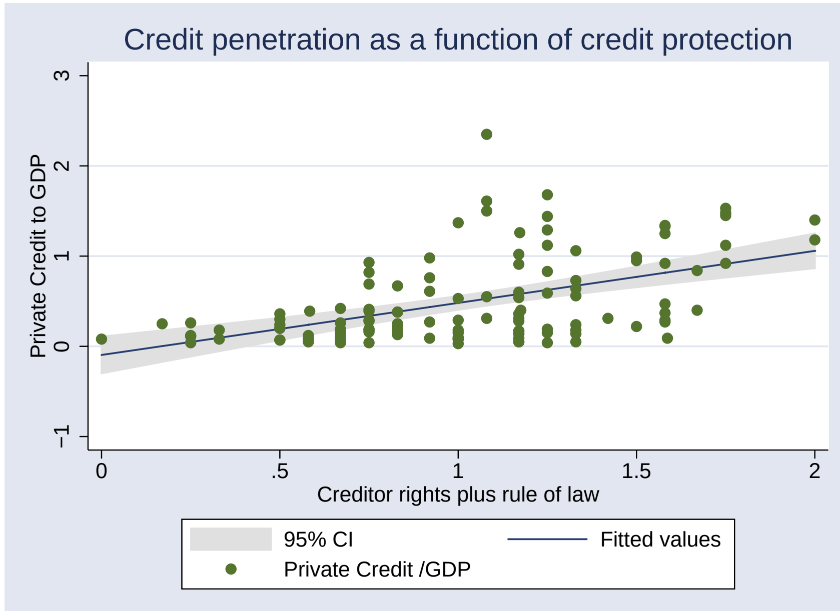

Figure 7: Legal protection and the ratio of private credit to GDP. Figure from Araujo and Funchal [2006].

legal protection should lead to broader capital markets, and that this happens because creditors "expect to recover a bigger portion of their loans in case of insolvency." Figure 7 shows that there is a relation between the quality of legal protection for loans (creditor protection plus a variable representing the extent of the rule of law in a country) and the development of the banking sector, though this development is also influenced by other factors, as can be seen by the wide dispersion in the points (this could also be a reflection of measurement error in the legal protection variable).

It is also a simple extension of proposition 4 to show that wealth inequality increases when the loan recovery rate decreases:

Corollary 6 *A decrease in the loan recovery rate $1-\phi$ leads to profits that are more concentrated, i.e., all credit constrained entrepreneurs (z such that $K_z < K^r$) have smaller profits while unconstrained entrepreneurs face constant profits ($K_z > K^r$).*

Proof For unconstrained entrepreneurs, since R is constant, so is K^* and therefore their profits. For constrained entrepreneurs:

$$
\begin{aligned}
\frac{d\pi(K+D)}{d\phi} &= \frac{\partial \pi}{\partial D}\frac{dD}{d\phi} + \frac{\partial \pi}{\partial r}\overbrace{\frac{dr}{d\phi}}^{=0} < 0, \quad \text{since} \\
\frac{dD}{d\phi} &= \frac{K+D}{f'(K+D)-(1+r)-\phi} < 0; \quad \text{from (17) in the appendix} \\
\frac{\partial \pi}{\partial D} &= f'(K+d)-(1+r) > 0
\end{aligned}
$$

∎

3 The Role of Inflexible Labor

Labor can be incorporated into the model under the following simplifying assumptions. Each firm demands L units of labor regardless of the amount of capital invested, and the cost to an agent of supplying l units of labor is $C(l)$, where $C(l)$ is strictly increasing and convex and satisfies $C(0) = C'(0) = 0$ and $\lim_{l\to\infty} C'(l) \to \infty$.[20] This assumption implies that firms are unable to adapt their labor levels to the new conditions of their mobile capital stock due to the MPS because the labor market is inflexible.[21]

For a given wage w, each agent will offer $l(w)$ units of labor, where $l(w)$ is the solution to the first-order condition: $w = C'(l(w))$. Since this first-order condition is independent of initial wealth, each agent offers the same number of units of labor in the market. Thus, the labor supply in this economy is given by $l(w)$ and the labor demand is given $\left(1 - G\left[K^d(w)\right]\right)L$, where $G\left[K^d(w)\right]$ is the mass of agents that are not able to get a loan.

The pair $(K^d(w), D^d(w))$ satisfy the following conditions (analogous to $\psi(K^d, D^d) = \Psi_2(K^d, D^d) = 0$ in definition 1):

$$
f\left(K^d(w)+D^d(w), L\right) - (1+r)D^d(w) - wL - \phi(K^d(w)+D^d(w)) = 0 \tag{12}
$$

$$
f_1\left(K^d(w)+D^d(w), L\right) - (1+r+\phi) = 0. \tag{13}
$$

The labor market equilibrium is then determined by the following equation

$$
l(w) = \left(1 - G\left[K^d(w)\right]\right)L \Longrightarrow G\left[K^d(w)\right] = \frac{L - l(w)}{L}. \tag{14}
$$

[20] We are assuming separable preferences between leisure and consumption, i.e., $U^z = c_z - C(l(z))$. This is an extreme simplification since labor is inflexible upwards and downwards. Downwards inflexibility can be due, for example, to an expensive indemnity to fired workers.

[21] So is hiring, but the impact of this restriction on the efficiency of the economy is minor.

It readily follows from this analysis that the equilibrium wage is determined by the measure of agents that are able to get a loan, as determined by the analysis of the previous sections.

We can extend the results of proposition 1. First, all economies where the distribution of mobile capital stocks has no restricted agents has the same wage rate. If there are some restricted entrepreneurs (due to an MPS, for instance), the wage rate is lower than in an economy with no restricted agents. Any MPS of the distribution of mobile capital that increases the mass of credit constrained agents lowers the demand for labor end therefore the equilibrium wage rate.

Under the assumption that $1 + (dr/dv) > 0$ for $v = \Theta, \phi$, an increase in the fixed cost of starting a business or a fall in the recovery rate of loans both increase the measure of credit constrained agents and therefore reduce the labor demand and the equilibrium wage rate. Finally, note that in equation (12), there is an additional subtracted term $-wL$. If the firm in the interval $[K^d, K^r]$ could adapt its labor to the conditions after an MPS, the impact on the firm could be smaller. In this context, note that K^d will rise because labor cannot be fired, reflecting the fact that labor inflexibility makes an economy less able to resist an MPS without losing efficiency.

Proposition 5 *Compared to an homogenous economy with flexible employment,*

1. *Any MPS such that $\Gamma(K^r) = 0$ has no effect on the equilibrium and on output.*

2. *Any MPS with $\Gamma(K^r) > 0$ has lower salaries, and entrepreneurs would be better off if they could lower L.*

3. *Compared to an economy with the same MPS but flexible salaries, labor rigidity adds additional inefficiencies, $D'_z < D_z$, $\forall K_z \in [K^d, K^r]$.*

4 Conclusions

This paper analyzes the effects of credit constraints in a static general equilibrium model where agents have heterogenous wealth. We examine the efficiency of this economy under different distributions of wealth among agents, where the average wealth remains the same. Without credit constraints, there would be no effect, but this is not the case in the model, so there is a loss of productive efficiency in more unequal economies. Since our credit constraints depend on the amount creditors can recover on loans which are defaulted, we study how the sensitivity of the economy to wealth redistributions depends on the loan recoverability ratio.

Our model introduces inefficiency through several channels: individuals who are excluded form the loan market lose their specific capital; those that are capital constrained operate less efficiently; and finally, those that are not constrained have an excess capital stock compared to what would have chosen in the absence of credit constraints. On the other hand, the fact that fewer firms operate represents a saving in terms of fixed costs, so net –as opposed to gross– output could increase in certain cases. In this context, first, we find a parameter that describes the maximum amount of redistribution which leaves the economy unaltered with respect to an homogenous economy. This is analogous to the ability of an economy to resist shocks without impairment. We show that the amount of redistribution that leaves the economy unaltered depends on the loan recovery rate. Improvements in loan recovery tend to make the economy more resistant to redistributions.

Moreover, we analyze the comparative statics of the model in response to changes in the fixed cost of starting a firm and that of reducing the loan recovery rate. In both cases there is a fall in the demand for loans (as agents become more credit constrained or decide not to start a business) therefore lowering the interest rate of the economy. Furthermore, decreases in the loan recovery rate leads to increased wealth concentration in the economy.

Next we examine an open economy that allows capital movements. In this setting, the previous effects get translated into inflows or outflows of capital. In this case the efficient size of firms does not change, because the interest rate remains constant. Nevertheless, the inefficiencies caused by agents that are excluded from the loan market or those that are credit constrained continue to exist. Therefore increased dispersion of mobile capital stocks has the same effects as those of the closed economy. Similarly, an increase in the fixed cost of a firm or a fall in the loan recovery rate produces an outflow of capital and a decrease in the efficiency of the economy. Moreover, decreases in the loan recovery rate lead to more wealth inequality.

We have simulated a closed economy version of the model, and we show that the effects of reducing the loan recovery rate can be quite large. The equilibrium interest rate can fall by tow thirds and the productive capacity of the economy can fall by ....

Next, we introduce inflexible labor into this economy and we repeat the comparative statics exercises performed in the economy with no role for labor. The main effects reappear, but they are enhanced by the fact that there are labor restrictions on firing (and on hiring). The wage rate falls as demand for labor falls as firms become credit constrained or decide not to operate when wealth is distributed more unequally. In fact the economy with inflexible labor is less able to resist redistribution of wealth without impairment (as compared to an economy with flexible labor).

One of the interesting features of the present model is that it incorporates features of bankruptcy, and not just simple credit constraints. In the model, agents may lose their specific capital if they are unable to get a loan to operate their firms, even though their projects are profitable. Analogously, in a real bankruptcy, firms may face liquidity crisis and fail, even though their projects are profitable and there is a real economic loss due to the loss of specific capital. An extension of this model would improve the analogy by using a real dynamic model, where a shock to wealth (in our setting a redistribution of wealth) of existing entrepreneurs makes them unable to obtain working capital.

In such a dynamic setting, the redistribution of assets of our static model would be analogous to an economic shock, and our results linking the ability to resist redistribution without degradation of the economy to the loan recovery rate would enable us to interpret the results obtained by Galindo and Micco [2004] in figure 8 on page 28.

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5 Appendix

In this appendix we prove some of the lemmas.

Lemma 5 *The demand for capital is downwards sloping in r.*

Proof The demand for capital is given in (4) as

$$\mathcal{D} = \int_{K^d}^{K^r} (K_z + g(K_z))d\Gamma(K_z) + K^*(1 - \Gamma(K^r)).$$

The sign of $d\mathcal{D}/dr$ is the same as the sign of:

$$\partial\mathcal{D}/\partial r = \int_{K^d}^{K^r} \frac{\partial K^*}{\partial r} d\Gamma(K_z) - K^*\Gamma(K^r)\frac{\partial K^r}{\partial r} + \int_{K^d}^{K^r} \frac{\partial g(K_z)}{\partial r} d\Gamma(K_z) + \underbrace{[K^r + g(K^r)]}_{K^*}\Gamma(K^r)\frac{\partial K^r}{\partial r} - [K^d + g(K^d)]\Gamma(K^d)\frac{\partial K^d}{\partial r} \quad (15)$$

Note that the second and fourth terms on the RHS cancel out. The first term is clearly negative, since $\partial K^*/\partial r = 1/(f''(K^*) < 0$. For the remaining terms, note that in the half-open interval $(K^d, K^r]$, the function $g(K_z)$ satisfies $\Psi(K_z, g(K_z)) = 0$. Differencing with respect to r, we have:

$$\frac{dg(K_z)}{dr} = \frac{g(K_z)}{[f'(K_z + g(K_z)) - (1 + r + \phi)]} < 0$$

which implies that the third term is negative. For the last term, note that the partial derivative $\partial g(K_d)/\partial r = -\infty$ (it is only defined on the right). Hence differencing the second expression that defines the pair (K^d, D^d), i.e., $\Psi_2(K^d, g(K^d)) = f'(K_d + g(K^d)) - (1 + r + \phi) = 0$ we get

$$\frac{\partial K^d}{\partial r} = \frac{1}{[f''(K_d + g(K^d))(1 + (\partial g(K^d)/\partial r))]} > 0$$

Therefore all the terms are negative and $\partial \mathcal{D}/\partial r < 0$. ∎

Proposition 6 *A decrease in the loan recovery rate $1 - \phi$ leads to profits that are more concentrated, i.e., there is a value of capital $K^* > \hat{K} > K^d$ such that all entrepreneurs with $K > \hat{K}$ experience an increase in their profits, while profits fall for the remaining entrepreneurs (those with $K \in [K^d, \hat{K}]$).*

Proof Profits are concentrated among fewer agents because under the condition $1 + dr/d\phi > 0$, we have $dK^d/d\phi > 0$ by (8). Profits for those who receive credit are higher because entrepreneurs can be divided among those that are unconstrained and receive $\pi(K^*)$, and constrained agents. For unconstrained agents, their profits increase increases with ϕ, since

$$\begin{aligned}\frac{d\pi(K^*)}{d\phi} &= \frac{\partial \pi}{\partial K^*}\frac{\partial K^*}{\partial r}\frac{dr}{d\phi} + \frac{\partial \pi}{\partial r}\frac{dr}{d\phi} \\ &= \frac{\partial K^*}{\partial r}\frac{dr}{d\phi}\underbrace{[f(K^*) - (1 + r)]}_{=0} - K^*\frac{dr}{d\phi} \\ &> 0\end{aligned}$$

For constrained agents (i.e., those with $K_z \in [K^d, K^r])$, who receive profits $\pi(K + D)$ (we omit the subindex z to simplify the notation):

$$\frac{d\pi(K + D)}{d\phi} = \frac{\partial \pi}{\partial D}\frac{dD}{d\phi} + \frac{\partial \pi}{\partial r}\frac{dr}{d\phi} \tag{16}$$

where $\partial \pi/\partial D = f(K + D) - (1 + r) > 0$. To determine $dD/d\phi$ we use

$$0 = \frac{d\Psi(K + D)}{d\phi} = [f'(K + D) - (1 + r) - \phi]\frac{dD}{d\phi} - D\frac{dr}{d\phi} - (K + D)$$

from which we recover:

$$\frac{dD}{d\phi} = \frac{(K + D) + D\frac{dr}{d\phi}}{[f'(K + D) - (1 + r) - \phi]} < 0 \tag{17}$$

because the denominator is negative and $1 + dr/d\phi > 0$. The second term in (16) is $(\partial\pi/\partial r)(dr/d\phi) = -(K + D)(dr/d\phi) > 0$. Adding all these terms together,

$$\begin{aligned} \frac{d\pi(K+D)}{d\phi} &= \frac{[f'(K+D) - (1+r)]\left((K+D) - D\frac{dr}{d\phi}\right)}{f'(K+D) - (1+r) - \phi} - (K+D)\frac{dr}{d\phi} \\ &= \frac{[f'(K+D) - (1+r)]\left((K+D)\left(1 - \frac{dr}{d\phi}\right) - D\frac{dr}{d\phi}\right) + \phi(K+D)\frac{dr}{d\phi}}{f'(K+D) - (1+r) - \phi} \end{aligned}$$

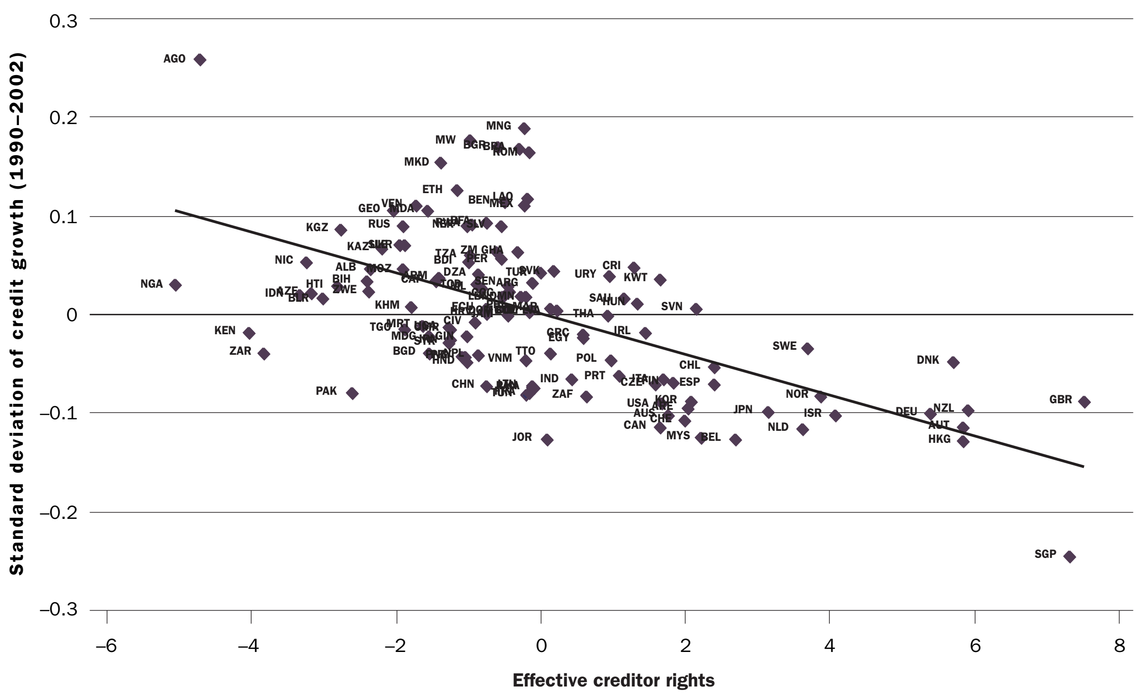
The two terms in the numerator have opposite signs. However, since

$$\lim_{K+D \to K^*} f'(K+D) - (1+r) = 0$$

so the denominator is negative in a left-neighborhood of K^*, and therefore $d\pi(K+D)/d\phi > 0$ in that neighborhood. On the other hand, at $(K^d + D^d)$ we have $f'(K^d + D^d) - (1+r) - \phi = 0$, so after simplification there remain only positive terms in the denominator. By continuity of the denominator, there is a $\hat{K}$ with $K^* > \hat{K} > K^d$ such that profits increase to the right of $\hat{K}$ and decrease to the left. ∎

FIGURE 2

Credit Volatility and the Protection of Creditor Rights, 1990–2002



Note: The figure controls for the standard deviation of external shocks.

Source: Authors' calculations

Figure 8: Credit volatility and creditor rights (From Galindo and Micco [2004])