On financial frictions and firm market power*

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Abstract

There are two opposing welfare effects of market power in a model with monopolistic competition, loan defaults and moral hazard. The loss of output produced if firms set a higher mark-up over marginal costs confronts with some gain due to higher expected profits and the reduction of defaults. Such tradeoff results in an optimal level of market power that decreases with the efficiency of liquidation following default on a loan. If moral hazard is pervasive, credit rationing cuts down the default rates and mitigates the welfare cost of financial frictions.

JEL Classification: E44, G21, G33.

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1 Introduction

There is an extensive literature that looks at the macroeconomic interaction between the financial and the real sectors of an economy. Brunnermeier *et al.* (2011) provide a comprehensive survey. Within that literature, this paper deals with the role of firms' market power in shaping the effects of financial frictions due to both non verifiability of firms' ex post returns *à la* Townsend (1979) and moral hazard *à la* Holmstrom and Tirole (1997). Firms' market power, other things equal, leads to prices higher than marginal costs, which reduces output compared to perfect competition, causing a welfare loss. However, by increasing firms' profitability, market power can mitigate the adverse effects that financial frictions have on firms' activity, leading to a welfare gain. Our contribution is to explore such trade off in a static general equilibrium model in which firms are monopolistically competitive, and asymmetric information leads to the use of debt contracts and to the possibility of moral hazard. Such asymmetric information causes welfare losses due to firm [defaults on loans and the possibility of credit rationing. Within this environment, we study and characterize the optimal degree of market power (i.e., the one that maximizes household welfare), which we find it strictly positive.

Our model incorporates uncertainty due to idiosyncratic shocks on consumption varieties. Households choose labor supply, the level of effort they exert managing their firms, the amount of consumption, its composition in terms of varieties, and the amount of bank deposits. Firms are monopolistically competitive and produce differentiated consumption goods by employing labor. In order to produce, firms need external finance, which is provided by competitive banks facing financial frictions due to the non verifiability of both firms' *ex post* returns and managerial effort. Non verifiability of *ex post* returns implies the use of standard debt contracts in the financing of firms. As a consequence, the possibility of default emerges. Non verifiability of managerial effort generates the possibility of moral hazard as households might have the incentive to exert low effort to seek private benefits. Both costly loan defaults and moral hazard generate welfare losses. We provide a full analysis of the equilibria that might characterize the economy depending on the relevance of financial frictions and the conditions for their existence. Specifically, we find that the equilibrium might be characterized either by loan market clearing and high effort, by credit rationing and high effort, or by loan market clearing and low effort. Furthermore, we study the incentive compatibility constraint faced by firm's management to derive the analytical condition that determines the pervasiveness of moral hazard, which results in credit rationing. Moral hazard turns pervasive only in the case in which firms do not have enough market power.

In order to provide a systematic analysis of the interplay between the financial frictions and market power, we first characterize the equilibrium when either moral hazard or costly default is the only financial friction, and discuss how market power interacts with each of the two frictions in isolation. Then, we provide a numerical simulation of the general case, in which both frictions are present, since no closed form solution can be found in this case. For such quantitative exercise, we first calibrate the model in order to match evidence from US data. The results draw different equilibria regions depending on the level of firm's market power, the size of the private benefit if exerting low effort, and the gap between high effort and low effort. We find that when firm market power rises, higher mark-ups increase firm profitability, which dampens the moral hazard problem and lowers the aggregate loss from loan defaults. As a consequence of these welfare-enhancing effects, the optimal level of market power is strictly positive.

Our paper contributes to the extensive literature on the macroeconomic effects of financial frictions. Several contributions have focused on the long-run consequences of credit rationing and misallocation. For instance, Piketty (1997) shows that credit rationing due to moral hazard leads to the possibility of low output and growth regimes, with high interest rates and higher wealth inequality. Banerjee and Moll (2010) argue that capital misallocation resulting from credit constraints can be very persistent with quantitatively important consequences.[1] The results of our paper dispute the conventional wisdom on the welfare effects of credit rationing. With financial frictions, the adoption of credit rationing could be a safeguard to

[1] There have been other papers focusing on the impacts of financial frictions on productivity and business creation. Buera and Shin (2013) study how misallocation due to financial frictions affects significantly the speed of convergence after reforms triggering an efficient allocation of resources. Midrigan and Yi Xu (2014) show that financial frictions reduce productivity by distorting entry and technology adoption decisions. Moll (2014) shows that financial frictions have long-run lasting consequences with transitory productivity shocks, while if shocks are sufficiently persistent, self-financing could still be a good substitute for external finance.

limit escalating defaults and interest rates in times of severe idiosyncratic uncertainty.

Complementary to the above literature, we explore the effects on welfare and output induced by the interplay between market power and financial frictions due to asymmetric information. Relatedly, Galle (2019) constructs a general equilibrium model to analyze how competition affects the efficiency of capital allocation across heterogeneous firms in the presence of financial constraints. The key finding is that lower market power results in lower markups, but also slows down capital accumulation, thereby reducing the positive steady state impact of increased competition, which is confirmed by empirical findings based on data from India. In the same vein, Jungherr and Strauss (2017) study the effect of market power in a growth model of a small open economy characterized by exogenous financial constraints. Higher market power brings higher earnings, which result in higher self-financing of investment. In the presence of borrowing constraints, the higher self-financing strengthens capital accumulation. Their empirical testing based on South Korea micro data confirms such prediction. In Galle (2019) and Jungherr and Strauss (2017), the negative effect of competition in the presence of financial constraints stems from the fact that more competition leads to lower profits, which reduce self-financing. Differently, in our fully microfounded model, the negative effect of competition is due to the fact that less competition increases firms' profitability and makes them less likely to default on loans. As a result, the adverse effects of financial frictions due to moral hazard and costly defaults can be mitigated when reducing competition to increase firm's market power.

The rest of the paper is organized as follows. Section 2 presents the model. In Section 3, we characterize the model equilibria, while Section 4 discusses the welfare effects of market power under different sources of financial frictions. A baseline calibration of the model parameters is proposed in Section 5. The quantitative analysis begins in Section 6 examining the interaction between market power and private benefits to bring pervasive moral hazard. Section 7 provides numerical simulations of the general equilibrium effects of financial frictions depending on firms' market power, moral hazard and the liquidation technology, and also on the welfare costs of financial frictions using the household consumption equivalence. Section 8 concludes the paper with a summary of results and some related discussion.

2 The model

We consider an economy with households, firms and banks. Households who own the firms, supply labor in exchange of a salary and manage firms, buy bank deposits, and consume final goods. Firms use labor and external finance to produce varieties of consumption goods. Banks issue deposits and finance firms' operations.

2.1 Households

The economy is populated by a continuum of size one of households who live for one period. They choose how much labor to supply, how much income to consume, and the composition of their consumption in terms of varieties, where the latter choice is separable from the former two. They also decide their demand for bank deposits. Their utility function is

$$u(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \psi \frac{n^{1+\gamma}}{1+\gamma}$$

where, σ and γ are the elasticities of the marginal utility with respect to the consumption index, c, and labor, n, respectively, and ψ is a scale parameter that measures the relative weight of labor disutility. Taking the Dixit and Stiglitz (1977) aggregation scheme, the consumption index is

$$c = \left[\int_0^1 e(i) c(i)^{1-\theta} di \right]^{\frac{1}{1-\theta}}$$

where $c(i)$ is consumption of variety i, $e(i)$ is a variety-specific taste shock, and $0 < \theta < 1$ is the inverse of Dixit and Stiglitz (1977)'s elasticity of substitution. We assume that $e(i)$ is uniformly distributed between $[\underline{\epsilon}, \overline{\epsilon}]$, with $\overline{\epsilon} > \underline{\epsilon} > 0$, and density function $\frac{1}{\overline{\epsilon}-\underline{\epsilon}}$, so that its expected value and variance are

$$\begin{aligned} E[e(i)] &= \int_{\underline{\epsilon}}^{\overline{\epsilon}} \frac{1}{\overline{\epsilon}-\underline{\epsilon}} e(i) de(i) = \frac{\overline{\epsilon}+\underline{\epsilon}}{2} \\ Var[e(i)] &= \int_{\underline{\epsilon}}^{\overline{\epsilon}} \frac{1}{\overline{\epsilon}-\underline{\epsilon}} \left(e(i) - \frac{\overline{\epsilon}+\underline{\epsilon}}{2} \right)^2 de(i) = \frac{1}{12} \left(\overline{\epsilon} - \underline{\epsilon} \right)^2 \end{aligned}$$

Individuals make their consumption decisions after the realization of the idiosyncratic shock, therefore they face no uncertainty. Accordingly, the inverse demand function for variety i is found to be[2]

$$\frac{p(i)}{p} = e(i)\left(\frac{c(i)}{c}\right)^{-\theta} \tag{1}$$

where, the idiosyncratic shock $e(i)$ brings an exogenous demand shift and

$$p = \left[\int_0^1 p(i)^{\frac{\theta-1}{\theta}} e(i)^{1/\theta} di\right]^{\frac{\theta}{\theta-1}}$$

is the Dixit-Stiglitz price index.

The sources of income for the households are the salary, wn, at a competitive real wage, w; firms' dividends, d; and the return, $rdep$, on bank deposits, dep, which pay a risk-free interest rate, r, which is equal to the opportunity cost of deposits.[3] Households decide the level of consumption, c, labor supply, n, and deposits, dep, so to solve the following maximization problem:[4]

$$\begin{aligned} \max_{\{c,n,dep\}} \quad & \frac{c^{1-\sigma}}{1-\sigma} - \psi\frac{n^{1+\gamma}}{1+\gamma} \\ \text{s.to:} \quad & wn + d + rdep \geqslant c \\ wn \quad & \geqslant \quad dep \end{aligned}$$

The first order conditions associated with the above maximisation problem are

$$\begin{aligned} c^{-\sigma} - \lambda &= 0 \\ -\psi n^{\gamma} + (\lambda + \varphi)\, w &= 0 \\ \lambda r - \varphi &= 0 \\ wn + d + rdep &= c \\ wn &= dep \end{aligned}$$

[2] See section A1 of the Appendix for the standard derivation.

[3] We could provide a full analysis of household's decision to deposit within banks *versus* alternative risk-free assets. However, it is clear that so long as r exceeds the return on alternative assets, households will choose deposits. Therefore, in equilibrium r will be equal to the return on the alternative asset. We impose this result upfront to simplify the exposition.

[4] In principle, we should explicitly assume that households have an endowment of time, and impose the constraint that the amount of labor they choose to offer, n, cannot exceed that endowment. Rather than doing that, we solve the model under the implicit assumption that the unconstraint level of labor supply is lower than the time endowment. This is always verified for a time endowment large enough.

where λ and φ are, respectively, the Lagrangian multipliers of the budget constraint and the deposit constraint. Hence, the optimal labor supply schedule satisfies

$$w = \frac{\psi n^{\gamma} c^{\sigma}}{1+r}$$

and the budget constraint can be rewritten as follows

$$c = (1+r)\, wn + d \tag{2}$$

2.2 Financial intermediation and financial frictions

Firms hire labor and pay wages before they produce. Accordingly, they need external financial resources in order to pay those wages. Financial resources are supplied by competitive banks .We introduce two sources of friction in the economy: non verifiability of *ex post* firm returns and moral hazard.

Non verifiability of *ex post* returns implies that banks finance firms by means of standard debt contracts (i.e., loans) as in Townsend (1979), and also Bolton and Dewatripont (2005, chapter 5). As a result, the possibility of firm's default emerges. This causes an inefficiency so long as some of the firms' value is lost following liquidation upon default.

We model moral hazard by assuming that the distribution of the idiosyncratic shock, $e(i)$, is affected by the level of effort exerted by the households managing of the firm. Effort can either be high or low and it is not contractible. In particular, it is assumed that the level of effort exerted determines the lower bound, $\underline{\epsilon}$, of the support of the distribution of $e(i)$. The lower bound, $\underline{\epsilon}$, equals $\underline{\epsilon}_H$ if firm management exerts high effort, and $\underline{\epsilon}_L$ if it exerts low effort, with $\underline{\epsilon}_L < \underline{\epsilon}_H$. As a consequence, the expected firm's revenue declines in the presence of low effort, while its variance increases.[5] However, we assume that if households exert low managerial effort, they earn private benefits as in Holmstrom and Tirole (1997), and also in Tirole (2006, chapter 3). The intuition is as follows. If exerting low effort, households can abuse of the managing position to distract resources away from the firm in their own interest. We adopt the standard assumption that private benefits are a constant fraction,

[5] For a long-run neutrality of the idiosyncratic demand shocks under high effort, it is assumed that $\frac{\overline{\epsilon}+\underline{\epsilon}_H}{2} = 1$, which implies $E\left[e(i)\right] = 1$ and $Var\left[e(i)\right] = \frac{(\overline{\epsilon}-1)^2}{3}$.

$b > 0$, of the size of the loan if the level of managerial effort is low, and they are equal to zero if managerial effort is high.[6] Therefore, a higher volume of activity, that implies more financial resources borrowed by the firm, generates higher private benefits if the firm's management exerts low effort, which enter the expected payoff in an additive way.

2.3 Firms

The economy is populated by a continuum of size one of firms operating in a monopolistically competitive market. Firms are managed by households who appropriate profits and private benefits. Each firm produces one differentiated variety of the consumption goods, facing the Dixit-Stiglitz inverse demand constraint (1). The optimal choice of output takes place before observing the realization of the idiosyncratic demand shock, $e(i)$. Regarding the production technology, firm i produces, $y(i)$; using labor, $n(i)$; according to the following linear production function:

$$y(i) = An(i) \tag{3}$$

where $A > 0$ is a productivity parameter. Given the production function (3), in order to produce $y(i)$, firm i needs to demand a loan of size $wy(i)/A$, to pay salaries $wn(i)$. For a given value of the interest rate of the loan, $r_f(i)$, the total cost for firm i, producing $y(i)$, would be $(1 + r_f(i))\, wy(i)/A$.

Recalling the demand function (1), the total real revenue for firm i is

$$\frac{p(i)}{p} y(i) = e(i) \left(\frac{c(i)}{c} \right)^{-\theta} y(i)$$

The inverse demand elasticity θ is a measure of firms' market power because it shapes the mark-up of the price charged over the marginal cost of production.[7] It can also be noted

[6] Alternative specifications, including Hermalin (1992) and Raith (2003), assume that the private benefits are proportional to the expected profit of the firm.

[7] Such correspondence between market power and the Dixit-Stiglitz elasticity of substitution across consumption goods is common in macroeconomic models with monopolistic competition industries (see the New Keynesian-DSGE literature following Christiano *et al.*, 2005). In general, such models are characterised by a household's love for variety effect. In a partial equilibrium set-up, Ethier (1982) and Benassy (1996) separate market power of firms from the love for variety effect. In general equilibrium, Azar and Vives (2021) exam-

that firms' revenues depend on the realization of the idiosyncratic shock, $e(i)$. Using market-clearing conditions at firm level, $c(i) = y(i)$, we obtain

$$\frac{p(i)}{p}y(i) = e(i)c^{\theta}y(i)^{1-\theta}$$

Firm i expected profit from production activity conditional on managerial effort, $\underline{\epsilon}$, is

$$E(\pi(i)|\underline{\epsilon}) = \int_{\underline{\epsilon}}^{\overline{\epsilon}} \frac{1}{\overline{\epsilon} - \underline{\epsilon}} \left[e(i)c^{\theta}y(i)^{1-\theta} - (1 + r_f(i))\, w\frac{y(i)}{A} \right] de(i) \tag{4}$$

A loan default occurs if total revenues are lower than payments due to banks. The firm is otherwise solvent. Accordingly, firm i defaults if and only if

$$e(i)c^{\theta}y(i)^{1-\theta} < (1 + r_f(i))\, w\frac{y(i)}{A}$$

This brings the following definition of the critical value of the idiosyncratic shock[8]

$$\widehat{e}(i) = \max\left\{ \underline{\epsilon},\ \ (1 + r_f(i))\,\frac{w}{A}y(i)^{\theta}c^{-\theta} \right\} \tag{5}$$

Firm i defaults if $\underline{\epsilon} < e(i) < \widehat{e}(i)$. In the event of default , the firm earns zero, and the bank appropriates the liquidation value of the loan. Therefore, firm's management has the incentive to default on firm's loans if and only if $e(i) < \widehat{e}(i)$, and to repay the loan otherwise.

Since $\frac{\overline{\epsilon}-\widehat{e}(i)}{\overline{\epsilon}-\underline{\epsilon}}$ is the probability of repayment and $\frac{\widehat{e}(i)-\underline{\epsilon}}{\overline{\epsilon}-\underline{\epsilon}}$ is the probability of default, the expected profit of firm i can be written (solving the integrals in expression 4) as follows

$$E(\pi(i)|\underline{\epsilon}) = \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon})}c^{\theta}y(i)^{1-\theta} - \frac{\overline{\epsilon} - \widehat{e}(i)}{\overline{\epsilon} - \underline{\epsilon}}\,(1 + r_f(i))\, w\frac{y(i)}{A}$$

2.3.1 Incentive compatibility

Banks cannot verify the level of effort exerted by firm's management. As a consequence, households exert high effort in managing their firms if and only they have the incentive to do so.

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ine the role of the elasticity of substitution and the love for variety effect in a model with a Cournot-type oligopoly. While we leave this interesting extension for future research, we control for the love for variety effect when measuring the welfare loss due to financial frictions.

[8] In practical terms, the value of the critical shock $\widehat{e}(i)$ implied by (5) is $(1 + r_f(i))\,\frac{w}{A}y(i)^{\theta}c^{-\theta}$, unless market power θ becomes sufficiently high to give a value of $\widehat{e}(i)$ below its lower bound $\underline{\epsilon}$. For those cases, (5) sets $\widehat{e}(i) = \underline{\epsilon}$.

If a firm is financed with a loan of size $wy(i)/A$ to produce a quantity $y(i)$ of output, and the households owning firm i exert high managerial effort, $\underline{\epsilon}_H$, their expected payoff is equal to the expected profits,

$$E(\pi(i)|\underline{\epsilon}_H) = \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_H)} c^\theta y(i)^{1-\theta} - \frac{\overline{\epsilon} - \widehat{e}(i)}{\overline{\epsilon} - \underline{\epsilon}_H} (1 + r_f(i))\, w \frac{y(i)}{A} \tag{6}$$

which, by the law of large numbers, will become the dividend $d = E(\pi(i)|\underline{\epsilon}_H)$ to be received by households in the budget constraint (2).

Differently, if exerting low effort, the expected pecuniary payoff of firm i's management would be equal to the expected profits, $E(\pi(i)|\underline{\epsilon}_L)$, plus private benefits, $bwy(i)/A$. That is,

$$E(\pi(i)|\underline{\epsilon}_L) + bl(i) = \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_L)} c^\theta y(i)^{1-\theta} - \left[\frac{\overline{\epsilon} - \widehat{e}(i)}{\overline{\epsilon} - \underline{\epsilon}_L} (1 + r_f(i)) - b \right] w \frac{y(i)}{A} \tag{7}$$

In this case of exerting low effort, the pecuniary private benefit is also included as part of the dividend obtained by the household $d = E(\pi(i)|\underline{\epsilon}_L) + bl(i)$.

In order for households to have incentive to exert high managerial effort, the following Incentive Compatibility Constraint (ICC) should be satisfied

$$E(\pi(i)|\underline{\epsilon}_H) \geqslant E(\pi(i)|\underline{\epsilon}_L) + bwy(i)/A$$

Substituting for $E(\pi(i)|\underline{\epsilon}_H)$ and $E(\pi(i)|\underline{\epsilon}_L)$ using expressions (6) and (7), and solving for $y(i)$, we find that the ICC reduces to the following expression

$$y(i) \leqslant \left(\frac{A\left(\frac{(\underline{\epsilon}_H - \underline{\epsilon}_L)\left(\overline{\epsilon}^2 - \widehat{e}(i)^2\right)}{(\overline{\epsilon} - \underline{\epsilon}_H)(\overline{\epsilon} - \underline{\epsilon}_L)} \right)}{2w\left(\frac{(\underline{\epsilon}_H - \underline{\epsilon}_L)(\overline{\epsilon} - \widehat{e}(i))\left(1 + r_f(i)\right)}{(\overline{\epsilon} - \underline{\epsilon}_H)(\overline{\epsilon} - \underline{\epsilon}_L)} + b \right)} \right)^{1/\theta} c \tag{8}$$

2.4 Banks

The economy is populated by a continuum of size one of banks, which finance firms' operations. They issue deposits paying a real risk-free interest rate, r, and use the proceeds to finance firms. Loan contracts are offered to firms in competition *á la* Bertrand, which leads to having banks with zero profits in equilibrium.[9] Due to the non-verifiability of *ex*

[9] Following an alternative approach, and based on the seminal paper by Peters (1984), Huang *et al.* (2021) use constrained Bertrand competition as banks may face problems to raise enough deposits to finance loans. This setup is potentially interesting because the additional friction results in higher interest rates and some profit for the banks.

post returns, the financing of each firm i takes the form of a standard debt contract defined by the interest rate, $r_f(i)$, and the amount of the loan, $l(i)$. Accordingly, the bank receives a return, $r_f(i)$, per unit of loan if firm i is able to repay, and appropriates the liquidation value of the firm's revenues in the event of default. We assume that a fraction $(1-\tau)$ of firm revenues, with $\tau \in [0,1]$, is destroyed during the process of liquidation of the loan upon default. The expected value of a loan of size $l(i)$ extended to a firm i, exerting effort at $\underline{\epsilon}$, and producing $y(i)$ is

$$\frac{\overline{\epsilon}-\widehat{e}(i)}{\overline{\epsilon}-\underline{\epsilon}}\int_{\widehat{e}(i)}^{\overline{\epsilon}}\left(\frac{1}{\overline{\epsilon}-\widehat{e}(i)}\left(1+r_f(i)\right)l(i)\right)de(i)+\frac{\widehat{e}(i)-\underline{\epsilon}}{\overline{\epsilon}-\underline{\epsilon}}\tau\int_{\underline{\epsilon}}^{\widehat{e}(i)}\frac{1}{\widehat{e}(i)-\underline{\epsilon}}e(i)c^{\theta}y(i)^{1-\theta}de(i) \quad (9)$$

According to equation (9), banks' expected profits account for both the return upon loan repayment and the expected liquidation value upon default (the fraction τ of revenues from sales). Taking the integral in the latter term, we get the liquidation value

$$lv(i)=\tau\frac{\widehat{e}^2(i)-\underline{\epsilon}^2}{2\left(\widehat{e}(i)-\underline{\epsilon}\right)}y(i)^{1-\theta}c^{\theta} \quad (10)$$

which implies the following loss of value due to loan default

$$loss(i)=(1-\tau)\frac{\widehat{e}^2(i)-\underline{\epsilon}^2}{2\left(\overline{\epsilon}-\underline{\epsilon}\right)}y(i)^{1-\theta}c^{\theta} \quad (11)$$

We note that, if the loan size is the same across firms, equations (10) and (11) also measure aggregate expected values. Also, since we have no aggregate uncertainty, by the law of large numbers, such aggregate expected values are the same as the *ex post* aggregate realization. A necessary condition for banks to be willing to finance firm i is that the expected value of the loan, $l(i)$, is greater or equal than the cost of issuing the corresponding deposit

$$\frac{\overline{\epsilon}-\widehat{e}(i)}{\overline{\epsilon}-\underline{\epsilon}}\left(1+r_f(i)\right)l(i)+\frac{\widehat{e}(i)-\underline{\epsilon}}{\overline{\epsilon}-\underline{\epsilon}}lv(i)\geq(1+r)l(i) \quad (12)$$

where the left-hand side is obtained by taking the integral in (9) and inserting the definition of liquidation value (10), and the right-hand side measures the cost of the deposit. Banks compete to *à la* Bertrand offer the amount of lending demanded by firms, $l(i)=wy(i)/A$, at the cost of credit, $r_f(i)$, that maximize firms' expected payoff (9) subject to the banks' participation constraint (12) and the ICC constraint (8). Bertrand competition across banks implies that the equilibrium the interest rate of the loan, $r_f(i)$, for a given size of the loan, is pinned down by the following relationship

$$1 + r_f(i) = (1+r)\frac{\overline{\epsilon} - \underline{\epsilon}}{\overline{\epsilon} - \widehat{e}(i)} - \frac{\widehat{e}(i) - \underline{\epsilon}}{\overline{\epsilon} - \widehat{e}(i)}\frac{lv(i)}{l(i)} \tag{13}$$

where $\underline{\epsilon} = \underline{\epsilon}_H$ if firm satisfies the ICC given by equation (8), while $\underline{\epsilon} = \underline{\epsilon}_L$, otherwise.

3 General equilibrium

We now characterize the general equilibrium and discuss the existence conditions. First, let us describe the timing of events:

Stage 0. Given the relative prices, the risk-free interest rate and the real wage, households choose consumption and consumption varieties, demand deposits and supply labor. Depending on wages and the interest rate on loans, firms demand labor and loans, and choose production. Banks issue deposits at the risk-free interest rate, choose the loan interest rate and the supply of loans.

Stage 1. Households choose effort on firm management.

Stage 2. Idiosyncratic shocks take place, consumption takes place, and payoffs are realized.

Having described the timing of events, we define the equilibrium as follows:

Definition 1. *Given the exogenous risk-free interest rate, r, a general equilibrium is:*

- a set of relative prices $p(i)/p$ for $i \in [0,1]$; loan interest rates, $r_f(i)$ for $i \in [0,1]$; and a real wage, w;

- a set of quantities for the varieties of consumption goods, $y(i)$ for $i \in [0,1]$; loans, $l(i)$ for $i \in [0,1]$; labor, n; and deposits, dep;

- a managerial effort level, $\underline{\epsilon}$;

such that agents are playing their best strategies and the markets for goods, labor, and deposits clear, while the market for loans can either clear or be characterized by credit rationing depending on whether the ICC is either not binding or binding.

We now turn to the description of the general equilibrium with either high or low managerial effort. As we shall see, the equilibrium with high effort is characterized either by credit rationing or credit market clearing depending on whether moral hazard is pervasive or not.

3.1 Equilibrium with high managerial effort ($\underline{\epsilon} = \underline{\epsilon}_H$)

Using (13) and (10) to substitute for $(1 + r_f(i))$ and $lv(i)$ and imposing $\underline{\epsilon} = \underline{\epsilon}_H$ in (8), the ICC becomes

$$y(i) \leqslant \left(\frac{A\left[(\overline{\epsilon}^2 - \widehat{e}(i)^2) + \tau \left(\widehat{e}^2(i) - \underline{\epsilon}_H^2 \right) \right] (\underline{\epsilon}_H - \underline{\epsilon}_L)}{2w(\overline{\epsilon} - \underline{\epsilon}_H)(\overline{\epsilon} - \underline{\epsilon}_L) \left[\frac{\underline{\epsilon}_H - \underline{\epsilon}_L}{\overline{\epsilon} - \underline{\epsilon}_L}(1+r) + b \right]} \right)^{1/\theta} c \equiv y_{\max}(i) \qquad (14)$$

As it can be seen, other things equal, the maximum level of production compatible with the incentives of firm's management to exert high effort, $y_{\max}(i)$, declines with private benefits, b. This is due to the fact that higher private benefits exacerbate the moral hazard problem by making shirking more attractive. Furthermore, $y_{\max}(i)$ falls if the gap between high and low effort $(\underline{\epsilon}_H - \underline{\epsilon}_L)$ rises as the expected revenue of low effort decreases relative to that expected with high effort. Finally, $y_{\max}(i)$ increases with the percentage of the firm's value recovered by banks in case of firm liquidation following default, τ, as the contribution of defaulting firms to the value of the loan would increase.

Plugging the cost of borrowing and the liquidation value given by (13) and (10), respectively, in the expected profit function (6), and imposing $\underline{\epsilon} = \underline{\epsilon}_H$, the maximization problem of the firm, conditional on firm's management exerting high effort, becomes

$$\max_{\{y(i)\}} \quad E\left(\pi(i)\right)|\underline{\epsilon}_H) = \left(\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau \left(\widehat{e}^2(i) - \underline{\epsilon}_H^2 \right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)} \right) c^\theta y(i)^{1-\theta} - (1+r)\frac{y(i)}{A}$$
$$\text{s.to: } y(i) \leq y_{\max}(i)$$

where $y_{\max}(i)$ is defined in (14).

The firm's optimal choice of the amount of output produced can be either constrained or not. We know that the level of firm production is associated with a level of firm's loan. Therefore, constrained production corresponds to credit rationing, while unconstrained production is associated with credit market clearing.

In order to characterize the unconstrained equilibrium with high effort, we find the optimal production under the guess that the constraint $y(i) \leq y_{\max}(i)$ is slack, and then we study the necessary and sufficient condition that verifies our guess. The first order condition of the above problem, imposing that the constraint, would be

$$\frac{(1-\theta)\left[\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)\right]}{2\left(\overline{\epsilon} - \underline{\epsilon}_H\right)} y(i)^{-\theta} c^{\theta} - (1+r)\frac{w}{A} = 0$$

which leads to the optimal unconstrained level of production chosen by firms

$$y(i) = \left(\frac{A(1-\theta)\left[\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)\right]}{2w\left(\overline{\epsilon} - \underline{\epsilon}_H\right)(1+r)}\right)^{1/\theta} c \tag{15}$$

We now have to verify under which condition such optimal level of production satisfies $y(i) \leq y_{\max}(i)$. Substituting for $y(i)$ using (15), and for $y_{\max}(i)$ based on (14), we find that the necessary and sufficient condition for the resulting inequality to be satisfied is

$$\theta > \frac{b}{\frac{\underline{\epsilon}_H - \underline{\epsilon}_L}{\overline{\epsilon} - \underline{\epsilon}_L}(1+r) + b} \equiv \theta_{\min} \tag{16}$$

The above condition states that if θ is greater than the critical value $\theta_{\min}$, the unconstrained optimal level of production chosen by the firm's management under high effort, given by equation (15), satisfies the ICC constraint. In this case, moral hazard does not play a role in equilibrium. That is, the equilibrium is characterized by credit market clearing only if firms' market power, measured by θ, is sufficiently high.[10] We note that the critical level of market power, $\theta_{\min}$, rises with the level of private benefits, b, associated with managerial misconduct of the firm (which it is a moral hazard indicator). We interpret this result in the following way. In poor institutional environments, where managerial misconduct is more rewarding, more market power is needed to give firms' owners the right incentive to maximize firm's value by exerting high effort.

Whenever condition (16) is not satisfied, any equilibrium in which firms' management exerts high effort, if it exists, is characterized by credit rationing. Firm's ICC would be binding, so the production of the firm is constrained at $y_{\max}(i)$ given by equation (14).

[10] In the Appendix (section A.5), we derive the analytical solution for $\widehat{e}(i)$, y, c, w, $r_f(i)$, n, and household utility $u(c,n)$ associated with the general equilibrium in which firms' management exerts high effort and $\theta > \theta_{\min}$ so that the credit market clears.

Finally, the existence of an equilibrium with high effort, whether constrained or not, requires an additional necessary condition. Firm's management should have no incentive to deviate from high effort to low effort.[11] Given a high effort equilibrium, firm's management has no incentive to deviate if

$$\pi(i)|_{\underline{\epsilon}_{H\rightsquigarrow L}} \leqslant \pi(i)|_{\underline{\epsilon}_H} \tag{17}$$

where

$$\pi(i)|_{\underline{\epsilon}_{H\rightsquigarrow L}} = \left(\frac{\overline{\epsilon}^2 - \widehat{e}_L(i)^2 + \tau\left(\widehat{e}_L^2(i) - \underline{\epsilon}_L^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_L)}\right) c^\theta y_L(i)^{1-\theta} - ((1+r) - b)\,\frac{w y_L(i)}{A}$$

is the expected profit associated with firm's management deviation to low effort, while $\pi(i)|_{\underline{\epsilon}_H}$ is given in equation (6).[12]

3.2 Equilibrium with low managerial effort ($\underline{\epsilon} = \underline{\epsilon}_L$)

When households choose low managerial effort, $\underline{\epsilon}_L$, the cost of borrowing and the liquidation value of the loan are obtained by imposing $\underline{\epsilon} = \underline{\epsilon}_L$ in equations (13) and (10). The resulting expressions can be plugged in equation (7) to write down the following optimizing problem of the firm

$$\max_{\{y(i)\}} \quad \left(\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_L^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_L)}\right) c^\theta y(i)^{1-\theta} - (1+r-b)\,\frac{y(i)}{A} w \tag{18}$$

The unconstrained solution relies on the following first order condition

$$\frac{(1-\theta)\left(\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_L^2\right)\right)}{2\left(\overline{\epsilon} - \underline{\epsilon}_L\right)} c^\theta y(i)^{-\theta} - ((1+r) - b)\,\frac{w}{A} = 0$$

Solving for $y(i)$ yields

$$y(i) = \left(\frac{(1-\theta)\,A\left(\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_L^2\right)\right)}{2w\left(\overline{\epsilon} - \underline{\epsilon}_L\right)((1+r) - b)}\right)^{1/\theta} c$$

[11] Note that if firms deviate to low effort, they anticipate the outcome of the subsequent game.

[12] Condition (17) must be verified taking the aggregate variables evaluated at the equilibrium with high effort. The expected profits in case of deviation, $\pi(i)|_{\underline{\epsilon}_{H\rightsquigarrow L}}$, are obtained considering that all firm-level variables are conditional on firm's management exerting low effort. See Appendix (section, A.3), for the equations that determine $y_L(i)$ and $\widehat{e}_L(i)$.

A necessary condition for the existence of the equilibrium is that firm's management has no incentive to deviate to high effort. The formal condition is

$$\pi(i)|_{\underline{\epsilon}_{L\rightsquigarrow H}} \leqslant E(\pi(i)|_{\underline{\epsilon}_L}) + bl(i) \tag{19}$$

where

$$\pi(i)|_{\underline{\epsilon}_{L\rightsquigarrow H}} = \left(\frac{\overline{\epsilon}^2 - \widehat{e}_H(i)^2 + \tau\left(\widehat{e}_H(i)^2 - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)}\right) c^\theta y_H^{1-\theta}(i) - (1+r)\frac{y_H(i)}{A} w$$

is firm's expected profit if firm's management deviates to high effort (given the equilibrium values of aggregate variables), and $E(\pi(i)|_{\underline{\epsilon}_L}) + bl(i)$ is given by (18). The equations that determine $y_H(i)$ and $\widehat{e}_H(i)$ are shown in section A.4 of the Appendix.

4 The welfare effects of market power

Since the general model cannot be fully solved analytically, before moving to its numerical simulation and in order to better understand the role of market power, we analyze the following special cases:

1. An economy with no moral hazard, where the only financial friction is due to costly defaults.
2. An economy with moral hazard and costless defaults.

4.1 Welfare effects of market power with no moral hazard and costly defaults

It can be immediately verified that when $b = 0$, $\theta_{\min} = 0$ in (16) and moral hazard is ruled out. Under this special case, the economy behaves as discussed in the previous section, when analyzing the equilibrium with high effort. Therefore, its analytical solution, which is provided in section A.5 of the Appendix, suits the analysis of the welfare effects of market power in the absence of moral hazard. As derived in that section of the Appendix, the equilibrium value of household's utility is

$$u(c,n) = \kappa^{\frac{(1+\gamma)(1-\sigma)}{(\sigma+\gamma)(1-\theta)}} A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}} \left(\frac{1}{1-\sigma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{\psi}{1+\gamma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1+\gamma}{\sigma+\gamma}}\right) \tag{20}$$

where

$$\kappa \equiv \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)}$$

and

$$\widehat{e}(i) = \max\left\{\underline{\epsilon}_H, \frac{\overline{\epsilon} - \sqrt{\overline{\epsilon}^2 - (1+\theta(1-\tau))\left[(1-\theta)\overline{\epsilon}^2 + \theta\tau\underline{\epsilon}_H^2\right]}}{(1+\theta(1-\tau))}\right\}$$

is the equilibrium value of the critical shock that determines the loan default rate. We assess the welfare effect of market power by studying the derivative of $u(c,n)$ with respect to θ, $\frac{\partial u(c,n)}{\partial\theta}$. Unfortunately, $\frac{\partial u(c,n)}{\partial\theta}$ turns out not to be tractable in the general case of $\tau \in [0,1]$. In order to circumvent this difficulty, we proceed as follows.

Market power should affect welfare through two opposing channels. First, mark-ups from market power reduce firms' production and welfare. Second, by inducing higher firm's revenues, market power decreases the probability and the extent of defaults, which increases welfare. Such positive effect should be weaker the lower default costs are, i.e. the higher the efficiency of the liquidation technology measured by τ is. Indeed, it can be shown that welfare is an increasing function of τ (see section A.6 of the Appendix). That given, in order to assess the welfare effects of market power in a tractable way, we focus on the two extreme cases: $\tau = 1$ (zero default costs), and $\tau = 0$ (highest default costs). The welfare effects of market power should be negative in the first case and ambiguous in the second case.

Considering the extreme cases, $\tau = 1$ and $\tau = 0$, the value of household utility given by equation (20) can be decomposed as follows

$$u(c,n) = f(\theta)g(\theta)$$

where, according to the analytical solutions presented in sections A.7 and A.8 of the Appendix, the functions $f(\theta)$ and $g(\theta)$ are

$$f(\theta) = \begin{cases} \left(\frac{2\theta\overline{\epsilon}^2}{(\overline{\epsilon}-\underline{\epsilon}_H)(1+\theta)^2}\right)^{\frac{(1+\gamma)(1-\sigma)}{(\sigma+\gamma)(1-\theta)}} & \text{if } \tau = 0 \\ 1 & \text{if } \tau = 1 \end{cases}$$

$$g(\theta) = A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}}\left(\frac{1}{1-\sigma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{\psi}{1+\gamma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1+\gamma}{\sigma+\gamma}}\right)$$

The effect of θ on household utility is measured by

$$\frac{\partial u(c,n)}{\partial\theta} = \frac{\partial f(\theta)}{\partial\theta}g(\theta) + \frac{\partial g(\theta)}{\partial\theta}f(\theta)$$

where partial derivatives are

$$\frac{\partial f(\theta)}{\partial\theta} = \begin{cases} e^{\frac{a_2}{1-\theta}\log\left(\frac{a_1(1+\theta)^2}{\theta}\right)}\frac{a_2}{(1-\theta)^2}\left[\log\left(\frac{a_1(1+\theta)^2}{\theta}\right)-\frac{(1-\theta)^2}{\theta(1+\theta)}\right] & \text{if } \tau=0 \\ 0 & \text{if } \tau=1 \end{cases} \tag{21}$$

$$\frac{\partial g(\theta)}{\partial\theta} = \frac{A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}}\psi^{-\frac{1-\sigma}{\sigma+\gamma}}}{\sigma+\gamma}\left[(1-\theta)^{\frac{1-\sigma}{\sigma+\gamma}}-(1-\theta)^{\frac{1-2\sigma-\gamma}{\sigma+\gamma}}\right] \tag{22}$$

with $a_1 = \frac{\overline{\epsilon}-\epsilon_H}{2\overline{\epsilon}^2}$ and $a_2 = \frac{(\sigma-1)(1+\gamma)}{\sigma+\gamma}$. It is easy to verify in (22) that $\frac{\partial g(\theta)}{\partial\theta} < 0$, given $\theta \in [0, \overline{\epsilon}-1]$, and the household preference parameters with values $\sigma > 1$ and $\gamma > 0$. In principle, the relative risk aversion coefficient, σ, could take any positive value. However, its empirical estimates are typically well above one to be consistent with a low value of the elasticity of intertemporal substitution (Yogo, 2004). Accordingly, we stick to the empirically relevant case $\sigma > 1$, so that $\frac{\partial g(\theta)}{\partial\theta} < 0$ holds. Therefore, since $f(\theta)$ is strictly positive, the product $\frac{\partial g(\theta)}{\partial\theta}f(\theta)$ is negative, which relates to the negative welfare effect of market power due to lower production.

Regarding $\frac{\partial f(\theta)}{\partial\theta}g(\theta)$, if $\sigma > 1$ and

$$\frac{(\overline{\epsilon}-1)}{\overline{\epsilon}^2} < \frac{\theta}{(1+\theta)^2}e^{\frac{(1-\theta)^2}{\theta(1+\theta)}} \tag{23}$$

both $\frac{\partial f(\theta)}{\partial\theta} < 0$, given $\tau = 0$ in (21), and $g(\theta) < 0$, where we note that condition (23) is satisfied for any feasible values of $\overline{\epsilon}$ and θ.[13] Therefore, we would have $\frac{\partial f(\theta)}{\partial\theta}g(\theta) > 0$, which would counterbalance the negative sign of $\frac{\partial g(\theta)}{\partial\theta}f(\theta)$. As a result, the sign of $\frac{\partial u(c,n)}{\partial\theta}$ would become ambiguous so long as $\tau = 0$.[14] The reason is that more market power reduces both the level of production and the default costs. Differently in the case of $\tau = 1$, the sign of $\frac{\partial u(c,n)}{\partial\theta}$ will always be negative. If there are no costs upon loan defaults, the only effect of market power is to reduce production, which is detrimental for welfare.

[13] For example, when $\epsilon = 1.4$ and $\theta = 0.32$ (values used in the baseline calibration to be introduced in Section 5), it is found $0.2041 < 0.5488$ in (23).

[14] Numerical simulations without moral hazard and with $\tau = 0$ show that the benefits of raising market power, θ, exceed the costs for low values of θ. So, the sign of $\frac{\partial u(c,n)}{\partial\theta}$ is positive and a higher market power raises household utility.

4.2 Welfare effects of market power with moral hazard and costless defaults

To look at the effects of moral hazard in isolation, we now consider the case in which private benefits are positive, $b > 0$, and impose $\tau = 1$ so that loan defaults are costless. In equilibrium, either the ICC is binding, $\theta < \theta_{\min}$, so that credit rationing occurs, or the ICC is not binding, $\theta \geqslant \theta_{\min}$, and the credit market clears. According to the analytical solution provided in section A.7 of the Appendix, the equilibrium value of the household's utility is

$$u(c,n) = \begin{cases} \left(\frac{A^{1+\gamma}}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} \left[\left(\frac{1}{1+\frac{b}{1+r}\frac{(\overline{\epsilon}-\underline{\epsilon}_L)}{(\underline{\epsilon}_H-\underline{\epsilon}_L)}} \right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{1}{1+\gamma} \left(\frac{1}{1+\frac{b}{1+r}\frac{(\overline{\epsilon}-\underline{\epsilon}_L)}{(\underline{\epsilon}_H-\underline{\epsilon}_L)}} \right)^{\frac{1+\gamma}{\sigma+\gamma}} \right] & \text{if } \theta < \theta_{\min} \\ A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}} \left(\frac{1}{1-\sigma} \left(\frac{1-\theta}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{\psi}{1+\gamma} \left(\frac{1-\theta}{\psi}\right)^{\frac{1+\gamma}{\sigma+\gamma}} \right) & \text{if } \theta \geqslant \theta_{\min} \end{cases}$$

The welfare effect of raising market power is

$$\frac{\partial u(c,n)}{\partial \theta} = \begin{cases} 0 & \text{if } \theta < \theta_{\min} \\ \frac{A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}} \psi^{-\frac{1-\sigma}{\sigma+\gamma}}}{\sigma+\gamma} \left[(1-\theta)^{\frac{1-\sigma}{\sigma+\gamma}} - (1-\theta)^{\frac{1-2\sigma-\gamma}{\sigma+\gamma}} \right] & \text{if } \theta \geqslant \theta_{\min} \end{cases} \tag{24}$$

It can be observed that the second part of (24) is an expression of positive sign because $(1-\theta)^{\frac{1-\sigma}{\sigma+\gamma}} > (1-\theta)^{\frac{1-2\sigma-\gamma}{\sigma+\gamma}}$, with $0 < \theta < 1$, $\sigma > 1$ and $\gamma > 0$.

If moral hazard is pervasive, $\theta < \theta_{\min}$ in equation (24), the equilibrium value of household's utility is not affected by the level of market power, $\frac{\partial u(c,n)}{\partial \theta} = 0$. Differently, if private benefits are low enough so that moral hazard is not an issue ($\theta \geqslant \theta_{\min}$), the equilibrium household's utility is negatively affected by the level of market power, $\frac{\partial u(c,n)}{\partial \theta} < 0$. The intuition is that, in the first case, production is constrained, so that it is not affected by market power. In the second case, production is not constrained, so that more market power results in lower production.

Finally, by comparing the level of the household's utility in the two cases, we find that the welfare under high effort and credit rationing is greater than that under high effort and no moral hazard if and only if $\theta \geq \theta_{\min}$. However, we know that a necessary condition for credit rationing to be an equilibrium is $\theta < \theta_{\min}$. Therefore, we conclude that if moral hazard is the only friction, market power never has beneficial consequences for household welfare.

5 Calibration

In the remaining sections of the paper, we provide a quantitative analysis of the general version of the model that combines the friction due to the possibility of moral hazard and the one due to default costs. As the benchmark calibration, we set the model in a lending market clearing equilibrium with high effort. Table 1 reports the values of the calibrated parameters.

[Insert Table 1 here]

Labor productivity is normalized at $A = 1.0$ so that labor and output produced are identical. The inverse of the Dixit-Stiglitz demand elasticity is set at $\theta = 0.32$ to imply that firms' dividends bring 32% of total income in the steady state. Household preferences are modulated with an elasticity of utility with respect to consumption $\sigma = 1.25$, which is close to the common case of log preferences on consumption, and also resorts an elasticity of intertemporal substitution below 1.0. The elasticity of the disutility with respect to labor is $\gamma = 2.0$ to bring a Frisch elasticity of labor supply at 0.5, in line with the estimates reported by Altonji (1986), and Domeij and Flodén (2006). The scale parameter that captures the weight on labor disutility in the utility function is set at $\psi = 0.68$ in order to normalize output to one in the unconstrained equilibrium with high effort. The risk-free real interest rate, r is fixed at 1%, a reasonable assumption for a model that delivers annual observations.

The private benefits rate is set at $b = 0.03$, which implies that firms' management exerting low effort collects 3% of the total value of the loan. The shock distribution is bounded between $\bar{\epsilon} = 1.4$ and $\underline{\epsilon}_H = 0.6$ in the case of high managerial effort, which results in an expected value of the shock equal to 1 and a variance equal to 0.053. When firm's management exerts low effort, the lower bound slips down to $\underline{\epsilon}_L = 0.52$, which reduces the expected value of the shock to 0.96 and raises its variance to 0.065. The fraction of firm revenues that banks are able to recover in the event of loan default is set at 80%, i.e. $\tau = 0.8$. The equilibrium values of the endogenous variables resulting from the baseline calibration are provided in Table 2.

[Insert Table 2 here]

The probability of default, d, is 11.21%, and the annual real interest rate of loans, r_f, is 3.94%, giving a spread with respect to the 1% return of the risk-free asset at 2.94%. This number is close to the average gap between the Commercial and Industrial Loan rates over the intended Federal Funds rate for the US economy in the period between 1993 and 2017, which is 2.32%.[15] The probability of default also matches well the annual rate of exit of US total private establishments in the same period (11.69%).[16]

As we mentioned before, the numerical solution satisfies the necessary and sufficient conditions for a credit market clearing equilibrium with high effort to exist. In particular, the minimum value of θ necessary for the existence of such equilibrium is equal to 0.2463. Moreover, the expected profit if firm's management exerted low effort would turn to 0.2836. This is strictly lower than equilibrium expected profit under high effort, which is equal to 0.3132, making that deviation unprofitable.

6 Pervasiveness of moral hazard

In this section, we analyze whether, in the presence of moral hazard, the equilibrium with high effort is either unconstrained or turns constrained by the credit rationing of the banks. If (16) does not hold, moral hazard is pervasive, and then the equilibrium with high effort is constrained by the maximum amount of lending that banks are willing to provide (credit rationing).

[Insert Figure 1 here]

Using the baseline calibration of the model, we will now discuss how the pervasiveness of moral hazard depends on: (i) firms' market power, θ; (ii) the rate of private benefits, b; and

[15] Source: Survey of Terms of Business Lending released by the Board of Gobernors of the Federal Reserve System (http://www.federalreserve.gov/releases/e2/e2chart.htm).

[16] The average rate of exit has been computed using the quarterly series of establishment deaths included in the Business Employment Dynamics report released by the Bureau of Labor Statistics (BLS).

(iii) the effect that low effort has on the variability of the shock, proxied by $(\underline{\epsilon}_H - \underline{\epsilon}_L)$. These are the model elements that mostly affect the intensity of the moral hazard problem. Figure 1 displays the combinations of market power and private benefit rate that lead to either credit rationing (shaded area) or an unconstrained equilibrium (gridded area). Similarly, Figure 2 shows the combinations of θ and $\underline{\epsilon}_H - \underline{\epsilon}_L$ that result in the two possible regions of equilibria. In both graphs, the mark "$*$" represents the baseline calibration.

[Insert Figure 2 here]

For each rate of private benefits, Figure 1 plots the minimum level of market power, θ, required to avoid credit rationing for any given value of the private benefit rate, b. The line marks the frontier between two regions. In one region, characterized by a high θ combined with a sufficiently low b, the ICC is not binding. In the other region, characterized by a low θ combined with a sufficiently high b, the ICC is binding. Therefore, for a given level of private benefits, if market power is sufficiently low, the economy enters a credit rationing (constrained) equilibrium due to moral hazard. With low market power, the expected profits conditional on firm's management exerting high effort turn small, and private benefits associated with low managerial effort become more attractive. This induces credit rationing as moral hazard becomes pervasive. That is, the minimum level of private benefits necessary to have credit rationing is increasing in market power. Clearly, in the absence of private benefits, $b = 0$, the unconstrained equilibrium without credit rationing is the only equilibrium for any degree of firm market power, as moral hazard disappears.

For each level of the difference $(\underline{\epsilon}_H - \underline{\epsilon}_L)$, Figure 2 plots the line related to the minimum level of market power required for the ICC not to be binding. Equivalently to Figure 1, this line marks the frontier between two regions. In the north-east region, characterized by a sufficiently high θ for a given difference $(\underline{\epsilon}_H - \underline{\epsilon}_L)$, the ICC is not binding. In the south-west region, characterized by a sufficiently small difference $(\underline{\epsilon}_H - \underline{\epsilon}_L)$ for a given θ, the ICC is binding.

While more market power results in higher expected profits, a greater difference $(\underline{\epsilon}_H - \underline{\epsilon}_L)$ implies a larger drop in firm's expected profits if firm's management exerts low effort.

Therefore, the unconstrained equilibrium turns more likely both with a higher value of θ and a higher value of $(\underline{\epsilon}_H - \underline{\epsilon}_L)$. The intuition is that both large market power and large profits losses due to low effort reduce the case for moral hazard as firm's management has less incentive to exert low effort.

7 Numerical simulations

In this section, we analyze how the macroeconomic variables react to the two sources of financial frictions contemplated in our model: costly defaults and moral hazard. Loan defaults cause an inefficiency due to the fact that liquidation of the loan contract results in a loss as long as $\tau < 1$. Moral hazard, when it is pervasive, brings credit rationing and a suboptimal amount of output produced by the firms. We explore the general equilibrium effects of these frictions for alternative values in: (i) the inverse Dixit-Stiglitz elasticity, θ, that provides a measure of firm market power, and; (ii) the efficiency of the liquidation technology, τ. Special attention is devoted to the particular cases with no moral hazard (parameterized by setting the private benefit rate at 0%, $b = 0$) and with a fully-efficient liquidation technology ($\tau = 1$) that allows loan defaults occur with no associated loss.

7.1 Effects of market power

Figure 3 displays the equilibrium values of endogenous variables as θ moves from 0.0 to 0.5. The value of the baseline calibration for market power ($\theta = 0.32$) is marked with an asterisk "$*$". The baseline case (thick solid lines) is compared with the model specification without default losses (thick dotted lines), that without moral hazard (thin solid lines), and the case with neither moral hazard nor default losses (thin dotted lines). The shaded area (to the left of the value $\theta_{\min} = 0.2463$) indicates the region with credit rationing in the baseline case, as moral hazard turns pervasive when $\theta < \theta_{\min}$ and the ICC becomes binding.

The non-shaded area (values of $\theta \geq \theta_{\min}$) covers the region in which market power is sufficiently high so that the ICC is not binding. As market power rises within this unconstrained equilibrium region, the expected profit of the firm increases, while both the loan interest rate and default rate fall. The decreasing value of the default costs has a positive impact on household welfare that compensates the standard cost of higher mark-ups (falling output as market power increases). Remarkably, households' welfare rises with an increase of market power over the unconstrained equilibrium region, reaching a peak value precisely at $\theta = 0.4$ when the default rate touches down to 0% and the loan interest rate equalizes the interest rate of the risk-free asset, $r_f = r = 1\%$. That is, at the baseline calibration, market power affects welfare positively by reducing default losses more than it does negatively by causing a lower level of production compared to perfect competition. The tradeoff on the two terms contributing to $\frac{\partial u(c,n)}{\partial \theta}$described in subsection 4.1 is favorable to the positive effect of higher θ for household utility. Moral hazard plays no role because the ICC is satisfied and the equilibrium is identical to the one obtained without moral hazard. In the model specification without default costs, the default rates are the same, but the interest rate of the loan is lower and profits, consumption and welfare are higher. In all model specifications, any increase of market power beyond the value $\theta = 0.4$ turns undesirable because the loan default rate is already at its 0% lower bound, and the contractionary effect of higher mark-ups is still active. Due to this *excessive* market power, $\theta > 0.4$, the expected profit of the firm rises driven by higher mark-ups, but consumption, output and household utility are lower. These results are robust to any specification of the model discussed here.

If there is moral hazard and θ falls below $\theta_{\min}$, the model reaches an equilibrium with high effort and credit rationing. Banks respond to the moral hazard by limiting the size of the loan and firm managers prefer to exert high effort, because deviating to low effort would reduce their expected payoff. The amount of output produced by a firm under credit rationing falls below the amount produced in the absence of moral hazard (compare the solid and dashed lines in the cell 'Output" of Figure 3). The gap rises with less market power to reflect a larger effect of credit rationing in more competitive industries. However, as Figure 3 shows, under the baseline calibration, credit rationing leads to higher household utility compared to the model without moral hazard described by the thin lines. This result is stronger the lower is the level of market power, and highlights the possibility of a positive effect of credit rationing on economies with little market power and sufficiently high risk of firm defaults. Credit rationing keeps the interest rates around 8% and the default rate remains at the 20% ceiling. Meanwhile, in the market-clearing equilibrium without moral hazard, as market power falls both the default rate and the loan interest rate sharply rise, bringing severe default losses and a sharper decline of household utility.

When there is credit rationing and very low values of θ (approaching to the perfect competition scenario at $\theta = 0$), the condition for an equilibrium existence is not fulfilled. If managers exert high effort, they would increase the expected profit by deviating to low effort and collecting the private benefits (condition 17 does not hold). If managers exert low effort, a switch to high effort would also increase the expected profit (condition 19 does not hold either). There are always incentives to deviate from one effort choice to the other and the economy would enter loops of instability.[17]

[Insert Figure 3 here]

Summarizing, more market power leads to higher expected profits, lower probability of default and lower interest rates of the loans. If this effect is greater than the efficiency loss from firms' mark-up, a higher market power turn socially desirable because the welfare effects of the contraction of output and labor supply is lower than those from a decline in loan defaults. A low market power can bring credit rationing by the banks due to moral hazard and the possibility of shirking on the managerial effort decision. With credit rationing, output is constrained at an amount below the optimal one, and the default rates and interest rates barely change with a variation of market power. This explains the fact that a further reduction of market power under credit rationing is welfare enhancing because the mark-up shrinks while default rates remain flat.

These results are robust to changes in either the value of the labor supply elasticity, $1/\gamma$, or the level of labor productivity, A. For a sensitivity analysis, section A.10 of the Appendix displays the correspondence to the plots of Figure 3 at differentiates values of γ and A.

[17] We have also calculated the numerical solution with mixed strategies by assigning $[0, 1]$ shares of differentiated behavior of firm managers (low effort versus high effort). The lack of equilibrium also prevails with mixed strategies. The set of equations defining the mixed strategy equilibrium are available in section A.9 of the Appendix.

7.2 Effects of liquidation technology

We now turn to the quantitative analysis of how the efficiency of the banks' liquidation technology affects the economy. Figure 4 shows the behavior of a selection of endogenous variables of the model for $\tau \in [0, 1]$, keeping the other parameters at their baseline calibration values (solid lines). There are also dashed lines that represent the specification with a lower market power ($\theta = 0.20$) that results in credit rationing, and also dotted lines for the model specification with $\theta = 0.20$ and no moral hazard ($b = 0$). For the case of the baseline calibration and the combination of low effort without moral hazard, the economy is in a market-clearing equilibrium with high effort at any value of the liquidation technology parameter, τ. The lower bound ($\tau = 0$) is an economy in which banks are unable to appropriate any revenue from firm sales and the whole loan value is lost in the event of a loan default. The upper bound ($\tau = 1$) is an economy in which liquidation upon default is fully efficient and all revenues from sales of the firm can be used to cover the value of the loan. The equilibrium at the baseline calibration value of τ, equal to 0.8, is also marked in Figure 4.

[Insert Figure 4 here]

A more efficient liquidation technology (higher τ) always leads to an equilibrium with more consumption and a greater household utility, while the amount of output produced by firms is slightly reduced. The expected value of the loan upon default rises due to a lower default loss. This is associated with a lower interest rate, larger loans, and higher expected profits (see Figure 4). Consumption moves up with a higher τ due to the income effect driven by the increase of dividends. The interpretation of the decrease in output from the supply side relies on the fact that a better liquidation technology comes along with lower interest rates and, therefore, a higher mark-up of firms, which dampens labor supply and cuts down the amount of output produced. The continuously upward path of welfare with a higher τ leads to a maximum value attained at the fully efficient liquidation technology ($\tau = 1.0$).[18]

[18] Note that this positive effect on welfare is the result of putting together the higher utility from the increase on consumption and the lower disutility from the decrease of labor supply.

When there is credit rationing caused by moral hazard (dashed lines), the effects of changing the parameter τ are of the same sign and generally of a higher size. Thus, the efficiency of the liquidation technology can save a higher value of the loan upon defaults, reduce further the interest rate and have a greater impact on welfare when the economy is affected by credit rationing. In the case of low market power and no moral hazard (dotted lines), the effects are even larger because the economy suffers from very high default rates, interest rates and default costs. As τ approaches the case of a fully efficient liquidation technology ($\tau \rightsquigarrow 1$), the values of the interest rate, the loss from defaults and household welfare converge in the three specifications of the model, although the default rates and output are lower with a high market power.

7.3 Welfare analysis

In this section, we provide numerical simulations of the welfare effects of market power. Figure 5 displays the welfare costs obtained at different levels of θ, under alternative sources of financial frictions. Welfare costs are measured in terms of the consumption equivalence (as a percentage of forgone output) with respect to a frictionless economy in which there are no default loss ($\tau = 1$) and no moral hazard ($b = 0$).[19] Table 3 reports the numbers of these welfare costs for several values of θ and specifications of the model. For the baseline calibration values of $\theta = 0.32$ and $\tau = 0.8$, the welfare cost is 4.09% of output. Table 4 shows the value of θ that minimizes the welfare costs for a given value of τ. Welfare costs behave

[19] As discussed earlier in the paper, in general, the household's utility could change with θ, not only due to the interplay between market power and financial frictions, but also due to the love for variety effect (Ethier, 1982, Benassy, 1996). However, since we measure the welfare loss relative to the case of a fully efficient liquidation technology, our measure of the welfare loss would control by itself for the love for variety effect. Moreover, **in our model we consider the case of Dixit-Stiglitz preferences with a mass of varieties of final goods normalized to** 1, **which implies that the love for variety effect disappears as we explain below**. In the general case, with a mass N **of varieties**, the equilibrium value of the consumption bundle is $c = (N)^{\frac{1}{1-\theta}} c(i)$. Taking the derivative with respect to θ yields

$$\frac{\partial c}{\partial \theta} = (N)^{\frac{1}{1-\theta}} c(i) \log(N) \frac{1}{(1-\theta)^2} + \frac{\partial c(i)}{\partial \theta} (N)^{\frac{1}{1-\theta}}$$

If $N = 1$, $\log(1) = 0$ follows, and it is immediate to see that the love for variety effect disappears.

very differently with respect to θ, depending on the settings assumed for both τ and b.

- In the upper left quadrant, Figure 5 shows the welfare cost of an economy with moral hazard and moderate default losses (the case of the baseline calibration with $\tau = 0.8$ and $b = 0.03$). The welfare cost is minimum at the high market power value of $\theta = 0.4$, with a value of 3.43% of output. As discussed in subsection 7.1, large mark-ups increase the expected profit, reducing the probability of default to 0 and, therefore, having a loan interest rate equal to the risk-free rate. Within the interval [0.2463,0.4], a lower market power raises the welfare cost of financial frictions because the adverse effects of rising default rates overcome the beneficial effects of declining mark-ups, moving up the welfare cost from 3.43% at $\theta = 0.4$ to 4.09% at $\theta = 0.32$ (see Table 3). If θ turns lower than $\theta_{\text{min}} = 0.2463$, the ICC is not satisfied and banks do credit rationing. This brings a switch in the effect of lower market power for the welfare cost. A decrease of θ within the range of values that deliver credit rationing results in a reduction of the welfare cost of financial frictions. The default rate, the interest rate of the loan and the default losses are not affected by lower market power due to credit rationing, while the decreasing mark-ups have welfare enhancing effects. For values of $\theta < 0.055$, market power is very low (approaching to the perfect competition scenario $\theta \rightsquigarrow 0.0$), and the model enters the 'no equilibrium" region (dark shaded area in Figure 5) with incentives to continuously change the choice of managerial effort.

- In the upper right quadrant, Figure 5 provides the welfare costs for the model specification without moral hazard and with a liquidation technology that recovers 80% of firm revenue upon loan defaults ($\tau = 0.8$). The welfare cost is minimized when default rates are moved down to 0%, which it is observed (as in the baseline case with moral hazard) for a high market power value of $\theta = 0.4$. The welfare cost is also 3.43% of output value. Since there is no moral hazard, the lack of credit rationing always leads to negative welfare effects of reducing θ below the 0.4 threshold because interest rates, default rates and the corresponding default losses would increase significantly as the expected firm profit falls. In this case, having less market power is socially undesirable because the consequences of having loan defaults are more costly than the effects of reducing the mark-ups. For example, the welfare cost becomes 6.69% of output when $\theta = 0.18$ (see Table 3).

- The welfare cost for the specification of the model with moral hazard ($b = 0.03$) and a fully efficient liquidation technology ($\tau = 1$) is shown in the lower left quadrant of Figure 5. If moral hazard is not pervasive (values of θ higher than $\theta_{\min} = 0.2463$), any increase in market power reduces household utility and increases the welfare cost, which is consistent with the analytical solution derived in section A.7 of the Appendix. The rise in the mark-up reduces welfare while loan defaults are not costly because the liquidation technology is fully efficient. As one numerical example, rising θ from 0.32 to 0.40 would cut down the loan defaults rates to 0%, while household utility falls and the welfare cost increases from 2.02% to 3.43%. If market power falls below $\theta_{\min}$, the ICC is not satisfied and banks do credit rationing. The line that plots the welfare cost turns flat (see Figure 5), because any change of θ will have no effect on household utility.[20] Hence, the welfare cost is minimized within the credit rationing region, $\theta \in [0.17, \theta_{\min}]$, at a value of 1.03% of output. If market power would be further reduced below $\theta = 0.17$, the model enters the no equilibrium region because condition (17) is not satisfied when exerting high effort and (19) does not hold with low effort.

- The lower right quadrant of Figure 5 provides the welfare costs if all financial frictions are removed. The value of the welfare loss is 0% in the economy with no market power ($\theta \rightsquigarrow 0$), and it goes up with any increase in θ. The only welfare effect of changing θ is the one caused by altering the mark-up. This unambiguously leads to reductions of household utility when market power θ rises. The welfare costs describe a convex curve as θ rises that converges to the other model specifications at $\theta = 0.4$ with an equivalent value of 3.43% of output.

[Insert Figure 5 here]

[20] This result is consistent with the analytical solution of $u(c, n)$ derived in section A.7 of the Appendix for the values of θ that lead to credit rationing $\theta < \theta_{\min}$.

[Insert Table 3 here]

[Insert Table 4 here]

The economic interpretation of the observed relationship between welfare cost and market power is the following. A higher level of market power implies higher expected firms' profits which (i) gives firms' management stronger incentives to exert high effort, and; (ii) reduces the probability of default. Accordingly, market power helps preventing moral hazard and reduces default losses, where the latter effect is weaker the higher is the value of τ, vanishing completely for $\tau = 1$. Hence, with a fully-efficient liquidation technology ($\tau = 1$), the only positive effect of market power is to prevent moral hazard. This is the reason why the optimal value of market power in this case is at the interval of credit rationing [0.17,$\theta_{\min}$]. As τ goes down, market power also contributes positively to welfare by reducing losses related to costly defaults. If liquidation technology brings severe default losses, the socially desirable market power is large at $\theta = 0.4$ to reach zero default rates.

In all cases, the optimal degree of market power is the one that balances the positive effect of a higher θ, due to the mitigation of moral hazard and the reduction of default costs, with the standard negative effect that results from higher firms' mark-up and lower production compared to a perfectly competitive market.

Finally, the role of moral hazard for welfare analysis is ambiguous. If loan defaults are costly (low τ), credit rationing leads to lower welfare costs of financial frictions compared to economies without moral hazard. For example, Table 3 informs that the combination of $\theta = 0.18$ and $\tau = 0.8$ results in a welfare cost of 4.87% of output with moral hazard versus 6.69% without moral hazard. However, if the liquidation technology is efficient (value of τ approaching to 1), moral hazard results in a higher welfare loss as the negative welfare effects due to lower production associated with credit rationing outweigh the positive ones due to lower default rates. Thus, an economy with $\theta = 0.18$ and a fully-efficient liquidation technology $\tau = 1$ will have a welfare cost of 1.12 of output with moral hazard and 0.57% of output without it.

Table 4 indicates the values of θ that minimize the welfare costs (i.e., the optimal market power) at the four different specifications of the model.

8 Conclusions

We develop a static general equilibrium model with monopolistically competitive producers and financial frictions due to the non verifiability of both firms' managerial decisions and ex post profitability. Our analysis shows that firm's market power reduces the cost of borrowing and the loan default rates, creating a welfare gain that may offset the contractionary effect of mark-ups. Such trade-off between benefits and costs of increasing market power is not trivial. We find that, in general, in the presence of financial frictions, some degree of market power is required in order to maximize households' welfare. The reason is that market power helps preventing both pervasive moral hazard and inefficient loan defaults. Deviations from such optimal degree of market power may have significant welfare effects. For instance, with a relatively low level of market power, measured by $\theta = 0.32$, the welfare loss amounts to 4.09% of output. Such welfare cost would be cut down to 3.43% of output (66 basis points difference) if market power were higher, $\theta = 0.40$. As documented in the paper, these costs rise substantially when the efficiency of the liquidation of a defaulting loan is low. Therefore, the social costs of financial frictions can be reduced by either a more efficient liquidation technology or with by a higher degree of market power.

The theoretical and numerical analysis indicate that if the liquidation technology on loan defaults is efficient, the welfare cost is minimized at low levels of firm's market power. This is the case, even though low market power leads to pervasive moral hazard and credit rationing. As default rates increase due to lower market power, credit rationing emerges to alleviate the adverse effects of high default rates and default costs. Such financial constraint sets a ceiling on the rate of loan defaults and cuts down the related losses. In other words, credit rationing due to moral hazard is welfare enhancing if the liquidation technology is very inefficient. This has been tested in the comparison to the model specification without moral hazard (and no credit rationing), which brings lower levels of welfare.

The implications of these results for policy makers would require a previous evaluation of the institutional framework where financial markets operate. In economies with poor financial markets and underdeveloped legal systems, in which financial frictions are relevant and loan defaults are costly, promoting competition in the production sector might be detrimental to macroeconomic performance (La Porta *et al.,* 1998). In order to benefit from competition, these economies should undertake reforms, including that of the legal system, that foster the development of financial institutions to both reduce moral hazard and make firm liquidation more efficient to promote economic growth (Levine, 2005).

From a business cycle perspective, the vast literature on financial frictions and short term fluctuations starting with Bernanke and Gertler (1989) does not provide a systematic assessment of the role of firms' market power. Our analysis could be extended to a general-equilibrium dynamic framework to study how market power affects the role of financial frictions in shaping business cycle fluctuations by affecting the persistence and the amplification of short-run shocks, as well as to investigate the impact on firms' entry and exit.

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Tables and Figures

Table 1. Calibration of parameters

A	Labor productivity	1.00
θ	Market power (inverse Dixit-Stiglitz elasticity)	0.32
σ	Elasticity of consumption utility	1.25
γ	Elasticity of labor disutility	2.00
ψ	Weight of labor disutility	0.68
r	Risk-free interest rate	0.01
b	Private benefits rate	0.03
$\overline{\epsilon}$	Upper bound shock	1.40
$\underline{\epsilon}_H$	Lower bound shock with high effort	0.60
$\underline{\epsilon}_L$	Lower bound shock with low effort	0.52
τ	Liquidation value per unit of firm revenue	0.80

Table 2. Equilibrium values of the endogenous variables

Output, y	1.0000
Consumption, c	0.9788
Probability of default, d	0.1121
Interest rate of loans, r_f	0.0394
Critical shock, $\widehat{e}(i)$	0.6896
Real wage, w	0.6590
Labor, n	1.0000
Loan value, l	0.6590
Liquidation value, lv	0.5124
Default loss, $loss$	0.1281
Expected profit, $E(\pi(i))$	0.3224
Household utility, u	-4.2481

Table 3. Welfare costs of financial frictions (% of output)

	Perfect competition $\theta \rightsquigarrow 0.0$	Low market power $\theta = 0.18$	Medium market power $\theta = 0.32$	High market power $\theta = 0.40$
Baseline ($\tau = 0.8$, $b = 0.03$)	?	4.87	4.09	3.43
Only moral hazard ($\tau = 1.0$, $b = 0.03$)	?	1.12	2.02	3.43
Only default costs ($\tau = 0.8$, $b = 0.0$)	16.28	6.69	4.09	3.43
No financial frictions ($\tau = 1.0$, $b = 0.0$)	0.0	0.57	2.02	3.43

Table 4. Optimal market power, credit rationing and welfare costs

	Optimal market power, θ	Credit rationing?	Welfare cost (% of output)
Baseline ($\tau = 0.8$, $b = 0.03$)	0.40	No	3.43
Only moral hazard ($\tau = 1$, $b = 0.03$)	[0.17,0.2463]	Yes	1.03
Only default costs ($\tau = 0.8$, $b = 0$)	0.40	No	3.43
No financial frictions ($\tau = 1$, $b = 0$)	0.0	No	0.0

Figure 1. Unconstrained equilibrium *versus* credit rationing depending on θ and b.

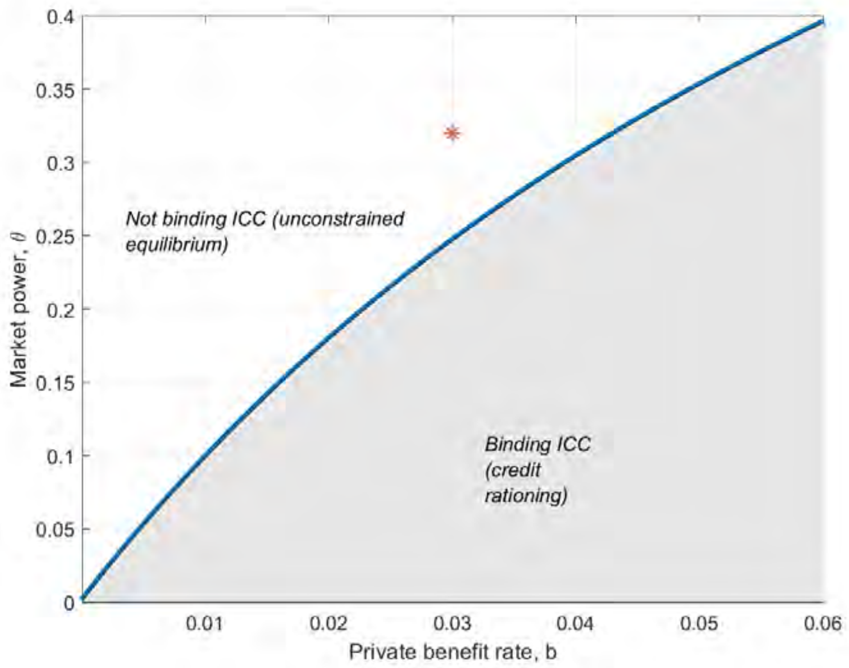


Figure 2. Unconstrained equilibrium *versus* credit rationing depending on θ and $\underline{\epsilon}_H - \underline{\epsilon}_L$.

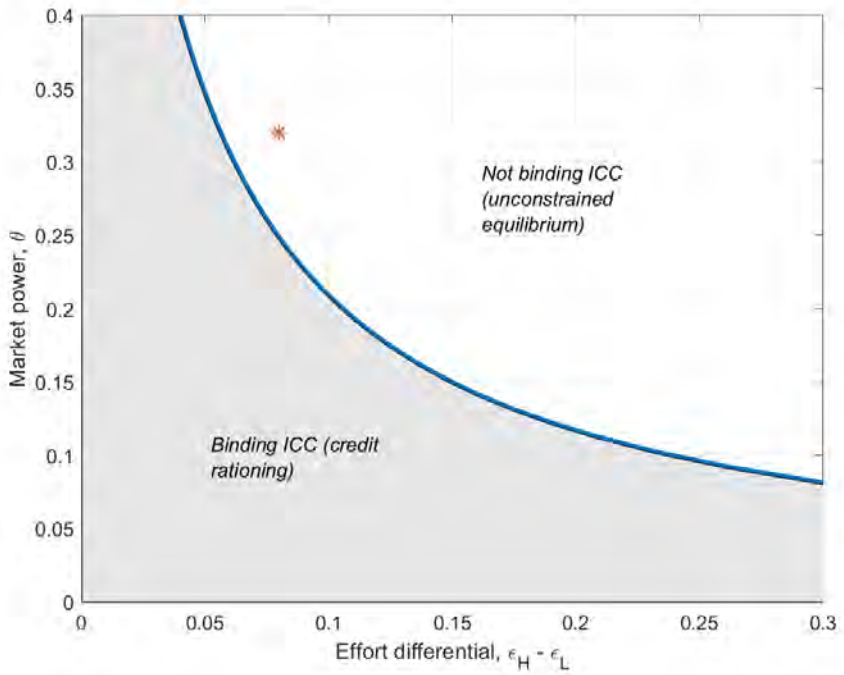


Figure 3. General equilibrium effects depending on market power, θ.

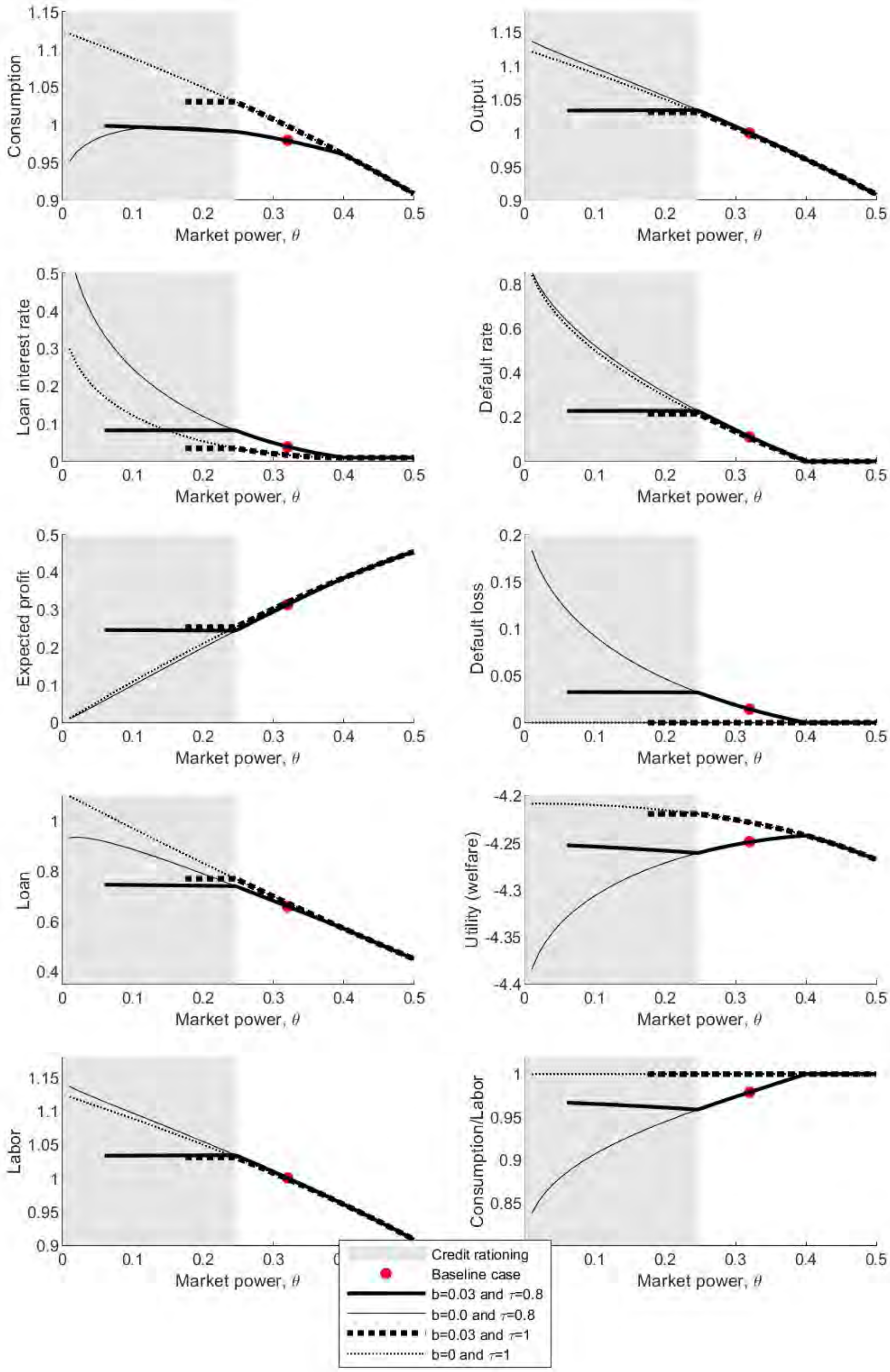


Figure 4. General equilibrium effects depending on liquidation technology, τ

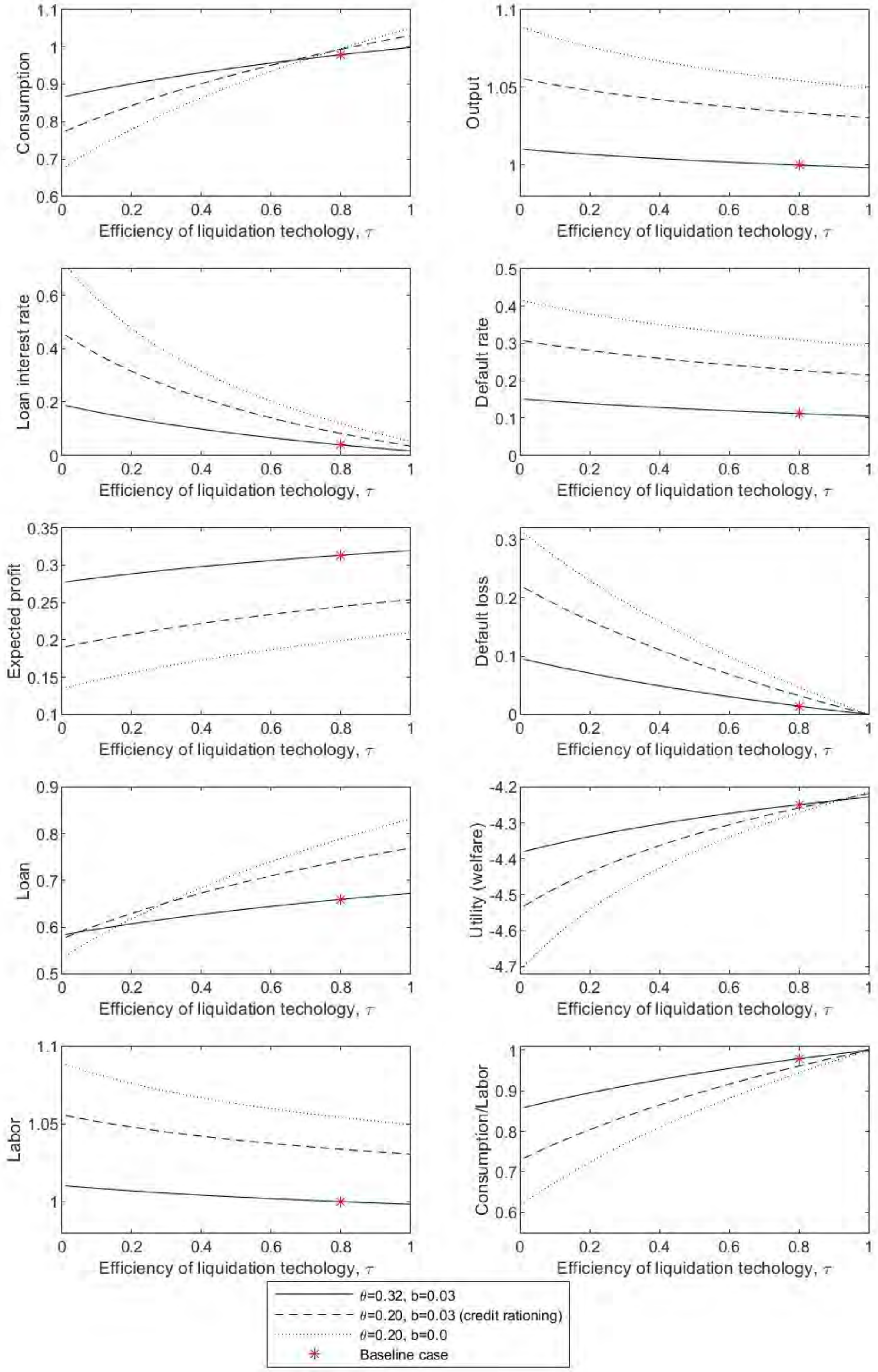
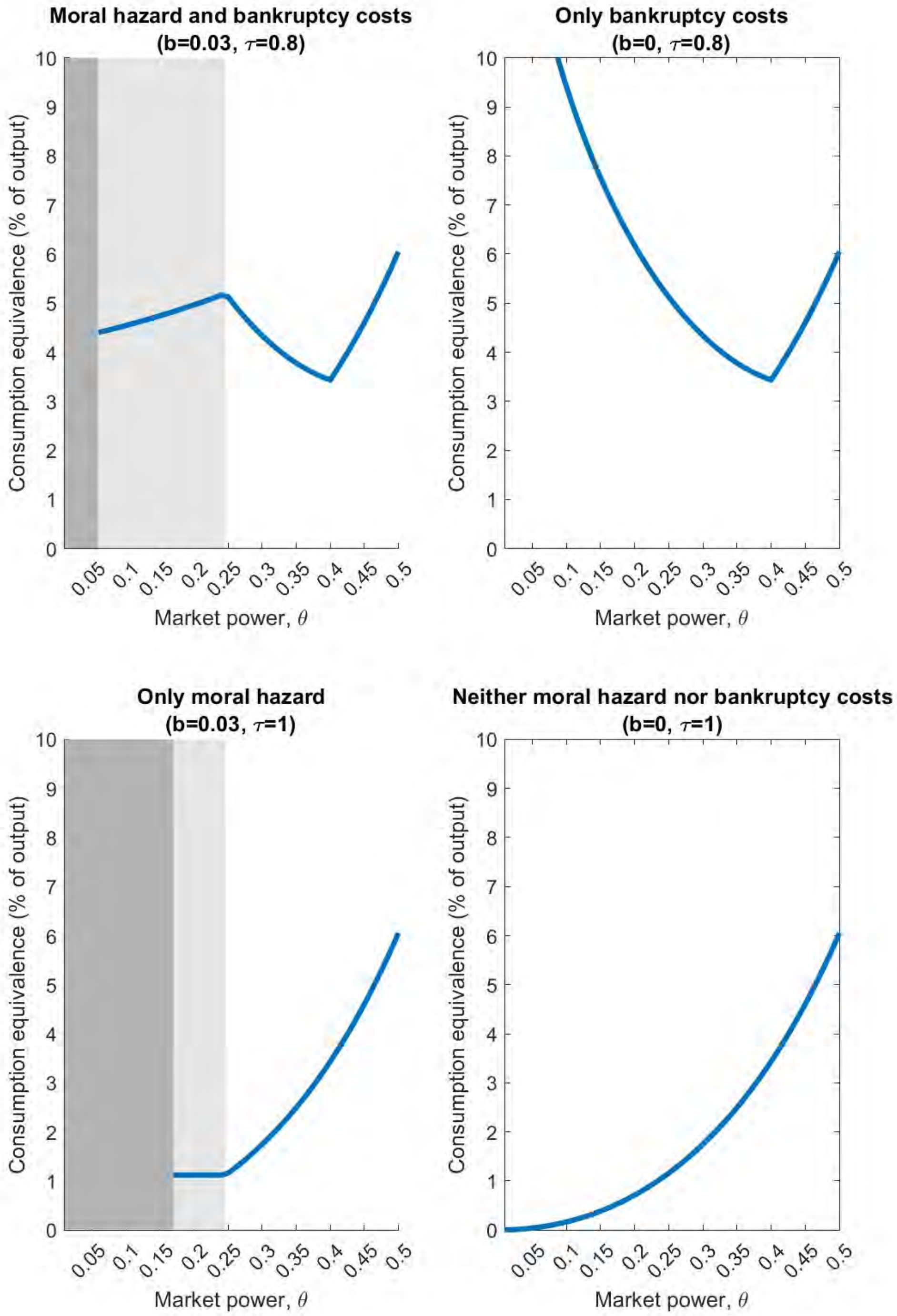


Figure 5. Welfare cost of financial frictions depending on market power.[21]



[21]Light shaded area is the "credit rationing" region, dark shaded area is the "no equilibrium" region.

Appendix

A.1 Optimal choice of the amount consumed of variety i

Households choose $c(i)$ by solving the following maximization problem:

$$\begin{aligned} \max_{\{c(i),\,c\}} \qquad & c = \left[\int_0^1 e(i)c(i)^{1-\theta}di\right]^{\frac{1}{1-\theta}} \\ \text{s.to:} \quad pc \; & = \int_0^1 p(i)c(i)di \end{aligned}$$

The associated first order conditions are (being λ the Lagrange multiplier):

$$\begin{aligned} c^{\theta}e(i)c(i)^{-\theta} - \lambda p(i) &= 0 \qquad \forall i \in [0,1] \\ 1 - \lambda p &= 0 \\ pc &= \int_0^1 p(i)c(i)di \end{aligned}$$

which leads to the (inverse) demand function, $\frac{p(i)}{p} = e(i)\left(\frac{c(i)}{c}\right)^{-\theta}$, where $p = \left[\int_0^1 p(i)^{\frac{\theta-1}{\theta}} e(i)^{1/\theta} di\right]^{\frac{\theta}{\theta-1}}$ is the price index.

A.2 Overall resources constraint

High effort case

In equilibrium, the budget constraint of the individual household holds as equality

$$(1+r)\,wn + d = c$$

Note that the above which coincides with the aggregate budget constraint since we have a continuum of size one of households. In equilibrium, firm-level dividends are the same across firms. Moreover, since we have a continuum of firms of size one, $d(i) = d$, where the dividend is the expected profit of the firms (law of large numbers)

$$d = \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_H)} c^{\theta} y^{1-\theta} - \frac{\overline{\epsilon} - \widehat{e}(i)}{\overline{\epsilon} - \underline{\epsilon}_H}\left(1 + r_f\right) w \frac{y}{A}$$

Note that we used the symmetric behavior across firms for the interest rate of the loan and the critical value of the idiosyncratic shock fact that $r_f(i) = r_f(j) = r_f$ and $\widehat{e}(i) = \widehat{e}(j)$ for all $i, j \in [0, 1]$. Substituting for d in the household budget constraint gives

$$(1 + r) \, wn + \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_H)} c^\theta y^{1-\theta} - \frac{\overline{\epsilon} - \widehat{e}(i)}{\overline{\epsilon} - \underline{\epsilon}_H} (1 + r_f) \, wn = c$$

The interest rate of the loan is in equilibrium

$$1 + r_f = \frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)} (1 + r) - \frac{\widehat{e}(i) - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)} \frac{lv}{l}$$

which can be inserted in the budget constraint to obtain

$$\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_H)} c^\theta y^{1-\theta} + \frac{\widehat{e}(i) - \underline{\epsilon}_H}{\overline{\epsilon} - \underline{\epsilon}_H} \frac{lv}{l} wn = c$$

Since the aggregate loan size is equal to the effective labor cost, $l = wn$, we can rewrite the previous expression as the following overall resources constraint

$$\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_H)} y \left(\frac{c}{y}\right)^\theta + \frac{\widehat{e}(i) - \underline{\epsilon}_H}{\overline{\epsilon} - \underline{\epsilon}_H} lv = c$$

The sources of income are the revenue from firms that survive and the liquidation value from firms that default on their loans. All income is spent on consumption goods.

Alternatively, we can use $lv = \frac{\tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{2(\widehat{e}(i) - \underline{\epsilon}_H)} y(i)^{1-\theta} c^\theta$ and $y(i) = y$ to reach

$$\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)} y \left(\frac{c}{y}\right)^\theta = c$$

Low effort case

Firm revenues are negatively affected by the lower expected value of the idiosyncratic shock ($\underline{\epsilon}_L < \underline{\epsilon}_H$) and a private benefit is collected as a fraction b of the size of the loan. The expected profit of the firm plus the private benefit bring the following firm dividend

$$d = \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_L)} c^\theta y^{1-\theta} - \frac{\overline{\epsilon} - \widehat{e}(i)}{\overline{\epsilon} - \underline{\epsilon}_L} (1 + r_f) \, w \frac{y}{A} + bl$$

where using the equilibrium conditions (dropping firm-level indexing as argued above for the high effort case), $l = wn = w\frac{y}{A}$, we have

$$d = \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon} - \underline{\epsilon}_L)} c^\theta y^{1-\theta} - \frac{\overline{\epsilon} - \widehat{e}(i)}{\overline{\epsilon} - \underline{\epsilon}_L} \left(1 + r_f - b\frac{\overline{\epsilon} - \underline{\epsilon}_L}{\overline{\epsilon} - \widehat{e}(i)}\right) w \frac{y}{A}$$

Recalling the household budget constraint, $(1+r)\,wn+d=c$, and plugging the above expression in the place of d, yields

$$(1+r)\,wn+\frac{\overline{\epsilon}^2-\widehat{e}(i)^2}{2(\overline{\epsilon}-\underline{\epsilon}_L)}c^\theta y^{1-\theta}-\frac{\overline{\epsilon}-\widehat{e}(i)}{\overline{\epsilon}-\underline{\epsilon}_L}\left(1+r_f-b\frac{\overline{\epsilon}-\underline{\epsilon}_L}{\overline{\epsilon}-\widehat{e}(i)}\right)wn=c$$

The equilibrium interest rate of the loan that results in competitive banking is

$$1+r_f=\frac{\overline{\epsilon}-\underline{\epsilon}_L}{\overline{\epsilon}-\widehat{e}(i)}(1+r)-\frac{\widehat{e}(i)-\underline{\epsilon}_L}{\overline{\epsilon}-\widehat{e}(i)}\frac{lv}{l}$$

which can be inserted in the previous expression to obtain

$$\frac{\overline{\epsilon}^2-\widehat{e}(i)^2}{2(\overline{\epsilon}-\underline{\epsilon}_L)}c^\theta y^{1-\theta}+\left(\frac{\widehat{e}(i)-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}\frac{lv}{l}+b\right)wn=c$$

Using $l=wn$ in the second term of the left side, the overall resources constraint becomes

$$\frac{\overline{\epsilon}^2-\widehat{e}(i)^2}{2(\overline{\epsilon}-\underline{\epsilon}_L)}c^\theta y^{1-\theta}+\frac{\widehat{e}(i)-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}lv+bl=c$$

which shows three sources of income: revenue from non-defaulting firms, liquidation value of loan defaults and the private benefit.

A.3 Set of equations defining equilibrium with high effort

General equilibrium with high effort

Output	$y = \min \left\{ \begin{array}{c} \left(\frac{(1-\theta)A\left[\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)\right]}{2(\overline{\epsilon}-\underline{\epsilon}_H)(1+r)w} \right)^{1/\theta} c, \\ \left(\frac{A\left(\frac{\left[\left(\overline{\epsilon}^2 - \widehat{e}(i)^2\right) + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)\right](\underline{\epsilon}_H - \underline{\epsilon}_L)}{(\overline{\epsilon}-\underline{\epsilon}_H)(\overline{\epsilon}-\underline{\epsilon}_L)} \right)}{2w\left[\frac{\underline{\epsilon}_H - \underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b\right]} \right)^{1/\theta} c \end{array} \right\}$
Interest rate of the loan	$1 + r_f = \frac{\overline{\epsilon}-\underline{\epsilon}_H}{\overline{\epsilon}-\widehat{e}(i)}(1+r) - \frac{\widehat{e}(i)-\underline{\epsilon}_H}{\overline{\epsilon}-\widehat{e}(i)} \frac{lv}{l}$
Loan	$l = wn$
Critical shock	$\widehat{e}(i) = \max\left\{\underline{\epsilon}_H, \ (1+r_f)\frac{w}{A}y^\theta c^{-\theta}\right\}$
Liquidation value	$lv = \frac{\tau\left(\widehat{e}^2(i)-\underline{\epsilon}_H^2\right)}{2(\widehat{e}(i)-\underline{\epsilon}_H)} y^{1-\theta} c^\theta$
Production	$y = An$
Labor supply	$w = \frac{\psi n^\gamma c^\sigma}{1+r}$
Firm dividend	$d = \left(\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i)-\underline{\epsilon}_H^2\right)}{2(\overline{\epsilon}-\underline{\epsilon}_H)} \right) c^\theta y^{1-\theta} - (1+r)w\frac{y}{A}$
Overall resources constraint	$\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2}{2(\overline{\epsilon}-\underline{\epsilon}_H)} c^\theta y^{1-\theta} + \frac{\widehat{e}(i)-\underline{\epsilon}_H}{\overline{\epsilon}-\underline{\epsilon}_H} lv = c$
If deviating to low effort:	
Critical shock	$\widehat{e}_L(i) = (1 + r_{f,L}(i))\frac{w}{A} y_L(i)^\theta c^{-\theta}$
Interest rate of the loan	$1 + r_{f,L}(i) = \frac{\overline{\epsilon}-\underline{\epsilon}_L}{\overline{\epsilon}-\widehat{e}_L(i)}(1+r) - \frac{\widehat{e}_L(i)-\underline{\epsilon}_L}{\overline{\epsilon}-\widehat{e}_L(i)} \frac{lv_L(i)}{l_L(i)}$
Output	$y_L(i) = \left(\frac{(1-\theta)A\left(\overline{\epsilon}^2 - \widehat{e}_L(i)^2 + \tau\left(\widehat{e}_L^2(i)-\underline{\epsilon}_L^2\right)\right)}{2w(\overline{\epsilon}-\underline{\epsilon}_L)((1+r)-b)} \right)^{1/\theta} c$
Liquidation value	$lv_L(i) = \frac{\tau\left(\widehat{e}_L^2(i)-\underline{\epsilon}_L^2\right)}{2(\widehat{e}_L(i)-\underline{\epsilon}_L)} y_L(i)^{1-\theta} c^\theta$
Firm dividend	$d_L(i) = \left(\frac{\overline{\epsilon}^2 - \widehat{e}_L(i)^2 + \tau\left(\widehat{e}_L^2(i)-\underline{\epsilon}_L^2\right)}{2(\overline{\epsilon}-\underline{\epsilon}_L)} \right) c^\theta y_L(i)^{1-\theta} - \frac{((1+r)-b)wy_L(i)}{A}$
Loan	$l_L(i) = w\frac{y_L(i)}{A}$

The set of 15 equations may provide a numerical solution for the 15 endogenous variables: y, $\widehat{e}(i)$, r_f, c, w, n, lv, l, d, $y_L(i)$, $lv_L(i)$, $l_L(i)$, $d_L(i)$, $\widehat{e}_L(i)$ and $r_{f,L}$. It should be noticed that the list of equations contemplates both cases: the loan market clearing equilibrium and the credit rationing equilibrium, characterized by the different values obtained for the firm-level amount of output.

A.4 Set of equations defining equilibrium with low effort

General equilibrium with low effort

Output	$y = \left(\frac{(1-\theta)A\left(\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_L^2\right)\right)}{2w(\overline{\epsilon}-\underline{\epsilon}_L)((1+r)-b)} \right)^{1/\theta} c$
Interest rate of the loan	$1 + r_f = \frac{\overline{\epsilon}-\underline{\epsilon}_L}{\overline{\epsilon}-\widehat{e}(i)}(1+r) - \frac{\widehat{e}(i)-\underline{\epsilon}_L}{\overline{\epsilon}-\widehat{e}(i)}\frac{lv}{l}$
Loan	$l = wn$
Critical shock	$\widehat{e}(i) = \max\left\{\underline{\epsilon}_L, \ \ (1+r_f)\frac{w}{A}y(i)^{\theta}c^{-\theta}\right\}$
Liquidation value	$lv = \frac{\tau\left(\widehat{e}^2(i)-\underline{\epsilon}_L^2\right)}{2(\widehat{e}(i)-\underline{\epsilon}_L)}y^{1-\theta}c^{\theta}$
Production	$y = An$
Labor supply	$w = \frac{\psi n^{\gamma} c^{\sigma}}{1+r}$
Firm dividend	$d = \left(\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i)-\underline{\epsilon}_L^2\right)}{2(\overline{\epsilon}-\underline{\epsilon}_L)}\right)c^{\theta}y^{1-\theta} - ((1+r)-b)\frac{wy(i)}{A}$
Overall resources constraint	$\frac{\overline{\epsilon}^2-\widehat{e}(i)^2}{2(\overline{\epsilon}-\underline{\epsilon}_L)}c^{\theta}y^{1-\theta} + \frac{\widehat{e}(i)-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}lv + bl = c$
If deviating to high effort:	
Critical shock	$\widehat{e}_H(i) = (1+r_{f,H}(i))\frac{w}{A}y_H(i)^{\theta}c^{-\theta}$
Interest rate of the loan	$1 + r_{f,H}(i) = \frac{\overline{\epsilon}-\underline{\epsilon}_H}{\overline{\epsilon}-\widehat{e}_H(i)}(1+r) - \frac{\widehat{e}_H(i)-\underline{\epsilon}_H}{\overline{\epsilon}-\widehat{e}_H(i)}\frac{lv}{l}$
Output	$y_H(i) = \left(\frac{(1-\theta)A\left[\overline{\epsilon}^2-\widehat{e}_H(i)^2+\tau\left(\widehat{e}_H^2(i)-\underline{\epsilon}_H^2\right)\right]}{2(\overline{\epsilon}-\underline{\epsilon}_H)(1+r)w}\right)^{1/\theta} c$
Liquidation value	$lv_H(i) = \frac{\tau\left(\widehat{e}_H^2(i)-\underline{\epsilon}_H^2\right)}{2(\widehat{e}_H(i)-\underline{\epsilon}_H)}y^{1-\theta}c^{\theta}$
Firm dividend	$d_H(i) = \left(\frac{\overline{\epsilon}^2-\widehat{e}_H(i)^2+\tau\left(\widehat{e}_H^2(i)-\underline{\epsilon}_H^2\right)}{2(\overline{\epsilon}-\underline{\epsilon}_H)}\right)c^{\theta}y_H(i)^{1-\theta} - (1+r)w\frac{y_H(i)}{A}$
Loan	$l_H(i) = w\frac{y_H(i)}{A}$

The set of 15 equations may provide a numerical solution for the 15 endogenous variables: y, $\widehat{e}(i)$, r_f, c, w, n, lv, l, d, $y_H(i)$, $r_{f,H}$, $\widehat{e}_H(i)$, $d_H(i)$, $lv_H(i)$ and $l_H(i)$.

A.5 Analytical solutions of the model without moral hazard

Moral hazard vanishes if private benefits from shirking are zero ($b = 0$). In this case, the criterion to have an unconstrained equilibrium $\theta > \frac{b}{\frac{\underline{\epsilon}_H - \underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b} \equiv \theta_{\min}$ is always satisfied because $\theta_{\min} = 0$ and $0 < \theta < 1$. Given the behavior of the banks, the equilibrium interest rate is

$$1 + r_f(i) = \frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)}(1+r) - \frac{\widehat{e}(i) - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)}\frac{lv(i)}{l(i)}$$

where we can have both the liquidation value and the size of the loan written in terms of output produced by the firm, $lv(i) = \frac{\tau\left(\widehat{e}^2(i)-\underline{\epsilon}_H^2\right)}{2(\widehat{e}(i)-\underline{\epsilon}_H)} y(i)^{1-\theta} c^{\theta}$ and $l(i) = wn(i) = w(y(i)/A)$, to obtain

$$1 + r_f(i) = \frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)}(1+r) - \frac{\tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{\left(\overline{\epsilon} - \widehat{e}(i)\right)} \frac{Ay(i)^{-\theta}c^{\theta}}{2w}$$

The optimal amount of output produced by the firm is

$$y(i) = \left(\frac{(1-\theta)\, A \left[\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)\right]}{2w\,(1+r)\left(\overline{\epsilon} - \underline{\epsilon}_H\right)} \right)^{1/\theta} c$$

and the cutoff value of the idiosyncratic shock to bring loan defaults is

$$\widehat{e}(i) = \left[1 + r_f(i)\right] \frac{w}{A} y(i)^{\theta} c^{-\theta}$$

Given values for the aggregate real wage, w, and consumption, c, the 3-equations system formed by the last 3 equations can be solved for the firm-level variables $y(i)$, $r_f(i)$ and $\widehat{e}(i)$. Inserting the expression that determines $1 + r_f(i)$ in that of the critical value of the shock $\widehat{e}(i)$, yields

$$\widehat{e}(i) = \left[\frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)}(1+r) - \frac{\tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{\overline{\epsilon} - \widehat{e}(i)} \frac{Ay(i)^{-\theta}c^{\theta}}{2w} \right] \frac{w}{A} y(i)^{\theta} c^{-\theta}$$

which simplifies to

$$\widehat{e}(i) = \left[\frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)}(1+r)\frac{w}{A} y(i)^{\theta} c^{-\theta} - \frac{\tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{\overline{\epsilon} - \widehat{e}(i)} \right]$$

The expression for $y(i)^{\theta}c^{-\theta}$ implied by the optimal amount of output can be plugged in the above expression to reach

$$\widehat{e}(i) = \frac{(1-\theta)\left[\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)\right]}{2\left(\overline{\epsilon} - \widehat{e}(i)\right)} - \frac{\tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{\overline{\epsilon} - \widehat{e}(i)}$$

that becomes the second-order polynomial

$$\left(1 + \theta\,(1-\tau)\right)\widehat{e}(i)^2 - 2\overline{\epsilon}\widehat{e}(i) + \left[(1-\theta)\,\overline{\epsilon}^2 + \theta\tau\underline{\epsilon}_H^2\right] = 0$$

with the solution roots

$$\widehat{e}(i) = \frac{\overline{\epsilon} \pm \sqrt{\overline{\epsilon}^2 - \left(1 + \theta\,(1-\tau)\right)\left[(1-\theta)\,\overline{\epsilon}^2 + \theta\tau\underline{\epsilon}_H^2\right]}}{\left(1 + \theta\,(1-\tau)\right)}$$

Given the bounded interval, $\underline{\epsilon}_H \leqslant \widehat{e}(i) \leqslant \overline{\epsilon}$, we must discard the positive root and keep the negative one, as the analytical solution within its boundaries

$$\widehat{e}(i) = \max\left\{\underline{\epsilon}_H, \frac{\overline{\epsilon} - \sqrt{\overline{\epsilon}^2 - (1+\theta(1-\tau))\left[(1-\theta)\overline{\epsilon}^2 + \theta\tau\underline{\epsilon}_H^2\right]}}{(1+\theta(1-\tau))}\right\}$$

Loan default rates are positive if $\theta < (\overline{\epsilon} - 1)$, with $\widehat{e}(i)$ determined by the second term on the right hand side of the expression for $\widehat{e}(i)$. Otherwise, default rates are zero and $\widehat{e}(i) = \underline{\epsilon}_H$.

Next, let us define κ as the following combination of model parameters and the analytical solution of $\widehat{e}(i)$

$$\kappa \equiv \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)}$$

so that, given the overall resource constraint, $\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)} y \left(\frac{c}{y}\right)^{\theta} = c$, derived in section A.2, we have

$$\left(\frac{c}{y}\right)^{1-\theta} = \kappa$$

Assuming firm symmetric behavior, $y(i) = y$, and then using $\left(\frac{c}{y}\right)^{1-\theta} = \kappa$ in the expression that determines the optimal amunt of production, leads to

$$y = \left(\frac{(1-\theta)A\kappa}{w(1+r)}\right)^{1/\theta} c$$

where considering $\frac{c}{y} = \kappa^{\frac{1}{1-\theta}}$ results in the following analytical solution for the real wage

$$w = \kappa^{\frac{1}{1-\theta}} \frac{(1-\theta)A}{(1+r)}$$

The labor supply function, $w = \frac{\psi n^{\gamma} c^{\sigma}}{1+r}$, can be rearranged to obtain

$$c = \left(\frac{w(1+r)}{\psi}\right)^{\frac{1}{\sigma}} (n)^{-\frac{\gamma}{\sigma}}$$

where inserting the linear production technology, $y = An$, it is obtained

$$c = \left[\frac{w(1+r)}{\psi}\right]^{\frac{1}{\sigma}} \left[\frac{y}{A}\right]^{-\frac{\gamma}{\sigma}}$$

Using the solution for the real wage and $c = \kappa^{\frac{1}{1-\theta}} y$ jointly solve for output and consumption, as follows

$$\begin{aligned} y &= \kappa^{\frac{1-\sigma}{(\sigma+\gamma)(1-\theta)}} \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \\ c &= \kappa^{\frac{1+\gamma}{(\sigma+\gamma)(1-\theta)}} \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \end{aligned}$$

The value of $y^{-\theta}c^{\theta}$ consistent with the previous result is

$$y^{-\theta}c^{\theta} = \left(\frac{\kappa^{\frac{1+\gamma}{(\sigma+\gamma)(1-\theta)}}}{\kappa^{\frac{1-\sigma}{(\sigma+\gamma)(1-\theta)}}}\right)^{\theta} = \kappa^{\frac{\theta}{(1-\theta)}}$$

Taking the above expression and the solution for the real wage in the equation for the interest rate of the loan, yields

$$1 + r_f(i) = \frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)}(1+r) - \frac{\tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{\left(\overline{\epsilon} - \widehat{e}(i)\right)}\frac{(1+r)}{2\kappa(1-\theta)}$$

which solves analytically for $r_f(i)$ given the solution for $\widehat{e}(i)$ from the polynominal root derived above.

Labor is proportional to output, $n = (1/A)y$, which easily leads to

$$n = \kappa^{\frac{1-\sigma}{(\sigma+\gamma)(1-\theta)}}\left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1-\sigma}{\sigma+\gamma}}$$

Finally, we can substitute the analytical solutions for both consumption and labor in the household utility function, $u(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \psi\frac{n^{1+\gamma}}{1+\gamma}$, to reach (after some algebra)

$$u(c,n) = \left(\kappa^{\frac{(1+\gamma)(1-\sigma)}{(\sigma+\gamma)(1-\theta)}} A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}}\right)\left(\frac{1}{1-\sigma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{\psi}{1+\gamma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1+\gamma}{\sigma+\gamma}}\right)$$

A.6. Welfare effect of the efficiency of the liquidation technology without moral hazard

For intermediate cases, $0 < \tau < 1$, we can compute the derivative $\frac{\partial\kappa}{\partial\tau}$ to see how a change in τ can affect household utility $u(c,n)$, as it is increasing in κ. Recalling the definition of κ introduced in section A.5, we study the following derivative

$$\frac{\partial\kappa}{\partial\tau} = \frac{1}{2(\overline{\epsilon} - \underline{\epsilon}_H)}\left[\widehat{e}(i)^2 - \underline{\epsilon}_H^2 - (1-\tau)\,2\widehat{e}(i)\frac{\partial\widehat{e}(i)}{\partial\tau}\right]$$

As also showed in section A.5 of the Appendix, the equilibrium value of $\widehat{e}(i)$ solves

$$\left(1 + \theta\,(1-\tau)\right)\widehat{e}(i)^2 - 2\overline{\epsilon}\widehat{e}(i) + \left[(1-\theta)\,\overline{\epsilon}^2 + \theta\tau\underline{\epsilon}_H^2\right] = 0$$

Taking the total differential with respect to $\widehat{e}(i)$ and τ, we find that the derivative of $\widehat{e}(i)$ with respect to τ is

$$\frac{\partial\widehat{e}(i)}{\partial\tau} = \frac{\theta\left(\widehat{e}(i)^2 - \underline{\epsilon}_H^2\right)}{2\left[\left(1+\theta\,(1-\tau)\right)\widehat{e}(i) - \overline{\epsilon}\right]}$$

which is negative if

$$\widehat{e}(i) < \frac{\overline{\epsilon}}{1+\theta\,(1-\tau)}$$

Thus, it is immediate to verify that the solution of $\widehat{e}(i)$,

$$\widehat{e}(i) = \max\left\{\underline{\epsilon}_H, \frac{\overline{\epsilon} - \sqrt{\overline{\epsilon}^2 - (1+\theta\,(1-\tau))\left[(1-\theta)\,\overline{\epsilon}^2 + \theta\tau\underline{\epsilon}_H^2\right]}}{(1+\theta\,(1-\tau))}\right\}$$

satisfies $\widehat{e}(i) < \frac{\overline{\epsilon}}{1+\theta(1-\tau)}$ to conclude that

$$\frac{\partial \widehat{e}(i)}{\partial \tau} < 0$$

which, finally, given equation the expression for $\frac{\partial \kappa}{\partial \tau}$, implies

$$\frac{\partial \kappa}{\partial \tau} > 0$$

This shows that an increase in the efficiency of firm's liquidation τ brings some welfare gain for households from the equilibrium with loan market clearing and high effort.

A.7. Analytical solution with costless defaults, $\tau = 1$

If the liquidation technology is fully efficient, $\tau = 1$, there are no default losses as the bank can collect the entire amount of firm revenue to cover the value of the loan. Moral hazard may still cause financial distress through credit rationing. As described in the text, there are model parameterizations that make the ICC be binding and the equilibrium implies credit rationing. Thus, two cases will be characterized here: the case of a non-pervasive moral hazard with an unconstrained equilibrium, and the case of a pervasive moral hazard that causes credit rationing. The condition (16) from the main text of the paper determines the threshold value for θ to be in one case or the other.

- Region with $\theta \geq \theta_{\min}$ and no credit rationing.

Since moral hazard plays no actual role in the equilibrium, the analytical solution for $\widehat{e}(i)$ in the model without moral hazard (see section A.5) can be rewritten at $\tau = 1$ to have

$$\widehat{e}(i) = \overline{\epsilon} - \sqrt{\theta\left(\overline{\epsilon}^2 - \underline{\epsilon}_H^2\right)}$$

The overall resources constraint is

$$\frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)} y \left(\frac{c}{y}\right)^{\theta} = c$$

that with $\tau = 1$ can be simplified to

$$\frac{\overline{\epsilon} + \underline{\epsilon}_H}{2} y \left(\frac{c}{y}\right)^{\theta} = c$$

Moreover, with the long-run property, $\frac{\overline{\epsilon}+\underline{\epsilon}_H}{2} = 1$, it is found that all output produced is devoted to consumption (as there is no loss upon defaults)

$$y = c$$

Therefore, it can be noticed that the corresponding value of κ with $\tau = 1$ collapses to 1

$$\kappa \equiv \frac{\overline{\epsilon}^2 - \widehat{e}(i)^2 + \tau\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)} = \frac{\overline{\epsilon}^2 - \underline{\epsilon}_H^2}{2(\overline{\epsilon} - \underline{\epsilon}_H)} = \frac{\overline{\epsilon} + \underline{\epsilon}_H}{2} = 1$$

which results in the following values for the endogenous variables

$$\begin{aligned}
y &= \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \\
c &= \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \\
n &= \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1-\sigma}{\sigma+\gamma}} \\
w &= \frac{(1-\theta)A}{(1+r)} \\
u(c,n) &= A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}} \left(\frac{1}{1-\sigma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{\psi}{1+\gamma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1+\gamma}{\sigma+\gamma}}\right)
\end{aligned}$$

- Region with $\theta < \theta_{\min}$ and credit rationing

The amount of output produced by the firm is constrained at $y_{\max}$, which for the case without default costs, $\tau = 1$, it can be rewritten as

$$y_{\max} = y(i) = \left(\frac{A\left(\frac{(\overline{\epsilon}+\underline{\epsilon}_H)(\underline{\epsilon}_H-\underline{\epsilon}_L)}{(\overline{\epsilon}-\underline{\epsilon}_L)}\right)}{2w\left[\frac{\underline{\epsilon}_H-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b\right]}\right)^{1/\theta} c$$

Recalling the cutoff value of the idiosyncratic shock, $\widehat{e}(i) = [1 + r_f(i)]\, \frac{w}{A} y(i)^{\theta} c^{-\theta}$, and inserting the equilibrium value of $1 + r_f(i)$, with $\tau = 1$, gives

$$\widehat{e}(i) = \left[\frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)}(1+r) - \frac{\left(\widehat{e}^2(i) - \underline{\epsilon}_H^2\right)}{(\overline{\epsilon} - \widehat{e}(i))} \frac{Ay(i)^{-\theta} c^{\theta}}{2w}\right] \frac{w}{A} y(i)^{\theta} c^{-\theta}$$

where plugging the value of $y(i)^{\theta}c^{-\theta}$ implied by the expression of $y_{\max}$, results in

$$\widehat{e}(i) = \left[\frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}(i)} (1+r) \frac{w}{A} \frac{A\left(\frac{(\overline{\epsilon}+\underline{\epsilon}_H)(\underline{\epsilon}_H-\underline{\epsilon}_L)}{(\overline{\epsilon}-\underline{\epsilon}_L)}\right)}{2w\left[\frac{\underline{\epsilon}_H-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b\right]} - \frac{(\widehat{e}^2(i) - \underline{\epsilon}_H^2)}{(\overline{\epsilon} - \widehat{e}(i))} \frac{1}{2} \right]$$

With some rearrangements (including the assumption that $\frac{\overline{\epsilon}+\underline{\epsilon}_H}{2} = 1$), the above expression becomes a second-order polynomial

$$\frac{1}{2}\widehat{e}^2(i) - \overline{\epsilon}\widehat{e}(i) + \frac{(1+r)(\overline{\epsilon} - \underline{\epsilon}_H)}{\left[(1+r) + \frac{\overline{\epsilon}-\underline{\epsilon}_L}{\underline{\epsilon}_H-\underline{\epsilon}_L} b\right]} + \frac{\underline{\epsilon}_H^2}{2} = 0$$

Let us define the auxiliary parameter Λ

$$\Lambda = \frac{(1+r)(\overline{\epsilon} - \underline{\epsilon}_H)}{\left[(1+r) + \frac{\overline{\epsilon}-\underline{\epsilon}_L}{\underline{\epsilon}_H-\underline{\epsilon}_L} b\right]} + \frac{\underline{\epsilon}_H^2}{2}$$

to solve the second-order polynomial as follows

$$\widehat{e}(i) = \overline{\epsilon} - \sqrt{\overline{\epsilon}^2 - 2\Lambda}$$

where the solution provided is the one consistent with $\underline{\epsilon}_H < \widehat{e}(i) < \overline{\epsilon}$.

As shown for the case $\theta > \theta_{\min}$, the overall resources constraint with $\tau = 1$ and $\frac{\overline{\epsilon}+\underline{\epsilon}_H}{2} = 1$ imply $y = c$. Combining $y = c$ with the expression that determines the constrained amount of output produced leads to

$$A\left(\frac{(\overline{\epsilon} + \underline{\epsilon}_H)(\underline{\epsilon}_H - \underline{\epsilon}_L)}{(\overline{\epsilon} - \underline{\epsilon}_L)}\right) = 2w\left[\frac{\underline{\epsilon}_H - \underline{\epsilon}_L}{\overline{\epsilon} - \underline{\epsilon}_L}(1+r) + b\right]$$

that can be solved for the real wage

$$w = \frac{A\left(\frac{(\underline{\epsilon}_H-\underline{\epsilon}_L)}{(\overline{\epsilon}-\underline{\epsilon}_L)}\right)}{\frac{\underline{\epsilon}_H-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b}$$

Labor supply is governed by the expression

$$w = \frac{\psi n^{\gamma} c^{\sigma}}{1+r}$$

where using $y = c$, $y = An$ and the solution for the real wage, brings the following analytical solution for output

$$y = \left(\frac{A^{1+\gamma}}{\psi\left(1 + \frac{b}{(1+r)} \frac{\overline{\epsilon}-\underline{\epsilon}_L}{\underline{\epsilon}_H-\underline{\epsilon}_L}\right)} \right)^{\frac{1}{\sigma+\gamma}}$$

Finally, the value of household utility is obtained as

$$u(c,n)=\frac{A^{\frac{(1-\sigma)(1+\gamma)}{\sigma+\gamma}}}{1-\sigma}\left(\frac{\left(\frac{(\underline{\epsilon}_H-\underline{\epsilon}_L)}{(\overline{\epsilon}-\underline{\epsilon}_L)}\right)(1+r)}{\psi\left(\frac{\underline{\epsilon}_H-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b\right)}\right)^{\frac{1-\sigma}{\sigma+\gamma}}-\psi\frac{A^{\frac{(1-\sigma)(1+\gamma)}{\sigma+\gamma}}}{1+\gamma}\left(\frac{\left(\frac{(\underline{\epsilon}_H-\underline{\epsilon}_L)}{(\overline{\epsilon}-\underline{\epsilon}_L)}\right)(1+r)}{\psi\left(\frac{\underline{\epsilon}_H-\underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b\right)}\right)^{\frac{1+\gamma}{\sigma+\gamma}}$$

which simplifies to

$$u(c,n)=\left(\frac{A^{1+\gamma}}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}}\left[\frac{1}{1-\sigma}\left(\frac{1}{1+\frac{b}{1+r}\frac{(\overline{\epsilon}-\underline{\epsilon}_L)}{(\underline{\epsilon}_H-\underline{\epsilon}_L)}}\right)^{\frac{1-\sigma}{\sigma+\gamma}}-\frac{1}{1+\gamma}\left(\frac{1}{1+\frac{b}{1+r}\frac{(\overline{\epsilon}-\underline{\epsilon}_L)}{(\underline{\epsilon}_H-\underline{\epsilon}_L)}}\right)^{\frac{1+\gamma}{\sigma+\gamma}}\right]$$

As it can be seen, the value of $u(c,n)$ does not depend on the level of market power θ.

A.8. Analytical solution with no moral hazard, $b=0$, and a fully-inefficient liquidation technology, $\tau=0$

Setting $\tau=0$ in the general analytical solution for the cutoff value of the idiosyncratic shock, (see section A.5), we have

$$\widehat{e}(i)=\frac{\overline{\epsilon}-\sqrt{\overline{\epsilon}^2-(1+\theta)\left[(1-\theta)\,\overline{\epsilon}^2\right]}}{1+\theta}$$

and its simplified version

$$\widehat{e}(i)=\frac{\overline{\epsilon}\,(1-\theta)}{1+\theta}$$

Since the idiosyncratic shock is bounded from below at $\underline{\epsilon}_H$, a correct specification is

$$\widehat{e}(i)=\max\left\{\frac{\overline{\epsilon}\,(1-\theta)}{1+\theta},\underline{\epsilon}_H\right\}$$

or (recalling $\frac{\overline{\epsilon}+\underline{\epsilon}_H}{2}=1$)

$$\widehat{e}(i)=\begin{cases}\frac{\overline{\epsilon}(1-\theta)}{1+\theta} & \text{if } \theta<\overline{\epsilon}-1\\ \underline{\epsilon}_H & \text{if } \theta\geqslant\overline{\epsilon}-1\end{cases}$$

The solution to $\widehat{e}(i)$ determines two regions of equilibrium:

- Region with $\theta<\overline{\epsilon}-1$ and positive default rates.

Take the corresponding part, $\widehat{e}(i)=\frac{\overline{\epsilon}(1-\theta)}{1+\theta}$, in the overall resources constraint

$$\frac{\overline{\epsilon}^2-\widehat{e}(i)^2+\tau\left(\widehat{e}^2(i)-\underline{\epsilon}_H^2\right)}{2(\overline{\epsilon}-\underline{\epsilon}_H)}y\left(\frac{c}{y}\right)^{\theta}=c$$

and imposing $\tau = 0$, we have

$$\frac{2\theta\bar{\epsilon}^2}{(\bar{\epsilon} - \underline{\epsilon}_H)(1+\theta)^2} y \left(\frac{c}{y}\right)^{\theta} = c$$

Refreshing the definition $\left(\frac{c}{y}\right)^{1-\theta} = \kappa$ conveys a value of κ at

$$\kappa \equiv \frac{2\theta\bar{\epsilon}^2}{(\bar{\epsilon} - \underline{\epsilon}_H)(1+\theta)^2}$$

The solution for the analytical variables can be obtained by mimicking the steps taken in section A.5 to reach

$$\begin{aligned}
y &= \left(\frac{2\theta\bar{\epsilon}^2}{(\bar{\epsilon}-\underline{\epsilon}_H)(1+\theta)^2}\right)^{\frac{1-\sigma}{(\sigma+\gamma)(1-\theta)}} \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \\
c &= \left(\frac{2\theta\bar{\epsilon}^2}{(\bar{\epsilon}-\underline{\epsilon}_H)(1+\theta)^2}\right)^{\frac{1+\gamma}{(\sigma+\gamma)(1-\theta)}} \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \\
w &= \left(\frac{2\theta\bar{\epsilon}^2}{(\bar{\epsilon}-\underline{\epsilon}_H)(1+\theta)^2}\right)^{\frac{1}{1-\theta}} \frac{(1-\theta)A}{(1+r)}
\end{aligned}$$

$$u(c,n) = \left(\left(\frac{2\theta\bar{\epsilon}^2}{(\bar{\epsilon}-\underline{\epsilon}_H)(1+\theta)^2}\right)^{\frac{(1+\gamma)(1-\sigma)}{(\sigma+\gamma)(1-\theta)}} A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}}\right) \left(\frac{1}{1-\sigma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{\psi}{1+\gamma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1+\gamma}{\sigma+\gamma}}\right)$$

- Region with $\theta \geqslant \bar{\epsilon} - 1$ and zero default rates.

Take the corresponding part, $\widehat{e}(i) = \underline{\epsilon}_H$, in the overall resources constraint with $\tau = 0$ to get

$$\frac{\bar{\epsilon} + \underline{\epsilon}_H}{2} y \left(\frac{c}{y}\right)^{\theta} = c$$

where using again the long-run property of neutral shocks, $\frac{\bar{\epsilon}+\underline{\epsilon}_H}{2} = 1$, leads to

$$y = c$$

with no efficiency loss because default rates are 0.

- As in the region without credit rationing from section A.7, the case $\kappa = 1$ leads to

$$
\begin{aligned}
y &= \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \\
c &= \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1+\gamma}{\sigma+\gamma}} \\
n &= \left(\frac{1-\theta}{\psi}\right)^{\frac{1}{\sigma+\gamma}} A^{\frac{1-\sigma}{\sigma+\gamma}} \\
w &= \frac{(1-\theta)A}{(1+r)} \\
u(c,n) &= A^{\frac{(1+\gamma)(1-\sigma)}{\sigma+\gamma}} \left(\frac{1}{1-\sigma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1-\sigma}{\sigma+\gamma}} - \frac{\psi}{1+\gamma}\left(\frac{1-\theta}{\psi}\right)^{\frac{1+\gamma}{\sigma+\gamma}}\right)
\end{aligned}
$$

A.9. Set of equations to define an equilibrium with mixed strategies on either high or low effort

A fraction υ of firm managers exert high effort, $\underline{\epsilon}_H$, while the fraction $1-\upsilon$ decide to collect the private benefit while exerting low effort, $\underline{\epsilon}_L$.

Block 1. Choosing high effort (13 equations)

$$
y_H(i) = \min \left\{ \begin{array}{c} \left(\frac{(1-\theta)A\left[\overline{\epsilon}^2 - \widehat{e}_H(i)^2 + \tau\left(\widehat{e}^2_H(i) - \underline{\epsilon}^2_H\right)\right]}{2(\overline{\epsilon}-\underline{\epsilon}_H)(1+r)w}\right)^{1/\theta} c, \\ \left[\frac{A\left(\frac{\left[\left(\overline{\epsilon}^2 - \widehat{e}_H(i)^2\right) + \tau\left(\widehat{e}^2_H(i) - \underline{\epsilon}^2_H\right)\right](\underline{\epsilon}_H - \underline{\epsilon}_L)}{(\overline{\epsilon}-\underline{\epsilon}_H)(\overline{\epsilon}-\underline{\epsilon}_L)}\right)}{2w\left[\frac{\underline{\epsilon}_H - \underline{\epsilon}_L}{\overline{\epsilon}-\underline{\epsilon}_L}(1+r)+b\right]}\right]^{1/\theta} c \end{array} \right\} \qquad (y_H(i))
$$

$$
\widehat{e}_H(i) = \max\left\{\underline{\epsilon}_H,\ (1+r_{f,H}(i))\,\frac{w}{A}y_H(i)^{\theta}c^{-\theta}\right\} \qquad (\widehat{e}_H(i))
$$

$$
1 + r_{f,H}(i) = \frac{\overline{\epsilon}-\underline{\epsilon}_H}{\overline{\epsilon}-\widehat{e}_H(i)}(1+r) - \frac{\widehat{e}_H(i)-\underline{\epsilon}_H}{\overline{\epsilon}-\widehat{e}_H(i)}\frac{lv_H(i)}{l_H(i)} \qquad (r_{f,H}(i))
$$

$$
lv_H(i) = \frac{\tau\left(\widehat{e}^2(i) - \underline{\epsilon}^2_H\right)}{2\left(\widehat{e}(i) - \underline{\epsilon}_H\right)} y_H(i)^{1-\theta}c^{\theta} \qquad (lv_H(i))
$$

$$
l_H(i) = w n_H(i) \qquad (l_H(i))
$$

$$
y_H(i) = A n_H(i) \qquad (n_H(i))
$$

$$
\pi_H(i)|\underline{\epsilon}_H = \left(\frac{\overline{\epsilon}^2 - \widehat{e}_H(i)^2 + \tau\left(\widehat{e}^2_H(i) - \underline{\epsilon}^2_H\right)}{2(\overline{\epsilon}-\underline{\epsilon}_H)}\right) c^{\theta} y_H(i)^{1-\theta} - (1+r)w\frac{y_H(i)}{A} \qquad (\pi_H(i)|\underline{\epsilon}_H)
$$

$$\pi_H(i)|_{\underline{\epsilon}_{H\rightsquigarrow L}} = \left(\frac{\overline{\epsilon}^2 - \widehat{e}_{HL}(i)^2 + \tau\left(\widehat{e}_{HL}^2(i) - \underline{\epsilon}_L^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_L)}\right) c^\theta y_{HL}(i)^{1-\theta} - ((1+r) - b)\,\frac{w y_{HL}(i)}{A} \tag{$\pi_H(i)|_{\underline{\epsilon}_{H\rightsquigarrow L}}$}$$

$$\widehat{e}_{HL}(i) = \max\left\{\underline{\epsilon}_L,\ \ (1 + r_{f,HL}(i))\,\frac{w}{A} y_{HL}(i)^\theta c^{-\theta}\right\} \tag{$\widehat{e}_{HL}(i)$}$$

$$1 + r_{f,HL}(i) = \frac{\overline{\epsilon} - \underline{\epsilon}_L}{\overline{\epsilon} - \widehat{e}_{HL}(i)}(1+r) - \frac{\widehat{e}_{HL}(i) - \underline{\epsilon}_L}{\overline{\epsilon} - \widehat{e}_{HL}(i)}\frac{lv_{HL}(i)}{l_{HL}(i)} \tag{$r_{f,HL}(i)$}$$

$$y_{HL}(i) = \left(\frac{(1-\theta)\,A\left(\overline{\epsilon}^2 - \widehat{e}_{HL}(i)^2 + \tau\left(\widehat{e}_{HL}^2(i) - \underline{\epsilon}_L^2\right)\right)}{2w\left(\overline{\epsilon} - \underline{\epsilon}_L\right)\left((1+r) - b\right)}\right)^{1/\theta} c \tag{$y_{HL}(i)$}$$

$$lv_{HL}(i) = \frac{\tau\left(\widehat{e}_{HL}^2(i) - \underline{\epsilon}_L^2\right)}{2\left(\widehat{e}_{HL}(i) - \underline{\epsilon}_L\right)} y_{HL}(i)^{1-\theta} c^\theta \tag{$lv_{HL}(i)$}$$

$$l_{HL}(i) = w\frac{y_{HL}(i)}{A} \tag{$l_{HL}(i)$}$$

Block 2. Choosing low effort (13 equations)

$$y_L(i) = \left(\frac{(1-\theta)\,A\left(\overline{\epsilon}^2 - \widehat{e}_L(i)^2 + \tau\left(\widehat{e}_L^2(i) - \underline{\epsilon}_L^2\right)\right)}{2w\left(\overline{\epsilon} - \underline{\epsilon}_L\right)\left((1+r) - b\right)}\right)^{1/\theta} c \tag{$y_L(i)$}$$

$$\widehat{e}_L(i) = \max\left\{\underline{\epsilon}_L,\ \ (1 + r_{f,L}(i))\,\frac{w}{A} y_L(i)^\theta c^{-\theta}\right\} \tag{$\widehat{e}_L(i)$}$$

$$1 + r_{f,L}(i) = \frac{\overline{\epsilon} - \underline{\epsilon}_L}{\overline{\epsilon} - \widehat{e}_L(i)}(1+r) - \frac{\widehat{e}_L(i) - \underline{\epsilon}_L}{\overline{\epsilon} - \widehat{e}_L(i)}\frac{lv_L(i)}{l_L(i)} \tag{$r_{f,L}(i)$}$$

$$lv_L(i) = \frac{\tau\left(\widehat{e}_L^2(i) - \underline{\epsilon}_L^2\right)}{2\left(\widehat{e}_L(i) - \underline{\epsilon}_L\right)} y_L(i)^{1-\theta} c^\theta \tag{$lv_L(i)$}$$

$$l_L(i) = w n_L(i) \tag{$l_L(i)$}$$

$$y_L(i) = A n_L(i) \tag{$n_L(i)$}$$

$$\pi_L(i)|_{\underline{\epsilon}_L} = \left(\frac{\overline{\epsilon}^2 - \widehat{e}_L(i)^2 + \tau\left(\widehat{e}_L^2(i) - \underline{\epsilon}_L^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_L)}\right) c^\theta y_L(i)^{1-\theta} - (1 + r - b) w\frac{y_L(i)}{A} \tag{$\pi_L(i)|_{\underline{\epsilon}_L}$}$$

$$\pi_L(i)|_{\underline{\epsilon}_{L\rightsquigarrow H}} = \left(\frac{\overline{\epsilon}^2 - \widehat{e}_{LH}(i)^2 + \tau\left(\widehat{e}_{LH}^2(i) - \underline{\epsilon}_H^2\right)}{2(\overline{\epsilon} - \underline{\epsilon}_H)}\right) c^\theta y_{LH}(i)^{1-\theta} - (1+r) w\frac{y_{LH}(i)}{A} \tag{$\pi_L(i)|_{\underline{\epsilon}_{L\rightsquigarrow H}}$}$$

$$\widehat{e}_{LH}(i) = \max\left\{\underline{\epsilon}_H,\ \ (1 + r_{f,LH}(i))\,\frac{w}{A} y_{LH}(i)^\theta c^{-\theta}\right\} \tag{$\widehat{e}_{LH}(i)$}$$

$$1 + r_{f,LH}(i) = \frac{\overline{\epsilon} - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}_{LH}(i)}(1+r) - \frac{\widehat{e}_{LH}(i) - \underline{\epsilon}_H}{\overline{\epsilon} - \widehat{e}_{LH}(i)}\frac{lv_{LH}(i)}{l_{LH}(i)} \tag{$r_{f,LH}(i)$}$$

$$y_{LH}(i) = \min\left\{\begin{array}{c} \left(\frac{(1-\theta)A\left[\overline{\epsilon}^2 - \widehat{e}_{LH}(i)^2 + \tau\left(\widehat{e}_{LH}^2(i) - \underline{\epsilon}_H^2\right)\right]}{2(\overline{\epsilon} - \underline{\epsilon}_H)(1+r)w}\right)^{1/\theta} c, \\ \left[\frac{A\left(\frac{\left[\left(\overline{\epsilon}^2 - \widehat{e}_{LH}(i)^2\right) + \tau\left(\widehat{e}_{LH}^2(i) - \underline{\epsilon}_H^2\right)\right](\underline{\epsilon}_H - \underline{\epsilon}_L)}{(\overline{\epsilon} - \underline{\epsilon}_H)(\overline{\epsilon} - \underline{\epsilon}_L)}\right)}{2w\left[\frac{\underline{\epsilon}_H - \underline{\epsilon}_L}{\overline{\epsilon} - \underline{\epsilon}_L}(1+r) + b\right]}\right]^{1/\theta} c \end{array}\right\} \tag{$y_{LH}(i)$}$$

$$lv_{LH}(i) = \frac{\tau\left(\widehat{e}^2_{LH}(i) - \underline{\epsilon}^2_L\right)}{2\left(\widehat{e}_{LH}(i) - \underline{\epsilon}_L\right)} y_{LH}(i)^{1-\theta} c^{\theta} \tag{$lv_{LH}(i)$}$$

$$l_{LH}(i) = w\frac{y_{LH}(i)}{A} \tag{$l_{LH}(i)$}$$

Block 3. Aggregates (4 equations)

$$w = \frac{\psi n^{\gamma} c^{\sigma}}{1+r} \tag{w}$$

$$n = \upsilon n_H(i) + (1-\upsilon) n_L(i) \tag{n}$$

$$(1+r)\, wn + \upsilon \pi_H(i)|\underline{\epsilon}_H + (1-\upsilon)\pi_L(i)|\underline{\epsilon}_L = c \tag{c}$$

$$y = \upsilon y_H(i) + (1-\upsilon) y_L(i) \tag{y}$$

Existence of equilibrium is granted when satisfying the following three necessary conditions

$$\pi_H(i)|\underline{\epsilon}_H \geqslant \pi_H(i)|\underline{\epsilon}_{H\rightsquigarrow L}$$

$$\pi_L(i)|\underline{\epsilon}_L \geqslant \pi_L(i)|\underline{\epsilon}_{L\rightsquigarrow H}$$

$$\pi_H(i)|\underline{\epsilon}_H = \pi_L(i)|\underline{\epsilon}_L$$

A.10. Sensitivity analysis. Changes in labor supply elasticity and in labor productivity.

Figure 3B. General equilibrium effects depending on market power, θ.

Labor supply elasticity at $\frac{1}{\gamma} = \frac{1}{10^6} \simeq 0$ (Null)

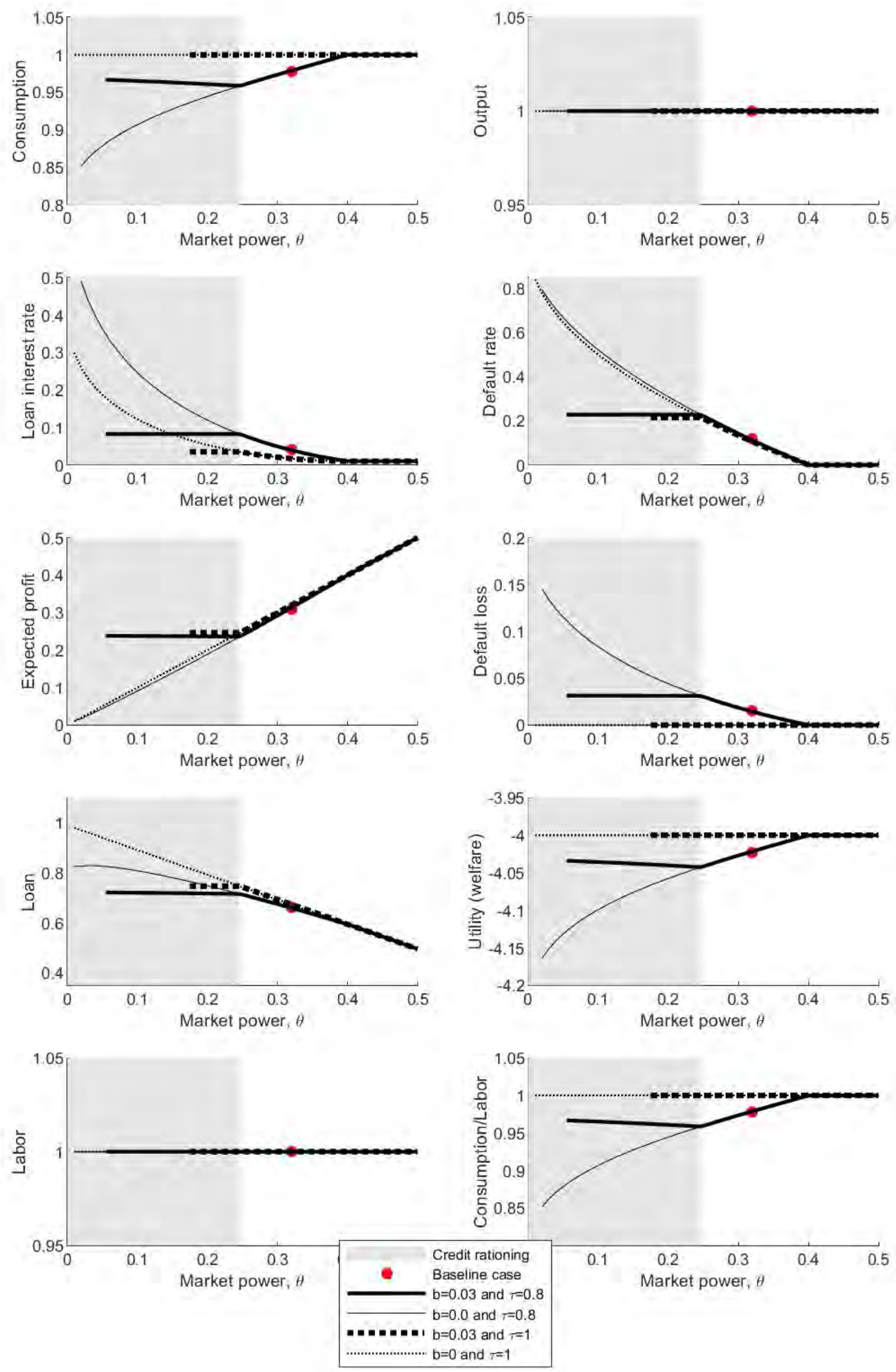


Figure 3C. General equilibrium effects depending on market power, θ. Labor supply elasticity at $\frac{1}{\gamma} = \frac{1}{4} = 0.25$ (Low)

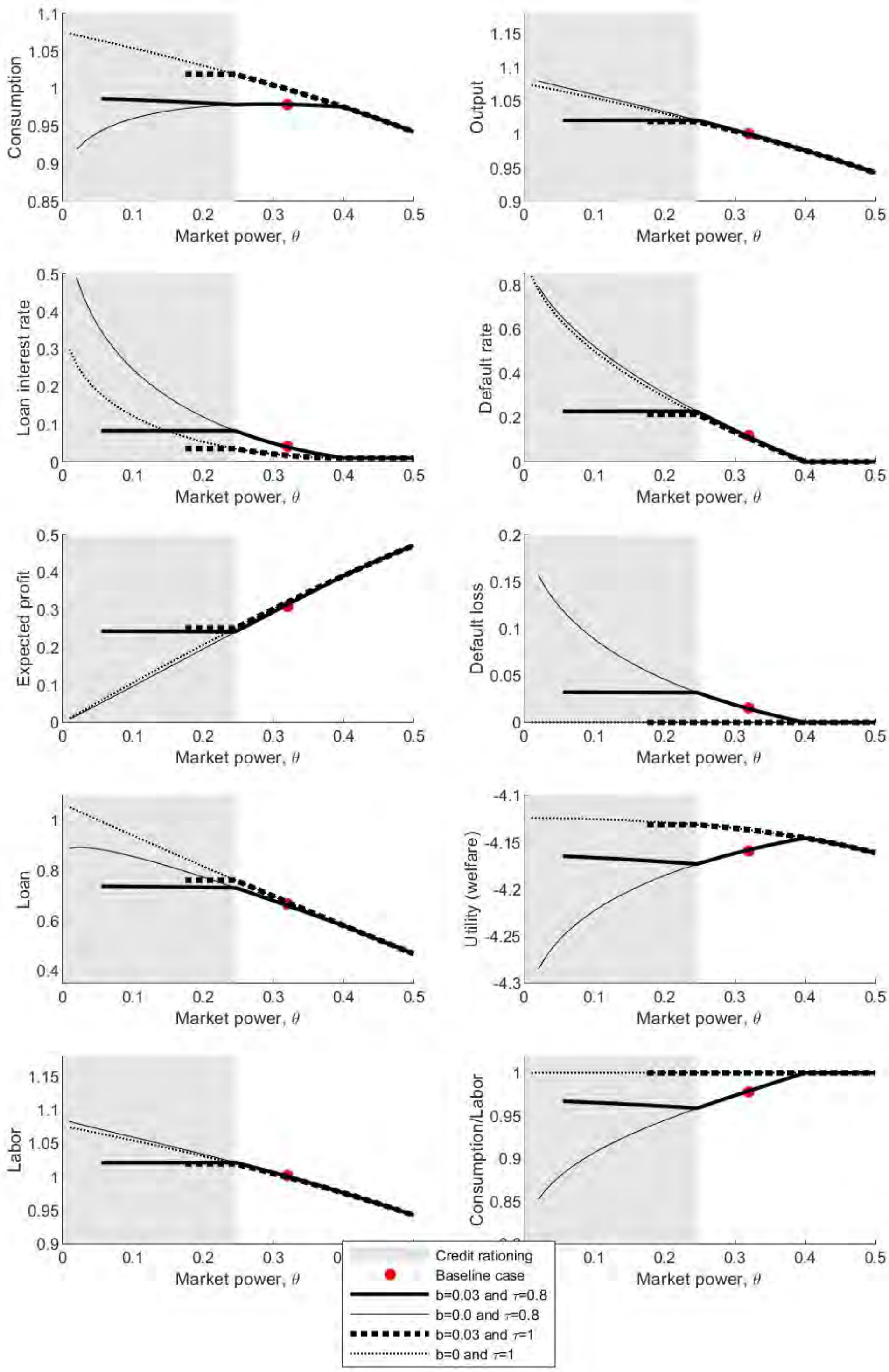


Figure 3D. General equilibrium effects depending on market power, θ.
Labor supply elasticity at $\frac{1}{\gamma} = \frac{1}{1} = 1.0$ (High)

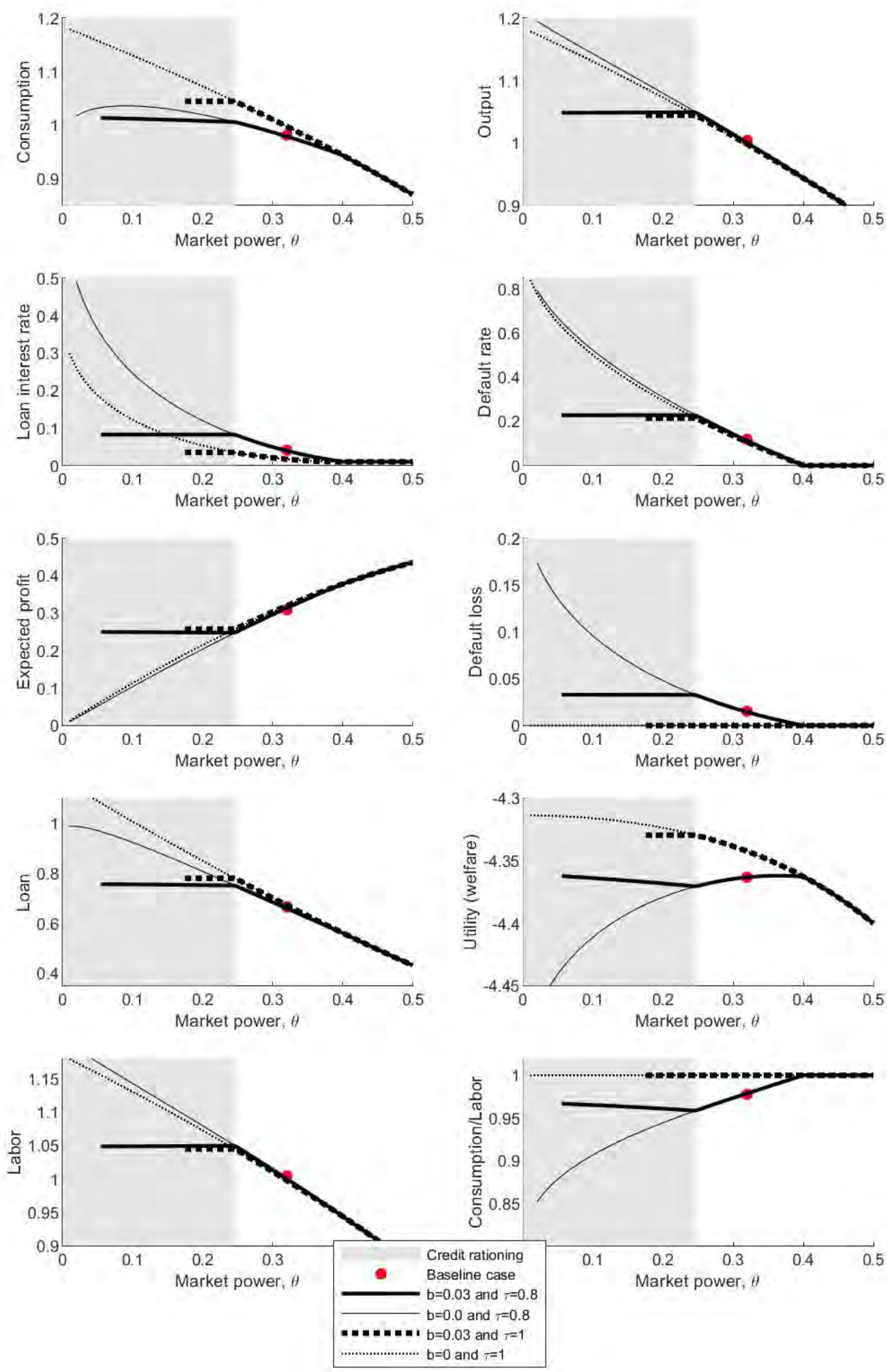


Figure 3E. General equilibrium effects depending on market power, θ. Labor productivity at $A = 1.1$ (High)

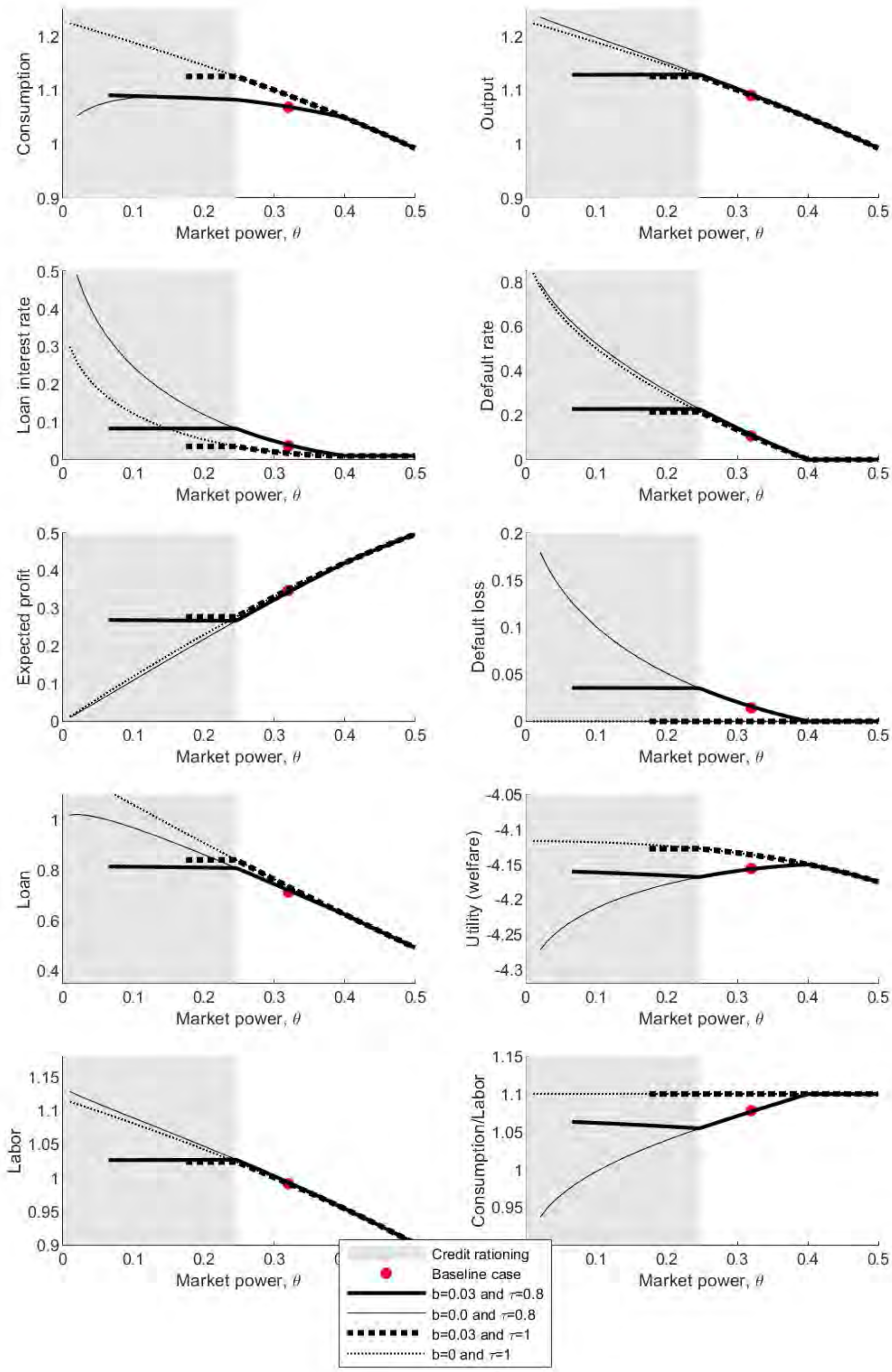


Figure 3F. General equilibrium effects depending on market power, θ.
Labor productivity at $A = 0.9$ (Low)