Universität Basel
Wirtschaftswissenschaftliche Fakultät

WWZ

August 2017

Credit from the Monopoly Bank

WWZ Working Paper 2017/15

Yvan Lengwiler, Kumar Rishabh

A publication of the Center of Business and Economics (WWZ), University of Basel.

Universität Basel
Peter Merian-Weg 6
4052 Basel, Switzerland
wwz.unibas.ch

Corresponding Author:
Kumar Rishabh
Tel: +41 (0) 61 207 33 17
Mail: kumar.rishabh@unibas.ch

Credit from the Monopoly Bank

Yvan Lengwiler* Kumar Rishabh†

August 30, 2017

Abstract

We establish that a monopoly bank never uses collateral as a screening device. A pooling equilibrium always exists in which all borrowers pay the same interest rate and put zero collateral. Absence of screening leads to socially inefficient lending in the sense that some socially productive firms are denied credit due to excessively high interest rate.

JEL classification: G21, D82, L12, D00.

Keywords: Monopoly bank, credit, contracts, screening, pooling, collateral.

1 Introduction

Banks are the most important source of debt finance. While the largest firms — especially the ones listed on organized financial exchanges — may have access to the corporate debt market, most firms do not enjoy this luxury. They depend on internal funds and on banks to acquire the capital they need for their operations.

Banking is a business that requires particular skills. It is still, despite the increasing standardization, a *people business* that depends on personal relationship. This is why the phenomenon of the *house bank* is relevant. One indication of this is the fact that

*Both authors: Faculty of Business and Economics, University of Basel, Peter Merian-Weg 6, CH-4002 Basel, Switzerland.

†Corresponding author, `kumar.rishabh@unibas.ch`.

banking, especially small and medium enterprise (SME) banking, is local in nature (Brevoort and Wolken, 2008). The local nature of banking creates opportunity for the banks to carve out captive local markets that allows them to exercise market power in pricing the loans. Emergence of local monopoly power could be driven by high cost of obtaining soft information about the potential borrowers located at longer distances (Agarwal and Hauswald, 2010), or it can be due to high travelling costs (Degryse and Ongena, 2005, Degryse, Laeven and Ongena, 2009). These effects are expected to be even more pronounced in the case of developing countries where the reliance of banks on soft information and the transportation costs may be even higher.

Bank market power and its relationship with access to credit and growth has been well studied empirically. In general, studies have found opposite results about this. The earlier argument by Petersen and Rajan (1995) and Marquez (2002), that monopoly power may enhance access to credit by allowing banks to develop lending relationships, seems to be challenged by a host of recent large scale panel studies (Love and Pería, 2015, Ryan, O'Toole and McCann, 2014, Chong, Lu and Ongena, 2013, Cetorelli and Strahan, 2006, Beck, Demirgüç-Kunt and Maksimovic, 2004). These studies have found that market power is associated with higher interest rates and lower access to credit for SMEs.

As far as the theory of monopoly bank is concerned, the literature is rather small. The classic Monti-Klein model (Monti, 1972; Klein, 1971; Freixas and Rochet, 2008, pp. 78-79) applies the basic tools of demand and supply curves to the credit market to conclude that a monopolist would set a higher interest rate and lower deposit rate. However, this is an aggregate analysis without informational or contractual structure. A strand of literature that is concerned with the informational and contractual aspects of financial intermediation, models banks as delegated monitors in the spirit of Diamond (1984) and Williamson (1986). Most notable papers in this literature are Guzman (2000) and Smith (1998), who compare monopoly and competitive banks in the presence of ex-post information asymmetry. In these models, the lenders cannot costlessly verify if the defaults reported by the firms are true or not. In such costly state verification models, credit rationing is generated without adverse selection (Williamson, 1986, 1987).

The focus of these papers is capital accumulation and growth and therefore they do not directly answer the question about market structure and credit access.

Another strand of models are those where information asymmetry is present ex-ante. Agents are heterogeneous at the time of signing the contracts, but the bank cannot identify the types of individual borrowers. This leads to a selection problem. Besanko and Thakor (1987) analyze such a model with a monopolistic bank and many borrowers that come in two types. The payoff of the projects of the first type of borrowers dominates the payoff of the second type in the first-order stochastic dominance sense. The authors establish that in this setting, the monopoly bank will not use collateral as a selection device.

Our paper also analyzes the selection problem that a monopolistic bank faces. We generalize the result of Besanko and Thakor (1987) to arbitrary distribution of types (continuous or discrete). We also prove that a (zero-collateral) pooling equilibrium exists under any arbitrary distribution as well. We characterize the equilibrium and identify the socially valuable projects or borrowers that are denied credit, leading to under-investment and welfare loss.

The result that a monopolist credit market produces under-investment is expected, but not trivial. It is well known that there is no welfare loss or under-investment when a monopolist can engage in price discrimination.[1] Moreover, the existence of a separating equilibrium and price discrimination are well established results in the monopolistic insurance market (Stiglitz, 1977, Chade and Schlee, 2012) that features a similar adverse selection problem. In our framework, this would mean that if a monopolist could screen (hence discriminate between) different types of borrowers using collateral, there might not be under-investment because the monopolist finds opportunity for higher profits in serving every socially productive type. However, we prove that even if collateral is available, the monopolist bank does not separate the types and offers only a pooling contract. We show that diminished access to credit is due to the more fundamental problem that collateral is

[1] More precisely in our model there might still be a welfare loss but no under-investment when the monopolist could successfully discriminate. This welfare loss is due to our assumption that collateral (and hence screening) is costly for the bank. If screening is costless then there is no welfare loss with monopoly discrimination. But as we explain later, this assumption plays no role in our results.

an ineffective screening device for the monopolist bank.

In our model, borrowers differ in their ability to run a project and this gets reflected in their probability of default. Their return conditional on success, however, is identical between types. The types can therefore be ordered according to the expected payoff of their projects, and low-risk borrowers first-order stochastically dominate the distribution of the returns for the high risk borrowers. A similar set-up has been used extensively in the literature (De Meza and Webb, 1987; Besanko and Thakor, 1987; Freixas and Rochet, 2008, pp. 153-157, Sengupta, 2014). This way of characterizing risk differs from Stiglitz and Weiss (1981) model where firms have the same expected value of the project but differ with respect to the riskiness of the project. In particular, they assume that the returns distribution of a low-risk borrower second-order stochastically dominates the returns distribution of the high-risk borrower. We also allow for existence of socially undesirable borrowers as in De Meza and Webb (1987). They show that in a competitive market there can be over-investment in the sense that even socially undesirable projects get access to credit.We show that a monopolist will never lend to such projects. Further, in contrast to the competitive screening models of credit market (Bester, 1985, Besanko and Thakor, 1987) that may suffer the problem of existence of equilibrium à la Rothschild and Stiglitz (1976) and Riley (1979), we show in our model the equilibrium exists under very general conditions.

Our result that a monopolist bank offers only zero-collateral contracts has significant implications for the discussion on growth and its relation with access to credit. The traditional development literature explains that growth is intricately linked to inequality as the poor entrepreneurs lack assets that can be pledged to access credit, resulting in loss of output. This view was remarkably challenged by De Soto (2000) who claimed that people cannot access credit not because they lack assets but because they lack title (or property rights) to use their assets as collateral. We show that if there is a monopolist bank, then whether the borrowers own any asset with or without a title to use it as collateral does not matter. This is because the bank does not require collateral. The limited access to credit in our model results from the monopoly power of the bank and not from the lack of collateralized assets. This implies that the policy of formalizing ownership or land titling may not be sufficient in enhancing growth. Considering that banks do use collateral in a competitive environment, policies of formalization asset ownership need to be complemented with strengthening competition in the credit market.

2 Setup of the model

We use a static model of monopoly credit market under adverse selection. There is a risk neutral monopoly bank (principal) facing a set of risk neutral small firms (agents) as potential borrowers. Each firm can run a risky project that requires one unit of capital. However, the firms do not own any capital and therefore need to borrow one unit from the bank if they decide to run the project. The project returns are stochastic. For a firm indexed by θ, the project fails with probability θ, giving zero return. With probability $1-\theta$, the project is successful and generates returns worth Y. The borrower can repay the bank if and only if the project is successful. θ is therefore also the probability that the firm defaults on its loan. θ is private information, and is distributed according to $\theta \overset{iid}{\sim} F$. F is common knowledge. The support of F is $\Theta \subseteq [0,1]$.

If a firm does not run the risky project it earns non-stochastic return V on some outside opportunity. The monopolist bank enjoys all the bargaining power and offers to each firm a take it or leave it contract (R,C), outlining the gross rate of return, R, and collateral, $C \geqslant 0$. It is assumed that the borrowers are identical in terms of their capacity to offer collateral. This set-up can be thought of as one involving small entrepreneurs as potential borrowers, in a developing country where entrepreneurs may own land or house that are essential commodities and not-liquid and therefore can not be used as capital but can be pledged as a collateral. We assume there is a dichotomy in collateral valuation between borrowers and the bank, where bank valuation of the collateral C is always βC, with $\beta < 1$. Thus, the bank, in case of a default, receives only a fraction β of the value of the collateral. This may reflect liquidation costs the bank faces in case of default (Besanko and Thakor, 1987, Sengupta, 2014). If a firm accepts the offer of the bank, it never defaults willfully and always repays if the project is successful. The cost of capital and intermediation by the bank per unit is assumed to be constant, $\rho \geqslant 1$ (supply of deposits is infinitely elastic).

As a convention for this paper we will denote firm expected surplus by 'u', and the bank's profit by 'π'. The expected surplus of a borrowing firm of type θ from a contract (R, C), is defined as its expected profit in excess of the outside opportunity V,

$$u(R, C, \theta) = (1-\theta)(Y-R) - \theta C - V,$$

while the expected surplus of the bank from the same contract is its expected profit

$$\pi(R, C, \theta) = (1-\theta)R + \theta\beta C - \rho.$$

3 The efficient allocation

3.1 The social planner

Let us start by analyzing, as a benchmark, what a benevolent social planner endowed with full information would choose. The social planner would maximize the expected net social surplus defined as the sum of expected surpluses for firms and the bank. The net social surplus from a contract $(R(\theta), C(\theta))$ is equal to $(1-\theta)Y - V - \rho - (1-\beta)\theta C(\theta)$. This is clearly maximized at $C(\theta) = 0$. Since the collateral imposes a deadweight loss, the social planner would choose zero collateral for all θ. Therefore, under first best, the expected social value of a firm with default probability θ is $(1-\theta)Y - \rho - V$. Firms with default probability

$$\theta \leqslant \theta_{\text{soc}} := 1 - \frac{V+\rho}{Y} \tag{1}$$

have a non-negative social value. We call such firms 'socially desirable.'

Assumption 1 *In order to make sure that there are socially profitable projects that need* *financing, we assume that* $V+\rho<Y$ *(so that* $\theta_{\text{soc}}>0$*) and that* $F(\theta_{\text{soc}})>0$. *This implies that there are some firms with sufficiently low* θ *that are socially desirable.*

The social planner finances all projects in $\Theta_{\text{soc}} := [0,\theta_{\text{soc}}]$, while projects in $\Theta\setminus\Theta_{\text{soc}}$ are not financed.

3.2 Monopoly with full information

If the monopolist bank is equipped with complete information, it can offer personalized contracts to each type of firm in such a way that the firms will accept the offer, but the bank collects the entire surplus. We assume that if a firm is indifferent between borrowing and not borrowing it chooses the former.

Proposition 1 *With full information, the monopolist bank offers type-specific contracts*

$$\left(R^{\text{fb}}(\theta),C^{\text{fb}}(\theta)\right)=\left(Y-\frac{V}{1-\theta},0\right) \tag{2}$$

to all firms $\theta\in\Theta_{\text{soc}}$ *and these firms accept. The bank does not offer contracts to firms* $\theta\notin\Theta_{\text{soc}}$ *and these firms therefore do not receive finance.*

Proof. It can be easily shown that the fully informed monopolist will extract the whole surplus by offering type-specific contracts, $(R(\theta),C(\theta))$, such that each firm earns a zero surplus i.e. $u(R(\theta),C(\theta))=0$. Therefore, the expected profit of the bank from a contract is $(1-\theta)Y-V-\rho-(1-\beta)C(\theta)$, which is, as in the social planner's problem, maximized by setting $C(\theta)=0$. This implies (2). Further, the monopolist will finance all firms that provide a non-negative expected profit. The bank does not offer any contract to firm $\theta\notin\Theta_{\text{soc}}$ since it earns negative expected profit from them. Consequently, the bank will finance only socially beneficial firms, $\theta\in\Theta_{\text{soc}}$. Since all the firms with $\theta\in\Theta_{\text{soc}}$ earn their reservation pay-off by borrowing at (2), they accept the offer. QED

The proposition establishes two things: First, the fully informed monopolist bank does not use collateral. Second, it implements the same allocation as the social planner, in the sense that the same firms receive finance. There is no efficiency loss. The bank's profit in this case is

$$\begin{aligned}\pi^{\text{fb}} &= \int_{\Theta_{\text{soc}}} \left[(1-\theta)Y - V - \rho\right] dF(\theta) \\ &= \left[(1-\hat{\theta})Y - V - \rho\right] F(\theta_{\text{soc}}) = Y(\theta_{\text{soc}} - \hat{\theta})F(\theta_{\text{soc}}) > 0,\end{aligned} \tag{3}$$

where $\hat{\theta} := \int_{\Theta_{\text{soc}}} \theta dF(\theta)/F(\theta_{\text{soc}}) = \mathbb{E}[\theta \mid \theta \in \Theta_{\text{soc}}]$. The bank's profit in (3) is also equal to the social welfare in this situation because all the borrower surplus is transferred to the monopolist bank.

The contract in (2) shows that with complete information, the better borrowers (with lower θ) end up paying higher interest rate than the worse borrowers (with higher θ). This is so because the monopolist captures the entire surplus possible in the trade, and since the lower θ type borrowers generate more surplus than the high θ type borrowers, the bank charges a higher interest rate to the former types.

3.3 Informationally-constrained efficient allocation

The informationally-constrained efficient allocation — or *second best*, as it is sometimes called — is the allocation that a social planner would chose if it was subject to the same informational constraint as the principal, in this case, as the monopolist bank. The social planner maximizes social welfare. It is obvious that it will still not use collateral as collateral entails a social loss. In fact, it can easily be seen that the social planner can implement the first best in this game. The social planner could offer the contract $(R_{\text{soc}}, 0)$ to all agents where,

$$R_{\text{soc}} := R^{\text{fb}}(\theta_{\text{soc}}) = Y - \frac{V}{1-\theta_{\text{soc}}} = \frac{\rho Y}{\rho + V}. \tag{4}$$

This is a pooling situation where the same contract is offered to all agents. Collateral is not used, and the interest rate is determined by the marginal socially valuable project θ_{soc}.

The result is, as in the full information case (sections 3.1 and 3.2), that only projects with $\theta \leqslant \theta_{\text{soc}}$ are funded. However, now the reason is that firms with $\theta > \theta_{\text{soc}}$ do not apply for credit at contract $(R_{\text{soc}}, 0)$. The marginal project θ_{soc} makes a net surplus of 0, earning an expected profit of just V, equal to the outside option. The better projects, $\theta < \theta_{\text{soc}}$, together collect an informational rent,

$$\begin{aligned}\text{Rent} &= \int_{\Theta_{\text{soc}}} u(R_{\text{soc}}, 0) dF(\theta) = \int_{\Theta_{\text{soc}}} \left[\frac{\theta_{\text{soc}} - \theta}{1 - \theta_{\text{soc}}}\right] V dF(\theta) \\ &= \frac{V}{1 - \theta_{\text{soc}}} (\theta_{\text{soc}} - \hat{\theta}) F(\theta_{\text{soc}}).\end{aligned} \tag{5}$$

In addition, the social planner makes a profit of

$$\begin{aligned}\text{Profit} &= \int_{\Theta_{\text{soc}}} \left((1-\theta)\left(Y - \frac{V}{1-\theta_{\text{soc}}}\right) - \rho\right) dF(\theta) \\ &= (\theta_{\text{soc}} - \hat{\theta})\left(Y - \frac{V}{1-\theta_{\text{soc}}}\right) F(\theta_{\text{soc}}) > 0.\end{aligned} \tag{6}$$

Total social surplus in the informationally-constrained efficient allocation is therefore

$$\text{Welfare} = \text{Rent} + \text{Profit} = \big((1-\hat{\theta})Y - V - \rho\big) F(\theta_{\text{soc}}), \tag{7}$$

which is, not surprisingly, the same as the first best welfare, and identical to the profit of the monopolist bank with full information. This is so because, in the three cases discussed, no deadweight loss is incurred as collateral is not used and the allocation is the same (the same projects are financed). Only the sharing of the welfare is different.

It is noteworthy that in this game the second best allocation is identical to the first best allocation. There is no intrinsic efficiency loss induced by the asymmetric information. The reason for this result is that all players — the bank and the borrowing firms — are risk neutral. There is no conflict between allocating capital and allocating risk. In this sense, this is a rather benign situation.

Yet, it is not clear that there is a *market* mechanism that can implement the efficient allocation. Benevolent dictators or social planners are technical tools used by the economists, but are, maybe unfortunately, not available in real life.

4 The monopolist bank with incomplete information

If the bank tries to offer the full information contracts when the types are not observable, all the borrowers would pretend to be the marginal borrower that is still financed in the first best (the θ_{soc} type), because this type gets the cheapest credit. All the borrowers would therefore pool at the contract $(R_{\text{soc}}, 0)$ and we would end up in the second best situation described in section 3.3, with the role of the planner taken over by the bank. In other words, the bank *could* implement the efficient allocation if it wanted to. But it is not clear that this is the best the bank can do for itself. Given that under the second best, the firms earn informational rents, the bank would want to capture some of it to increase its profits. The monopolist bank may want to employ collateral as a measure to sort different types of borrowers, by offering lower rate of interest along with higher collateral requirements. In this section we provide two important results. (i) We show the monopolist never uses collateral and therefore a separating equilibrium, where the bank could design a self selecting menu, does not exist, implying if there is any equilibrium it must be pooling. (ii) A pooling equilibrium indeed exists and even though it does not involve any costly collateral, it is generally inefficient as it sets too high an interest rate that some socially productive firms cannot access the credit market.

4.1 Collateral is not used

The bank profit maximization problem can be formulated using the revelation principle (Myerson, 1979) where we concentrate only on the menu of contracts that induce truth telling by the borrowers. The bank problem, thus, can be stated as follows:

$$\sup_{R(\cdot),C(\cdot)} \int_{\Theta^*} \left[(1-\theta)R(\theta) + \theta\beta C(\theta) - \rho\right] dF(\theta) \qquad \text{subject to} \tag{8}$$

$$(1-\theta)(Y - R(\theta)) - \theta C(\theta) \geqslant (1-\theta)(Y - R(\theta')) - \theta C(\theta') \qquad \forall \theta, \theta' \in \Theta^* \tag{9}$$

$$(1-\theta)(Y - R(\theta)) - \theta C(\theta) \geqslant V \qquad \forall \theta \in \Theta^* \tag{10}$$

$$(1-\theta')(Y - R(\theta)) - \theta' C(\theta) < V \qquad \forall \theta' \in \Theta \setminus \Theta^* \text{ and } \forall \theta \in \Theta^* \tag{11}$$

where $\Theta^* \subseteq \Theta$ and $C(\cdot) \geqslant 0$.

Constraints in (9) are the incentive compatibility constraints (ICs) that ensure that for each borrower truth-telling is optimal (i.e. firms willingly pick the contract that was designed for their type). Constraints in (10) are the participation constraints (PCs) that ensure that running the project is at least as good in expectation as the next best activity, for all borrowers in Θ^*. (11) could be called *non-participation constraints* (Non-PCs). They ensure that none of the firms not contained in Θ^* find any contract designed for firms in Θ^* worthwhile. (10) and (11) together make sure that the population of firms that apply for credit is identical to the population the bank has designed the contracts for.

In what follows we show, through a series of results, that the monopolist does not use collateral in any equilibrium. This is a generalization of Besanko and Thakor (1987) result to any arbitrary type distribution and to all possible equilibrium types. Denote by θ^*, the highest θ type contained in Θ^*.

Lemma 1 *IC for θ with respect to θ^* in* (9) *and PC for θ^* in* (10) *imply that the PC for any $\theta < \theta^*$ is redundant.*

Proof. Consider a $\theta < \theta^*$.

$$\begin{aligned} V &\leqslant (1-\theta^*)(Y - R(\theta^*)) - \theta^* C(\theta^*) && [\text{using (10) for } \theta^*] \\ &< (1-\theta)(Y - R(\theta^*)) - \theta C(\theta^*) && [\text{since } \theta < \theta^*] \\ &\leqslant (1-\theta)(Y - R(\theta)) - \theta C(\theta) && [\text{using (9) for } \theta \text{ with respect to } \theta^*] \end{aligned}$$

This implies $V < (1-\theta)(Y - R(\theta)) - \theta C(\theta)$. QED

This implies that the domain of contracts served by the bank is an interval that includes the best firms with $\theta \leqslant \theta^*$.

Lemma 2 *In any solution to the maximization problem* (8) *subject to* (9), (10) *and* (11), *the PC for θ^* in* (10) *will bind.*

Proof. Suppose we have a solution satisfying (9), (10) and (11) in which (10) for θ^* does not bind. Then $(1-\theta^*)(Y - R(\theta^*)) - \theta^* C(\theta^*) - V = \epsilon > 0$. Consider the alternative strategy where the bank offers a new contract $(\overline{R}(\theta), \overline{C}(\theta))$ for all $\theta \in \Theta^*$, where $\overline{R}(\theta) = R(\theta) + \epsilon/(1-\theta^*)$ and $\overline{C}(\theta) = C(\theta)$. The new contract preserves the participation constraint for $\theta = \theta^*$ and does not affect any incentive compatibility constraint. Further, at the new contract, all the non-participation constraints, (11), are satisfied, as in the original contract. This alternative strategy increases profits for the bank by $\epsilon \dfrac{1-\check{\theta}}{1-\theta^*} F(\theta^*) > 0$ where $\check{\theta} := \int_{\Theta^*} \theta dF(\theta)/F(\theta^*) = \mathbb{E}[\theta \mid \theta \in \Theta^*]$, leading to a contradiction. QED

Lemma 3 *Lemma 2 and IC for θ^* in* (9) *imply that all the Non-PCs in* (11) *are redundant.*

Proof. Consider a $\theta' \in \Theta \setminus \Theta^*$ and a $\theta \in \Theta^*$. By Lemma 1 this implies $\theta' > \theta^* \geqslant \theta$.

$$\begin{aligned}
(1-\theta')(Y - R(\theta)) - \theta' C(\theta) &< (1-\theta^*)(Y - R(\theta)) - \theta^* C(\theta) && [\text{since } \theta' > \theta^*] \\
&\leqslant (1-\theta^*)(Y - R(\theta^*)) - \theta^* C(\theta^*) && [\text{IC for } \theta^* \text{ with respect to } \theta] \\
&= V && [\text{Lemma 2}]
\end{aligned}$$

This implies $(1-\theta')(Y - R(\theta)) - \theta' C(\theta) < V$. QED

In order to show that the monopolist does not use collateral in any equilibrium we employ the following strategy. We show that a bank profit maximization problem in (8) subject to a fewer constraints than contained in (9) to (11) would generate strictly lower profits for the bank, if the bank uses positive collateral for any borrower, than the profit by pooling all the borrowers at the contract $\left(R^{\text{fb}}(\theta^*), C^{\text{fb}}(\theta^*)\right) = \left(Y - \frac{V}{1-\theta^*}, 0\right)$. Since the profit in a less constrained problem is at least as high as in the more constrained problem, it follows that the profit in the original problem would be strictly lower than pooling profits from the contract $\left(R^{\text{fb}}(\theta^*), C^{\text{fb}}(\theta^*)\right)$, if it involves any positive collateral. Further, since this pooling contract satisfies all the constraints in the original problem, it implies this contract provides a higher (pooling) profit to the monopolist than any other set of contracts involving positive collateral.

Consider a relaxed maximization problem where we maximize (8) subject to the following ICs,

$$(1-\theta)(Y - R(\theta)) - \theta C(\theta) \geqslant (1-\theta)(Y - R(\theta^*)) - \theta C(\theta^*) \qquad \forall \theta \in \Theta^* \qquad (9')$$

$$V = (1-\theta^*)(Y - R(\theta^*)) - \theta^* C(\theta^*) \geqslant (1-\theta^*)(Y - R(\theta)) - \theta^* C(\theta) \qquad \forall \theta \in \Theta^* \qquad (9'')$$

(10) and (11). $(9')$ and $(9'')$ together comprise only the incentive compatibility constraints for all θ with respect to θ^* and vice-versa, which are fewer constraints than (9). At the outset, note that results of Lemma 1 still apply in the relaxed problem as it can be checked that the proof of this Lemma requires just $(9')$. Clearly Lemma 2 is also satisfied for the relaxed problem as it holds true for any given ICs. Finally, Lemma 3 holds true as well since its proof requires just $(9'')$ and Lemma 2. Thus, in the relaxed problem as well, the PC for any $\theta < \theta^*$ and Non-PC for any $\theta > \theta^*$ are redundant.

Lemma 4 *In any solution to the maximization problem* (8) *subject to* $(9')$*,* $(9'')$*,* (10) *and* (11)*, the ICs in* $(9')$ *will bind.*

Proof. Suppose we have a solution satisfying $(9')$, $(9'')$, (10) and (11) in which $(9')$ for some θ with a positive mass does not bind. Then $(1-\theta)(Y - R(\theta)) - \theta C(\theta) - (1-\theta)(Y - R(\theta^*)) + \theta C(\theta^*) = \epsilon > 0$. Consider the alternative strategy where the bank designs a new contract $(\overline{R}(\theta), \overline{C}(\theta))$ for the firm indexed θ, where $\overline{R}(\theta) = R(\theta) + \epsilon/(1-\theta)$ and $\overline{C}(\theta) = C(\theta)$. The new contract preserves the IC for θ while not affecting any other such constraint in $(9')$. The new contract also satisfies $(9'')$ as the original contract and will also not affect participation constraint for θ^*. However, offering this new contract increases profits for the bank by $\epsilon dF(\theta) > 0$ leading to a contradiction. QED

Proposition 2 *Any solution to maximization problem* (8) *subject to* (9)*,* (10) *and* (11) *has* $C(\theta) = 0$ *for all* $\theta \in \Theta^*$.

Proof. Consider the relaxed maximization problem – (8) subject to (9′), (9″), (10) and (11). Since all the results derived in Lemmas 1 to 4 apply to this relaxed problem, we have

$$R(\theta^*) = Y - \frac{1}{1-\theta^*}V - \frac{\theta^*}{1-\theta^*}C(\theta^*) \qquad \text{[Lemma 2]}$$

$$\text{and} \quad (1-\theta)R(\theta) = (1-\theta)R(\theta^*) - \theta C(\theta) + \theta C(\theta^*) \qquad \text{[Lemma 4]}$$

$$\Rightarrow \quad (1-\theta)R(\theta) = (1-\theta)Y - \frac{1-\theta}{1-\theta^*}V - \frac{\theta^*-\theta}{1-\theta^*}C(\theta^*) - \theta C(\theta) \tag{12}$$

Using (12) in (8) and (9″) we can write the relaxed problem as,

$$\pi^1 = \sup_{R(\cdot),C(\cdot)} \left[(1-\check{\theta})Y - \frac{1-\check{\theta}}{1-\theta^*}V - \frac{\theta^*-\check{\theta}}{1-\theta^*}C(\theta^*) - \rho\right]F(\theta^*) - (1-\beta)\int_{\Theta^*}\theta C(\theta)dF(\theta),$$

$$\text{subject to } C(\theta^*) \geqslant C(\theta) \quad \forall \theta \in \Theta^*$$

where $\check{\theta} := \int_{\Theta^*}\theta dF(\theta)/F(\theta^*) = \mathbb{E}[\theta \mid \theta \in \Theta^*] < \theta^*$.

It is notable that π^1 is decreasing in C. Now we show that offering the pooling contract

$$(R(\theta), C(\theta)) = \left(R^{\text{fb}}(\theta^*), C^{\text{fb}}(\theta^*)\right) = \left(Y - \frac{V}{1-\theta^*}, 0\right) \quad \forall \theta \in \Theta^* \tag{13}$$

gives the bank a higher profit than π^1 . Note that all the constraints in the relaxed problem are satisfied at this contract. Using (8) again, the profit for the bank at this contract is

$$\begin{aligned}\pi^2 &= \int_{\Theta^*}\left[(1-\theta)Y - \frac{1-\theta}{1-\theta^*}V - \rho\right]dF(\theta) \\ &= \left[(1-\check{\theta})Y - \frac{1-\check{\theta}}{1-\theta^*}V - \rho\right]F(\theta^*).\end{aligned}$$

Clearly, $\pi^2 > \pi^1$ if $C(\theta^*) > 0$ or if $C(\theta) > 0$ for a non-zero mass of $\theta \in \Theta^*$. Further, note that the pooling contract $\left(R^{\text{fb}}(\theta^*), C^{\text{fb}}(\theta^*)\right)$ also satisfies all the constraints in the original problem as well. Using this and the fact that the profit under the more constrained maximization problem — (8) subject to (9), (10) and (11) — would be less than or equal to π^1, we conclude that this pooling contract, involving no collateral, dominates any contract involving positive collateral for any borrower. QED

The significance of Proposition 2 is this: we have shown that the monopolist bank will never use collateral and since collateral is the only device for the bank to enforce any separation, this result implies that if there is an equilibrium, it must be pooling involving zero collateral. Notably, this non-separation result is true irrespective of the distribution of types in the population.

The monopolist does not want to charge collateral for two reasons: (i) collateral does not effectively work as a sorting device and (ii) collateral use is costly.
Reason (i) highlights the fundamental problem in the designing of self-selecting menu in this set-up. In the usual principal-agent model, a monopolist uses a sorting device to introduce a distortion in the first best contract for the agent who every other agent wants to imitate under asymmetric information (called the 'bottom agent'). Doing so gives monopolist an opportunity to capture bigger share of the informational rent (and of the trade surplus) from the better agents by inducing them to rather choose the contracts designed for them even though sometime it may mean a loss of efficiency.

In our set-up, the bottom agent is the firm with the highest default probability that is served by the monopolist i.e. the firm indexed as θ^*. Starting from the first best contract for the θ^* firm, distorting its contract by an increase in the collateral and decrease in the interest rate would not help to separate the other agents because it makes the distorted contract even more desirable for the better type agents ($\theta < \theta^*$) resulting in a loss for the monopolist. Another kind of distortion– viz. increasing interest rate and decreasing collateral requirement for the θ^* agent is not feasible as the first best contract is in the corner in our case because of $\beta < 1$.

Notably, even if it was feasible (i.e. if $\beta = 1$ so that any point on the participation constraint for θ^* were first best) collateral will still be ineffective in separating the types. Again, starting from the first best contract, increasing collateral and decreasing interest rate will not be profitable for the same reason as above. Also, even if the first best contract is not in the corner now, it is worthwhile for the monopolist to charge the highest interest rate possible to the θ^* type, as now if better borrowers ($\theta < \theta^*$) imitate the θ^*, they pay higher interest rate as well. The monopolist obviously prefers this as it wants to charge the better borrowers a higher interest rate given they produce bigger surplus (as they are less likely to fail). This implies that θ^* pays the highest interest rate it can pay ($R_m^{\mathrm{fb}}(\theta^*)$) implying a zero collateral requirement for θ^*. The similar reasoning when extended to the marginally lower θ borrower than θ^* vis-a-vis other better borrowers would imply a zero collateral requirement for that borrower too. This means that all the borrowers except the best must be required to put zero collateral. If $\beta = 1$ the bank might charge a positive collateral to the best borrower ("top agent") as there is no better borrower to be extracted informational rent from. However, with $\beta < 1$ this one possibility is also ruled-out. As with $\beta < 1$ there is always an efficiency loss in charging positive collateral. Thus, the costly collateral makes any collateral use not worthwhile for the bank.

This result can also be understood by contrasting it with the literature on monopoly screening with countervailing incentives for example in Sengupta (2014) and in Freixas and Rochet (2008, pp. 153-157). In such environments the reservation utility of the borrowers depend on their types in such a way that it makes the first best interest rate for the low θ borrowers smaller than the first best interest rate of the high θ borrowers. Consequently, in such models the θ^* is not the bottom agent, it is rather the lowest θ firm and thus the high θ borrowers have the incentive to pretend like the low θ borrowers if the first best contracts were offered. In this case the monopolist may use the collateral as a separating tool even if it is costly. The reason is that now by distorting the contract for the low θ borrowers it can make the more risky borrowers rather choose their own contract capturing a part of their informational rent albeit at the cost of efficiency due to distortions.

Note we have not shown that the zero collateral pooling contract in (13) is an equilibrium. It is a contract that breaks any menu of contracts that use positive collateral ruling out the possibility of a separating equilibrium. Whether a pooling equilibrium in this problem exists or not is the next issue we deal with. We show a pooling equilibrium exists under all distribution types and we also characterize it.

4.2 Existence of a pooling equilibrium

An equilibrium requires all players not to have a profitable deviation from the equilibrium strategy. For firms, the only options they have is accept the universal contract or refuse it. The principal (the bank) could offer a menu of contracts instead, but we know from Proposition 2 that the equilibrium, if it exists, involves no collateral. Further, since the bank can not sort borrowers using the interest rate as all firms have an incentive to pretend to be the worse type, the bank profit maximization problem reduces to choosing a maximum default probability that it would allow in its set of borrowers and an interest rate where it would pool all the borrowers. Thus, restricting ourselves to pooling equilibria, the bank's problem is

$$(\theta_{\text{mon}}, R_{\text{mon}}) = \arg\max_{\tilde{\theta},\tilde{R}} F(\tilde{\theta})\left(\left(1-\mathbb{E}\left[\theta \mid \theta \leqslant \tilde{\theta}\right]\right)\tilde{R}-\rho\right) \tag{14}$$

subject to

$$(1-\theta)(Y-\tilde{R}) \geqslant V \quad \forall \theta \in [0,\tilde{\theta}] \tag{15}$$

$$(1-\theta)(Y-\tilde{R}) < V \quad \forall \theta \in (\tilde{\theta},1] \tag{16}$$

It is easy to see the the participation constraint, (15), for $\tilde{\theta}$ implies that it is redundant for all $\theta < \tilde{\theta}$. Further, using arguments similar to Lemma 2 we can show that PC for $\tilde{\theta}$ will bind. Further, since (15) is satisfied with equality for $\tilde{\theta}$, all the constraints in (16) are redundant. Using these results, we can reduce the bank's problem into an equivalent maximization problem of choosing the highest default probability it would allow in its set of borrowers.

$$\theta_{\text{mon}} = \arg\max_{\tilde{\theta}\in\Theta} F(\tilde{\theta})\left(\left(1-\mathbb{E}\left[\theta \mid \theta \leqslant \tilde{\theta}\right]\right)\left(Y-\frac{V}{1-\tilde{\theta}}\right)-\rho\right) \tag{17}$$

and $\quad R_{\text{mon}} = R^{\text{fb}}(\theta_{\text{mon}}) = Y - \dfrac{V}{1-\theta_{\text{mon}}}.$

A pair $(R_{\text{mon}}, \theta_{\text{mon}})$ is a **pooling equilibrium** if θ_{mon} is a maximizer of (17) and $R_{\text{mon}} = Y - V/(1-\theta_{\text{mon}})$. In such an equilibrium, all borrowers $\theta \leqslant \theta_{\text{mon}}$ borrow from the bank at the rate R_{mon}, and borrowers with $\theta > \theta_{\text{mon}}$ do not.

The allocation in a pooling equilibrium is generally inefficient because there is no reason to expect that $\theta_{\text{mon}} = \theta_{\text{soc}}$. Some socially beneficial projects might not receive funding from the monopolist bank. The section on examples elaborates on the exclusion of socially desirable firms by the monopolist. Before that we show a pooling equilibrium exists under any arbitrary type space.

4.2.1 Continuous distribution

We deal with the easiest case first and assume that the distribution function is continuous. This implies a continuous type space and a domain in the form of an interval, $\Theta = [0,1]$. It also rules out atoms in the distribution.

Proposition 3 *Suppose F is continuous. Then a pooling equilibrium* $(R_{\text{mon}}, \theta_{\text{mon}})$ *exists.*

Proof. We only need to show that (17) has a maximum. Note that the objective function is continuous and the domain Θ is compact. Hence, Weierstrass' Maximum Theorem applies. QED

4.2.2 Discrete distribution

A discrete type space means that there are discrete types with individual probabilities. The support of F is a finite, or countably infinite set $\Theta \subseteq [0,1]$. Let us denominate these atoms in their natural order, $\theta_1 < \theta_2 < \cdots$. If the set is finite, there is a highest point θ_n. We denote the probabilities of these types with $p_1, p_2, \ldots$, with $\sum_i p_i = 1$. Equivalently, we could define an extension of the distribution function to the convex hull of its support, $\Theta = [\theta_1, \sup\{\theta_1, \theta_2, \ldots\}]$, as $F(\theta) = \sum_{i=1}^{j(\theta)} p_i$, where $j(\theta)$ is the smallest integer such that $\theta_{j(\theta)} \leqslant \theta$.

Proposition 4 *Suppose the domain Θ of F is a countable set. Then a pooling equilibrium* $(R_{\text{mon}}, \theta_{\text{mon}})$ *exists.*

Proof. The maximization problem boils down to choosing an index m such that $\Theta_{\text{mon}} = \{\theta_1,\ldots,\theta_m\}$. If Θ is a finite set, $\Theta = \{\theta_1,\ldots,\theta_n\}$, one can compute the bank's profit for the $n+1$ different possibilities (for m varying from 0 to n), and then trivially pick the index that produces the greatest profit. If Θ is countably infinite, we are guaranteed the existence of maximal element by Zorn's lemma. QED

4.2.3 General existence result

In general, a distribution can have an uncountable domain, and still feature some atoms. For instance, consider this distribution,

$$F(\theta) = \begin{cases} \theta/2 & \text{if } \theta < 1/2, \\ \theta/2 + 1/2 & \text{if } \theta \geqslant 1/2. \end{cases}$$

This is a uniform distribution on the unit interval, with a mass of probability one half at $\theta = 1/2$. F is not continuous at this point, but F is also not a step function, so propositions 3 and 4 do not apply.

Consider another, more intricate example: Let $\alpha_i = 1/i$ and $p_i = 2^{-(1+i)}$ for $i \in \mathbb{N}$. Note that $\sum_{i=1}^{\infty} p_i = 1/2$. Let furthermore $j(\theta)$ be the smallest index such that $\alpha_{j(\theta)} \leqslant \theta$. Then,

$$F(\theta) = \frac{\theta}{2} + \sum_{i=1}^{j(\theta)} p_i$$

is a distribution with a continuous component, as well as infinitely many atoms.

We now show that existence of a pooling equilibrium extends also to these cases.

Proposition 5 *A pooling equilibrium* $(R_{\text{mon}}, \theta_{\text{mon}})$ *exists.*

Note that this proposition places no restrictions on F. It need not be continuous, and may or may not contain (in)finitely many atoms.

Proof. Proposition 3 covers the case if F is continuous. Proposition 4 covers the problem for a discrete type space. What remains is mixed cases with an uncountable support, as well as atoms.

Denote the atoms and their probabilities with α_i and p_i, respectively, and ordered according to their location (so $\alpha_i < \alpha_{i+1}$. If the set of atoms is finite, we add an ultimate atom $\alpha_{n+1} = 1$ with zero probability, $p_{n+1} = 0$. If $\alpha_1 > 0$, we add an atom α_0 with probability zero, p_0. If $\alpha_1 = 0$, we relabel all atoms by decreasing their labels by one, $\alpha_i \mapsto \alpha_{i-1}$ and $p_i \mapsto \pi_{i-1}$, for $i = 1,2,\ldots$.

Consider now a restriction of the distribution to the set $\Theta_i := [\alpha_i, \alpha_{i+1})$ and the profit function from (17),

$$\pi(\tilde{\theta}) := F(\tilde{\theta})\left(\left(1-\mathbb{E}\left[\theta \mid \theta \leqslant \tilde{\theta}\right]\right)\left(Y - \frac{V}{1-\tilde{\theta}}\right) - \rho\right), \tag{18}$$

but constrained to $\tilde{\theta} \in \Theta_i$. π is continuous on this domain. Let $\bar{\Theta}_i$ be the compact hull of Θ_i (so $\bar{\Theta}_i = [\alpha_i, \alpha_{i+1}]$), and let $\bar{\pi}_i$ be the continuous extension of π on $\bar{\Theta}_i$ (so $\bar{\pi}_i(\alpha_{i+1}) = \lim_{\tilde{\theta} \to \alpha_{i+1}} \pi(\tilde{\theta})$).

The function $\bar{\pi}$ is now a continuous function on a compact domain $\bar{\Theta}_i$, and thus attains a maximum

$$\theta_i^* = \arg\max_{\tilde{\theta} \in \bar{\Theta}_i} \bar{\pi}_i(\tilde{\theta}). \tag{19}$$

We do this for all $i = 0,1,2,\ldots$ and therefore get a collection of local maximizers, $(\theta_0^*, \theta_1^*, \theta_2^*, \ldots)$, and their corresponding maxima, $(\bar{\pi}_0(\theta_0^*), \bar{\pi}_1(\theta_1^*), \bar{\pi}_2(\theta_2^*), \ldots)$. We pick the interval i that features the largest local maximum and denote it with m, so $\bar{\pi}(\theta_m^*) \geqslant \bar{\pi}_i(\theta_i^*)$, for all i.

It remains to show that θ_m^* is not the upper bound of $\bar{\Theta}_m$, because the local upper bounds were extended and are not true values for the profit function (18). In other words, we have to show that the profit function does not 'jumps down' on atoms (it has to be right-continuous). To see this, note that (18) can also be written as follows,

$$\pi(\tilde{\theta}) := \int_0^{\tilde{\theta}} \psi(\theta,\tilde{\theta}) dF(\theta), \quad \text{where}$$
$$\psi(\theta,\tilde{\theta}) := (1-\theta)\left(Y - \frac{V}{1-\tilde{\theta}}\right) - \rho.$$

Note that the integrand ψ is continuous. Consider an atom (α_{i+1}, p_{i+1}). As $\tilde{\theta} \uparrow \alpha_{i+1}$, $\psi(\theta,\tilde{\theta})$ changes continuously. But in the limit, there is p_{i+1} more mass (the distribution function F *is* right-continuous). As long as $\psi(\theta,\tilde{\theta}) \geqslant 0$, the profit function π cannot 'jump down.' In fact, it will jump up by $\psi(\theta,\tilde{\theta})\alpha_{i+1}$. $\psi(\theta,\tilde{\theta}) \geqslant 0$ is ensured by profit maximization. Hence, if for some interval $\bar{\Theta}_i$, the local maximizer θ_i^* happens to be the extended point on the upper bound of $\bar{\Theta}_i$, i.e. α_{i+1}, then $\bar{\Theta}_i$ cannot be the interval containing the greatest local maximum ($i \neq m$), because $\pi(\alpha_{i+1}) > \bar{\pi}_i(\alpha_{i+1})$. QED

Proposition 6 $\theta_{\text{mon}} < \theta_{\text{soc}}$. *In words, the bank will never lend to θ_{soc} type firms.*

Proof. First note that $\theta_{\text{mon}} \leqslant \theta_{\text{soc}}$. Because if $\theta_{\text{mon}} > \theta_{\text{soc}}$, the bank can increase its profit by charging a marginally higher pooling interest rate that would drive out the firms producing negative surplus. By such an increase in the interest rate, the bank gains not only because the loss making borrowers are driven out but also now it is charging higher interest rate to better borrowers as well. What's left to be shown is that $\theta_{\text{mon}} \neq \theta_{\text{soc}}$. Suppose $\theta_{\text{mon}} = \theta_{\text{soc}}$. Let the bank marginally decreases the maximum default probability it allows to lend by choosing not to serve θ_{soc}. Note that the marginal social value of θ_{soc} is zero by definition. Therefore, the marginal loss in the expected profit of the bank by not serving θ_{soc}, by definition is 0. The marginal gain in the expected profit by not serving θ_{soc} is however strictly positive as $R_{\text{soc}} < R^{\text{fb}}(\tilde{\theta})\ \forall \tilde{\theta} < \theta_{\text{soc}}$. Therefore, there is a net gain in the bank's expected profit if the bank chooses not to serve θ_{soc}. QED

Proposition 6 shows there is always a potential inefficiency in the sense that $\theta_{\text{mon}} < \theta_{\text{soc}}$. Normally this will mean that there is a welfare loss as well, but it is possible that the distribution is such that there are no agents in a neighborhood of θ_{soc}. In such a case, the monopolistic equilibrium may deliver the same total surplus as the social planner could provide. We present such an example later.

5 Examples

In this section we elaborate on some concrete examples in order to convey some intuition about the properties of the equilibrium.

5.1 Uniform and power distributions

Let $\Theta = [0,1]$, $\rho = 1$, $V = 2$, $Y = 4$, $F(\theta) = \theta^n$. $n = 1$ is the uniform distribution. Table 1 presents three cases with $n = 0.5$, $n = 1$ and $n = 2$. The efficient allocation is to finance all projects up to default probability $\theta_{\text{soc}} = 0.25$. Few observations are clear: $\theta_{\text{mon}} < \theta_{\text{soc}}$ for all the three cases as established in proposition 6. R_{mon} is decreasing in n as with higher density at lower θ (i.e. with lower n) the bank has more incentives to charge higher interest rate to the good borrowers. This means as n increases the difference $\theta_{\text{soc}} - \theta_{\text{mon}}$ also becomes smaller and therefore the welfare loss in absolute terms is also lower.

Table 1: Welfare loss with power distributions

n	0.5	1	2
θ_{soc}	0.25	0.25	0.25
R_{soc}	1.333	1.333	1.333
welfare	0.3333	0.1250	0.0208
θ_{mon}	0.1130	0.1520	0.1880
R_{mon}	1.7452	1.6415	1.5369
bank's profit	0.2284	0.0785	0.0122
firms' rents	0.0571	0.0272	0.0055
welfare loss	0.0478	0.0192	0.0032
in %	14.35%	15.37%	15.40%

5.2 An example with discrete distribution and no welfare loss

Consider the discrete distribution with three types, $(\theta_1, \theta_2, \theta_3) = (0, 0.5, 1)$. Each of the types has equal probability. $Y = 5$, $V = 1.5$, and $\rho = 1$. The social surplus, $(1-\theta)Y - \rho - V$, of the three projects is, respectively, 2.5, 0, and −2.5. The social planner is therefore indifferent between financing type 1 only or type 1 and type 2.

The monopolist bank can choose to finance none, only type 1, type 1 and 2, or all three types. The interest rate of these three pooling contracts, and the resulting profit for the bank, are shown in Table 2.

Table 2: Monopolist's choice.

	R	π
none	> 3.5	0
1	3.5	0.833
1 & 2	2	0.333
1 & 2 & 3	$-\infty$	$-\infty$

The monopolist bank will therefore finance only type 1. Financing type 1 and type 2 is strictly worse for the bank than financing only the best project. Yet, the social value of these two allocations is identical because the social value of the type 2 project is zero (the private value of financing type 2 as well is lower for the bank, because it would need to lower the interest rate from 3.5 to 2.0 also for the type 1 projects). This is an example in which the unregulated monopolist bank with incomplete information happens to choose an allocation that maximizes social welfare.

5.3 Uniform distribution with atoms

Finally, we explore the case of a continuous distribution which also feature mass points or atoms. We consider a simple example where we start with a discrete distribution and the uniform distribution,

$$F_1(\theta) = \begin{cases} 1/10 & \text{if } \theta = 0 \\ 3/10 & \text{if } 0 < \theta \leqslant 1/5 \\ 5/10 & \text{if } 1/5 < \theta \leqslant 2/5 \\ 7/10 & \text{if } 2/5 < \theta \leqslant 3/5 \\ 9/10 & \text{if } 3/5 < \theta \leqslant 4/5 \\ 1 & \text{if } \theta = 1, \end{cases}$$

$$F_2(\theta) = \theta.$$

We construct a mixed distribution by using a weighted average of these two,

$$F(\theta) = wF_1(\theta) + (1-w)F_2(\theta).$$

If $w = 0$ we have the uniform distribution, if $w = 1$ we have a purely discrete distribution. For intermediate values, we get a distribution with a continuous type space but which also contains some mass points.

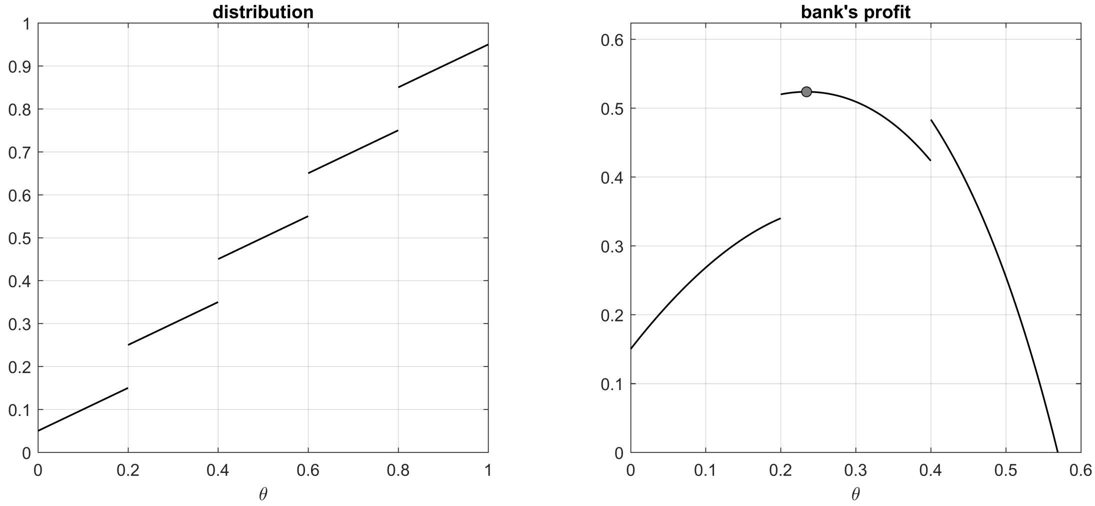

Figure 1: Continuous distribution with a bunch of mass points.

Figure 1 shows the distribution and the bank's payoff function for $w = 0.5$, $\rho = 1$, $V = 2$, $Y = 6$. We see that the payoff function never "jumps down," as shown in the proof of Proposition 5.

6 Conclusion

In this paper we have presented a model of monopolistic credit market under asymmetric information that results in equilibrium under-investment explaining why market power is associated with inefficiently low access to credit. We establish existence of equilibrium under very general conditions. Our equilibrium has three important characteristics: (i) The monopolist bank never uses collateral as a screening device implying it does not indulge in price discrimination. (ii) Since the bank does not separate between borrowers the only possible equilibrium is pooling with all the borrowers paying same interest rate. (iii) The interest rate that the monopolist sets is in general quite high that some socially productive firms can not access the credit.

Our model is a considerable generalization of the literature on banks in which the borrower heterogeneities lead to ordering of return distribution in the first-order stochastic dominance sense. In particular, we generalize Besanko and Thakor (1987) to completely arbitrary distributions — discrete, continuous, or mixed. We also estimate the deviation of the monopoly equilibrium from the social first best identifying 'deserving' firms that would not be financed by the monopolist. These results point that the institutional reforms such as formalization of asset ownership, most famously advocated by De Soto (2000), are not enough for enhancing credit access.

References

Agarwal, Sumit and Robert Hauswald, "Distance and private information in lending," *Review of Financial studies*, 2010, *23* (7), 2757–2788.

Beck, Thorsten, Asli Demirgüç-Kunt, and Vojislav Maksimovic, "Bank competition and access to finance: International evidence," *Journal of Money, Credit and Banking*, 2004, pp. 627–648.

Besanko, David and Anjan V Thakor, "Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets," *International Economic Review*, 1987, pp. 671–689.

Bester, Helmut, "Screening vs. rationing in credit markets with imperfect information," *The American Economic Review*, 1985, *75* (4), 850–855.

Brevoort, KP and JD Wolken, "Does distance matter in banking?," *Finance and Economics Discussion Series, Federal Reserve Board, Washington, D.C.*, 2008, *34.*

Cetorelli, Nicola and Philip E Strahan, "Finance as a barrier to entry: Bank competition and industry structure in local US markets," *The Journal of Finance*, 2006, *61* (1), 437–461.

Chade, Hector and Edward Schlee, "Optimal insurance with adverse selection," *Theoretical Economics*, 2012, *7* (3), 571–607.

Chong, Terence Tai-Leung, Liping Lu, and Steven Ongena, "Does banking competition alleviate or worsen credit constraints faced by small-and medium-sized enterprises? Evidence from China," *Journal of Banking & Finance*, 2013, *37* (9), 3412–3424.

Degryse, Hans and Steven Ongena, "Distance, lending relationships, and competition," *The Journal of Finance*, 2005, *60* (1), 231–266.

______ **, Luc Laeven, and Steven Ongena**, "The impact of organizational structure and lending technology on banking competition," *Review of Finance*, 2009, *13* (2), 225–259.

Diamond, Douglas W, "Financial intermediation and delegated monitoring," *The review of economic studies*, 1984, *51* (3), 393–414.

Freixas, Xavier and Jean-Charles Rochet, *Microeconomics of banking*, MIT press, 2008.

Guzman, Mark G, "Bank structure, capital accumulation and growth: a simple macroeconomic model," *Economic Theory*, 2000, *16* (2), 421–455.

Klein, Michael A, "A theory of the banking firm," *Journal of money, credit and banking*, 1971, *3* (2), 205–218.

Love, Inessa and María Soledad Martínez Pería, "How bank competition affects firms' access to finance," *The World Bank Economic Review*, 2015, *29* (3), 413–448.

Marquez, Robert, "Competition, adverse selection, and information dispersion in the banking industry," *Review of financial Studies*, 2002, *15* (3), 901–926.

Meza, David De and David C Webb, "Too much investment: a problem of asymmetric information," *The quarterly journal of economics*, 1987, pp. 281–292.

Monti, Mario, *Deposit, credit and interest rate determination under alternative bank objective function*, North-Holland/American Elsevier, 1972.

Myerson, Roger B, "Incentive Compatibility and the Bargaining Problem," *Econometrica*, 1979, pp. 61–73.

Petersen, Mitchell A and Raghuram G Rajan, "The effect of credit market competition on lending relationships," *The Quarterly Journal of Economics*, 1995, *110* (2), 407–443.

Riley, John G, "Informational equilibrium," *Econometrica: Journal of the Econometric Society*, 1979, pp. 331–359.

Rothschild, Michael and Joseph Stiglitz, “Equilibrium in competitive insurance markets: An essay on the economics of imperfect information,” *The quarterly journal of economics*, 1976, pp. 629–649.

Ryan, Robert M, Conor M O’Toole, and Fergal McCann, “Does bank market power affect SME financing constraints?,” *Journal of Banking & Finance*, 2014, *49*, 495–505.

Sengupta, Rajdeep, “Lending to uncreditworthy borrowers,” *Journal of Financial Intermediation*, 2014, *23* (1), 101–128.

Smith, R Todd, “Banking competition and macroeconomic performance,” *Journal of Money, Credit and Banking*, 1998, pp. 793–815.

Soto, Hernando De, *The mystery of capital: Why capitalism triumphs in the West and fails everywhere else*, Basic Civitas Books, 2000.

Stiglitz, Joseph E, “Monopoly, non-linear pricing and imperfect information: The insurance market,” *The Review of Economic Studies*, 1977, pp. 407–430.

——— **and Andrew Weiss**, “Credit rationing in markets with imperfect information,” *The American economic review*, 1981, *71* (3), 393–410.

Williamson, Stephen D, “Costly monitoring, financial intermediation, and equilibrium credit rationing,” *Journal of Monetary Economics*, 1986, *18* (2), 159–179.

———, “Costly monitoring, loan contracts, and equilibrium credit rationing,” *The Quarterly Journal of Economics*, 1987, *102* (1), 135–145.