Debt Contracts, Collapse and Regulation as Competition Phenomena

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Abstract

We study a credit market with adverse selection and moral hazard where sufficient sorting is impossible. The crucial novel feature is the competition between lenders in their choice of contracts offered. Qualities of investment projects are not observable by banks and investment decisions of entrepreneurs are not contractible, but output conditional on investment is. We explain the empirically observed prevalence of debt contracts as an equilibrium phenomenon with competing lenders. Equilibrium contracts must be immune against raisin–picking by competitors. Non–debt contracts allow competitors to offer sweet deals to particularly good debtors, who will self–select to choose such a deal, while bad debtors distribute themselves across all offered contracts.

Competition of banks introduces three possibilities for a break-down of credit markets that do not occur when a bank has a monopoly. First, average returns decrease since banks compete for good lenders which may make the lending altogether unprofitable. Second, banks can have an incentive to offer a debt contract and additional equity contracts to intermediate debtors. This combination, however, is in turn dominated by a simple debt contract that is only attractive for very good entrepreneurs. As a result no equilibrium in pure strategies exists. Existence can be restored, if the permissible types of contracts are limited by regulation resembling the separation of investment and commercial banking in the U.S. Third, allowing for random delivery on credit contracts leads to a break-down since all banks want to avoid the contract with the highest chance of delivery: that contract attracts all bad entrepreneurs.

1 Introduction

A standard Arrow–Debreu setting does not impose any constraints on the set of financial contracts. An important empirical phenomenon, however, is the prevalence of debt contracts which points to the significance of market imperfections. In this paper we show that in a competitive credit market either debt contracts arise as a unique type of contract or credit markets collapse. This collapse can be avoided if the number of types of contracts banks can offer is limited which resembles the separation of investment and commercial banking in the U.S. The key modeling device is an adverse selection and moral hazard framework where sufficient sorting is impossible and where the decision of entrepreneurs to invest is not contractible. The crucial novel feature is the competition between lenders in their choice of contracts offered when both adverse selection and moral hazard are present.

We consider a credit market with different types of entrepreneurs. They require external resources to invest in a project. Creditors cannot observe whether entrepreneurs invest or simply consume the resources granted to them. Nonetheless, they can observe and verify the output when investment has taken place at low costs. When only one bank offers financial contracts, entrepreneurs must accept equity contracts, since the financier can condition the repayment on the final output. If, however, banks compete against each other with a set of contracts, raisin–picking is not feasible anymore and banks must obtain equal repayments in equilibrium from all good entrepreneurs. However, bad entrepreneurs cannot be hindered from accepting financial contracts.

We identify three possibilities for a break-down of credit markets with competing banks that do not occur when a bank has a monopoly. Put differently, competition among financial intermediaries with menus of debt and equity contracts yield three inefficiencies in addition to the standard inefficiencies that arise in the presence of asymmetric information. First, average returns decrease since banks compete for good entrepreneurs but cannot avoid bad entrepreneurs which may make the lending altogether unprofitable. Second, banks can have an incentive to offer a menu of debt and equity contracts which, however, is dominated by a simple debt contract that is only attractive for very good entrepreneurs. As a result the credit market collapses. Existence can be restored in this scenario by a regulation that separates commercial from investment banking. Finally, allowing for random delivery on credit contracts leads to a break down since all banks want to avoid the contract with the highest chance of delivery because it attracts all bad entrepreneurs. Transparency requirements about the terms under which borrowers can receive loans could restore the functioning of the credit market in this case.

A debt contract in our context is distinguished from an equity contract by the nature of repayments. Under a debt contract, the creditor receives the same repayments from all debtors who can pay back. Under an equity contract, the bank receives the excess returns from all investing entrepreneurs and thus returns under an equity contract depend on the success of the investment project. The distinction between equity and debt contracts arises solely from the perspective of banks: the investment projects are riskless for entrepreneurs, but risky for banks because of asymmetric information. This distinction of debt and equity contracts in terms of returns and risk for less informed lenders is different from other recent explanations of the relevance of debt contracts which we shall briefly summarize.

The incomplete contracting literature, e.g. Aghion and Bolton, 1992, Hart and Moore, 1988, 1994, Berglöf and von Thadden, 1994, and the surveys of Hart, 1993 and 1995, explains why an investor enters into a debt contract with an entrepreneur who promises to make certain repayments. If the agent fulfills his obligations, he retains control of the asset. If he does not make the repayments, control shifts to the investor. In our model a debt contract also contains the right to control the assets in case of default. However, the shift of control in our model is always associated with zero repayments and the return characteristics distinguish debt and equity contracts.

The costly state verification literature developed originally by Townsend 1978, Diamond 1984, Gale and Hellwig 1985, Willamson 1986 and extended by e.g. Bernanke and Gertler 1989, Boyd and Smith 1993 and many others, show that debt contracts arise as the unique type of contracts when revenues from projects are private information, and ex post monitoring is costly. In our model, there are no costs of monitoring the output if entrepreneurs have invested, but it is impossible to prevent the entrepreneur from consuming his obtained funds.

Finally, there exists a large stream of literature on the cost and benefits of debt and equity in corporate finance, see Harris and Raviv, 1992, for a survey. Apart from the focus on different return structures of debt and equity contracts, none of these contributions follow our approach here.

Our model is also related to the literature on competition of principals in markets with adverse selection which has stressed the role of sorting devices and which has identified the possibility for a break-down of markets (see Hellwig 1987 and Kreps 1990 for surveys). Our model combines moral hazard and adverse selection and uses a very simple description of the returns of investment projects, but we allow for arbitrary many types of entrepreneurs. Each entrepreneur knows the return of his project and does not face any risk, but banks face the possibility that entrepreneurs have a low-quality project and no incentives to undertake investment. Moreover, no sorting device is available to separate good entrepreneurs from bad ones. The interaction of adverse selection and moral hazard in this economic environment creates new collapse possibilities in credit markets when lenders compete with equity and debt contracts. This could justify regulations.[1]

The tractable structure of our model may be useful for future applications. As illustrated by Uhlig (1995) and Gersbach (1997), the model is a useful tool to incorporate financial intermediation with adverse selection, moral hazard

[1] Our paper is also part of a broad literature examining the design of contracts in the presence of adverse selection and moral hazard (e.g. Fudenberg and Tirole 1990).

and monitoring aspects into macroeconomic models to address regulatory issues of financial markets or to examine fiscal and monetary policy.

The paper proceeds as follows. In the next section we outline the model. Then, we examine the bank's decision problem. In section 4 we examine the monopoly case. Sections 5 and 6 consider the competition case. The final section concludes.

2 Model

There are two periods - "this" period and the "next" period. We consider some finite number of entrepreneurs who have access to a project, but do not have the funds to finance it. Entrepreneurs are of different types $j = 1, \ldots, n$. Entrepreneurs of type j have quality $q_j \geq 0$ and constitute a fraction γ_j of the total entrepreneur population.

Qualities are labeled so that $q_1 < q_2 < \cdots < q_n$. Qualities q_j are strictly increasing in j. Projects are all of equal size. Suppose that the initial cost for each project is $I + z$, but the entrepreneur's initial wealth is only z. Hence, an entrepreneur must borrow at least I for the project to go ahead.

Given additional resources $I > 0$, he can choose to invest $(\delta_j = 1)$ or not $(\delta_j = 0)$. If he invests this period, he receives the cash flow

$$(I + z) \cdot q_j$$

next period. Otherwise, the return is unity and hence $I + z$. Entrepreneurs cannot have negative wealth next period.

Entrepreneurs can borrow additional funds from banks. Banks face the following informational asymmetries. The quality q_j is known to the entrepreneur, but not to banks. Moreover, banks cannot observe whether or not an entrepreneur invests. Thus, banks face a fixed pool of observationally identical borrowers. The banks, however, can only observe and verify realized cash flows next period if the entrepreneur invests. If the entrepreneur does not invest and simply consumes the funds granted to him, the banks cannot expect any repayment. In this respect, our model is somewhat orthogonal to the incomplete contract literature on financial contracts, where it is assumed that the output is not or only partially verifiable, independent from whether the entrepreneur invests.

It may be useful to discuss the main assumptions of our model. The unobservability of the investment decision is a standard scenario. Often, projects require specific human capital or may need the design of blueprints for machinery, buildings or logistics. Or, an inventor may spend a lot of time on reading and designing. Whether the efforts are directed towards the project or whether blueprints are competently drafted is unlikely to be observed by the bank.

The second assumption of our model is that the verification of output conditional on investment is possible at low or zero costs while entrepreneurs can have large private benefits if they do not invest. The assumption is justified by the possibilities banks have in order to secure the repayments if entrepreneurs invest. Monitoring to secure repayments takes many forms: inspection of firms' cash flow when customers pay, efforts to collateralize assets if those have been created in the process of investment and of selling products to customers. If the final products of the project of entrepreneurs are physical goods such as houses or machines, banks can secure repayment conditional on investment at very low costs. For simplicity, we assume that costs of verifying cash flow is zero if the entrepreneur has invested. For the same reason, we assume that repayment will be zero if entrepreneurs do not invest and just consume the funds. Both assumptions about monitoring possibilities can easily be relaxed.

There are potentially infinitely many banks (free entry); let m be the number of banks entering eventually. Since we later invoke the revelation principle, we can restrict contracts of banks to the class of contracts where agents truthfully reveal their type to the bank. We first discuss the nature of contracts and penalties for lying. Later we examine the corresponding participation and incentive compatibility constraints. Each bank i offers a contract $C_i = (\pi_{i,j}, R_{i,j})_{j=1}^n$ which specifies the acceptance probability $\pi_{i,j}$ and the repayment $R_{i,j}$. The contract has the following interpretation. An entrepreneur applying for a loan at the bank i first needs to state his type, say j. He will then receive the loan I with probability $\pi_{i,j}$. If the entrepreneur does not invest, he gets to eat all the funds available to him, and the bank gets nothing and cannot observe the type ex post. This is a consequence of our assumption that non-investing entrepreneurs cannot be forced to pay back. The quality of the investment project and thus the type of the entrepreneur does not matter in this case. If the entrepreneur invests instead, and is indeed of type j, the bank gets the $R_{i,j}$. If such an entrepreneur cannot pay back $R_{i,j}$, the bank receives $q_j(I+z)$ unless it is stated otherwise in the contract. If the entrepreneur invests and turns out to be of a different type, say $k \neq j$, the bank receives the entire cash flow $q_k(I+z)$, penalizing the lying agent[2].

We will distinguish two cases: contracts without random delivery, i.e. $\pi_{i,j} \in \{0;1\}$ and contracts where random delivery is allowed, i.e. $\pi_{i,j} \in [0;1]$.

An entrepreneur derives utility from terminal wealth W_j. Entrepreneurs are risk neutral: thus, their payoff u_j is expected wealth. If entrepreneurs have received additional funds from banks they decide whether to invest. The payoff of an entrepreneur, conditional on receiving a credit from bank i, amounts to:

$$u_{i,j}(\delta_j) = (1-\pi_{i,j})z + \pi_{i,j}\left(\delta_j \max\{0; (q_j(z+I) - R_{i,j})\} + (1-\delta_j)(z+I)\right) \tag{1}$$

The entrepreneur chooses $\delta_j \in \{0,1\}$ to maximize $u_{i,j}(\delta_j)$.

[2]We could allow banks to choose weaker sanctions for lying. For instance, an entrepreneur who announces to be type j, but is type k and invests could be treated as if he were type k. Allowing such weaker penalties in contracts makes the analysis more cumbersome. It will turn out that in no equilibrium it will be profitable for banks to offer contracts which are otherwise similar, but involve weaker penalties, if false announcements of types are detected. Allowing stronger penalties, like negative wealth, can certainly be thought of too, but have been ruled out by assumption.

Banks are assumed to be risk neutral. A bank can borrow unlimited funds at an interest rate $v = 0$. Clearly, a bank can only get a repayment if the entrepreneur invests, since otherwise the entrepreneur consumes the funds. Banks will not enter if the funds granted to entrepreneurs in this period exceed the expected repayments.

There are some contracts of a special type to which we have to refer to occasionally, and for which it is handy to have names. We call a contract $(\pi_{i,j}, R_{i,j})_{j=1}^{n}$ a *pure equity contract*, if $\pi_{i,j} \equiv 1$ and if $R_{i,j} = (q_j - 1)(I + z)$.[3] In that case, the bank bears the entire risk. We call a contract a *convertible debt* at repayment R, if $\pi_{i,j} \equiv 1$ and if $R_{i,j} = \min\{R; (q_j - 1)(I + z)\}$. Hence, if the return of the project is below R, the entrepreneur can convert the contract into a portion of the equity with associated repayment $(q_j - 1)(I + z)$. We call a contract a *pure debt contract* at repayment R, if $\pi_{i,j} = 1$ for all j and if the repayment $R_{i,j} \equiv R$ is independent of the type j. Moreover, under a pure debt contract, the bank obtains $q_j(I + z)$ if the entrepreneur has invested but cannot pay back R.[4] We aim at showing that any equilibrium with competition among creditors of the game which we are about to define can only involve pure debt contracts, unless the credit market breaks down.

The game unfolds as follows:

1. Banks simultaneously decide whether or not to enter and which contract to offer upon entering.

2. Entrepreneurs simultaneously choose banks and reveal their type.

3. The funding–lotteries $(\pi_{i,j})$ are executed (i.e. entrepreneurs have no chance of switching banks ex-post, if they are turned down).

[3]A pure equity contract can be bounded from above by the legal right of the entrepreneur to obtain a repayment according to his capital share. In such cases, we need the additional assumption $zq_j \leq I + z \quad \forall_j$.

[4]Hence, the debt contract contains the right of the lender to control the assets in case of default. In equilibrium, the shift of control will be associated with zero repayment since the entrepreneur will not decide to invest if returns are below R.

4. Funded entrepreneurs make a decision whether to invest.

5. Payoffs are realized and repayments occur.

An equilibrium to this game is a pure strategy, subgame perfect Nash equilibrium. It is a self–selection model in the sense of Rothschild and Stiglitz (1976) or Stiglitz and Weiss (1981). However, apart from differences in the returns of the investment projects, we have three additional complications. First, there is a moral hazard problem since entrepreneurs cannot be forced to invest. Second, non–investing entrepreneurs cannot be separated from investing entrepreneurs in the selection process. Hence, standard sorting devices such as collateral (see Bester 1985, Bester 1987), cannot be used to separate bad entrepreneurs from good ones. Third, we allow for arbitrary many types of entrepreneurs who have good projects. Competition of banks for such good types creates the distinction between debt and equity contracts and leads to the additional inefficiencies.

A subgame perfect Nash equilibrium is a set of credit contracts, such that each contract earns non–negative profits for a bank and creditors respond optimally in revealing their type and undertaking investments. Moreover, there exists no other contract for a bank which, when offered in addition, earns positive profits.

We assume additionally three tie–breakers in case of indifference for the entrepreneurs, which we state briefly now and describe in greater detail in the analysis below. First, entrepreneurs who are indifferent between investing and not investing always choose to invest. Similarly, entrepreneurs who are indifferent between telling the truth and lying always choose to reveal their true type. Second, investing entrepreneurs, who are indifferent between several banks, will choose each bank with equal probability. Third, entrepreneurs, who choose not to invest, will randomize across their most preferred banks so as to mimic the investing entrepreneurs. The first two tie–breaker rules are standard and innocuous, while the third tie–breaker rule is critical to the analysis and will be discussed in more detail when we examine competition in the credit market. Let $j^* = \min\{j \mid q_j \geq 1\}$. Hence, j^* is the first index value for which the return of the investment project is greater or equal to one.

Proposition 1 *The first best solution, in which a planner possesses complete information and can dictate the investment decision, is characterized by* $\delta_j = 1$, *iff* $q_j \geq 1$, *i.e., if* $j \geq j^*$.

In words, the social planner dictates to invest precisely in all those projects which meet at least the opportunity costs. The proposition is obvious.

3 The Decision Problem of the Bank

We first examine the last three stages of the game. The payoff for an investing, truth–telling entrepreneur of type j choosing bank i is given by (1) with $\delta_j = 1$, yielding payoff

$$\pi_{i,j}(\min\{R_{i,j}, q_j(I+z)\} - I),$$

for the bank from these entrepreneurs.

The payoff of any non-investing entrepreneur of type j, who chooses bank i and claims to be of type $k \neq j$, is given by

$$\tilde{\rho}(i,j,k) = (1 - \pi_{i,k})z + \pi_{i,k}(I + z) = z + \pi_{i,k}I$$

Note, that this entrepreneur will not invest, because of our "full confiscation in case of lying" assumption. The bank expects to loose the loaned resources $\pi_{i,k}I$.

Next we examine the decisions of the entrepreneur at the bank. Invoking the revelation principle, we can restrict contracts of banks to the class of revelation compatible contracts where entrepreneurs have an incentive to truthfully reveal their types to the bank. Let $\rho(i,j) = \max_{0 \leq \delta_j \leq 1} u_{i,j}(\delta_j)$ be the payoff to an entrepreneur of type j to choose bank i, who correctly reveals his type j and chooses whether to invest ($\delta_j = 1$) or not ($\delta_j = 0$). The contract C_i is said to be *revelation compatible*[5], if for all j,

$$\rho(i,j) \geq \max_k \tilde{\rho}(i,j,k),$$

i.e. if entrepreneurs are better off telling the truth.

One could add a participation constraint, requiring

$$(1-\pi_j)\cdot z + \pi_j \cdot (\max(q_j(I+z) - R_{i,j}, z+I)) \geq z \text{ for } j = 1,\ldots,n$$

Obviously, that participation constraint is automatically fulfilled since the entrepreneurs do not risk loosing anything by participating in the game. They can always take the received credit and consume the total amount of funds.

Let $\gamma_{i,j}$ be the joint probability that an entrepreneur is of type j and chooses bank i. Observe, that

$$\gamma_j = \sum_{i=1}^{m} \gamma_{i,j}.$$

Consider an entrepreneur of type j. Given choices between revelation compatible contracts, he will have to maximize $\rho(i,j)$. If there is at least one contract, for which $\rho(i,j)$ is maximal at $\delta_j = 1$, we assume that the entrepreneur will only choose to invest, $\delta_j = 1$ (this is the first tie–breaker mentioned above), and pick any of the banks, at which $\rho(i,j)$ is maximized for $\delta_j = 1$, with equal probability (this is the second tie–breaker mentioned above). These random picks determine $\gamma_{i,j}$ for these entrepreneurs. We call these entrepreneurs the *investors*. Let L be the set of all investor indices j, and let their total mass be denoted by λ, where

$$\lambda = \sum_{j \in L} \gamma_j$$

[5] We could also use the term "incentive compatible". Note, however, that our contracts still allow agents to shirk in the sense of not investing. Thus, the term "incentive compatible" may be misleading, leading to the choice of this term here.

Note that λ is endogenous since it is a function of the contracts offered.

All other entrepreneurs, i.e. those entrepreneurs, for which $\rho(i,j)$ can only be maximized by setting $\delta_j = 0$, are called *shirkers*: they will not invest. Shirking means that they do not repay anything to the bank in the next period. To insure truth telling, we get the following proposition:

Proposition 2 *Any revelation compatible contract of bank i must have*

$$\pi_{i,j} \geq \max_k \{\pi_{i,k}\}$$

for all shirkers $j \notin L$.

Proof: *For $j \notin L$, the revelation compatibility constraint can be rewritten as*

$$(1-\pi_{i,j})z + \pi_{i,j}(I+z) = \max_k \{(1-\pi_{i,k})z + \pi_{i,k}(I+z)\},$$

implying the result of the proposition because of $I > 0$. •

Shirkers will choose the bank that offers the highest chance for them to receive the investment amount I. Let $B(j) = \{i \mid \pi_{i,j} = \max_k \pi_{i,k}\}$ be the set of all bank indices i, that offer that highest chance to investors of type j. Below, we will show that $B(j)$ is the entire set, $B(j) = \{1, \ldots, m\}$. Note that shirkers truthfully reveal their type by the revelation compatibility of the contract. Shirkers are indifferent between banks in the set $B(j)$; in order to break that indifference, we are assuming our third tie–breaker rule. We assume that shirkers distribute themselves across the banks $i \in B(j)$ in exactly the same way as the investors do, i.e. we assume that a shirker of type $j \notin L$ chooses bank $i \in B(j)$ with the probability

$$p_{i,j} = \frac{\sum_{k \in L} \gamma_{i,k}}{\sum_{i \in B(j)} \sum_{k \in L} \gamma_{i,k}}$$

Note, that $\sum_{i \in B(j)} p_{i,j} = 1$. Obviously, $\gamma_{i,j} = p_{i,j}\gamma_j$ for $j \notin L$.[6]

This is a critical assumption for the further analysis, and is therefore worth some discussion. Imagine that investors distribute themselves across banks first, and that the size of a bank is then given by the number of investors financed by it. If shirkers distribute themselves according to bank size, they end up mimicking the investors.[7] An alternative story may run as follows. Indifferent borrowers are those who are of low quality and do not invest. Thus, they are indifferent because their terminal wealth does not depend on different repayments offered in the various contracts, and the funds provided by banks under different contracts are the same. Then, shirkers may want to mimic honest investors as best as they can, distributing themselves across lenders in the same proportion as honest investors. Suppose that a lender offers a new contract. Suppose that this new contract offers high quality entrepreneurs a better deal, while entrepreneurs with low quality are still indifferent since they do not invest. Certainly, investors would then redistribute themselves. If shirkers do not redistribute themselves likewise, they could be detected because they are not moving. The shirkers would be those that can never be attracted by such a new contract. Since they are indifferent about these contracts, they might as well move and thus avoid detection this way.

4 The Monopoly Case

We first consider the monopoly case, i.e. only one bank can offer contracts and further entry is impossible. To examine optimal contracts, we apply the revelation principle again, since the bank chooses an optimal mechanism

[6] If the set L is empty, i.e., if all entrepreneurs are shirkers, we assume that shirkers distribute themselves arbitrarily across banks. Since this case does not occur in equilibrium or in any relevant deviation strategies, the assumption is harmless.

[7] What counts is the proportion of shirkers a potential bank expects to attract. We assume that this proportion is monotonically related to the size of banks.

under incomplete information about the quality of the entrepreneurs. This implies that the bank can restrict its attention to credit policies that induce applicants to truthfully reveal their type. Recall that j^* is the first index value for which $q_j \geq 1$.

It is useful to introduce ψ^* as

$$\psi^* = \sum_{j \geq j^*} \gamma_j \cdot ((I + z)(q_j - 1) - I) - \sum_{j < j^*} \gamma_j \cdot I$$

In words, ψ^* is the profit of the bank if it obtains repayments above the invested funds from all entrepreneurs with quality levels of at least unity, i.e., if it offers a pure equity contract. From the entrepreneurs with lower quality, the bank suffers a loss equal to the granted credit. In the next proposition, we characterize the optimal credit policy by the bank using this profit expression.

Proposition 3

1. *If $\psi^* \geq 0$, then the optimal credit policy is given by the pure equity contract. Entrepreneurs invest, iff $j \geq j^*$. The optimal credit policy is efficient.*

2. *If $\psi^* < 0$, then optimal credit policy is given by*

$$\pi_j = 0 \quad \forall j = 1, \ldots, n$$

   The optimal credit policy is inefficient.

Credit policy by a monopolist is inefficient for $\psi^* < 0$, since in this case, credits for good projects are not granted. This source of inefficiency is present because the contracts are pooling with respect to bad entrepreneurs. They can not be distinguished from investing entrepreneurs. For $\psi^* \geq 0$, the mix of good and bad projects is sufficiently favorable so that the bank can compensate losses in low return projects by equity participation in projects with high returns. The distribution of funds involves a subsidy to bad entrepreneurs by banks and, ultimately, by good entrepreneurs. The monopolistic bank gets all rents from good entrepreneurs ($j \geq j^*$). However, the bank cannot separate bad from good entrepreneurs.

Proof:

1. *For j with $\pi_j > 0$, it is obvious that $R_j < 0$ can never be optimal for the monopolist, since the bank incurs losses. For $\pi_j = 0$ we can assume $R_j \geq 0$ w.l.o.g.. Similarly, we can restrict R_j to be bounded above by $(I + z)q_n$, say, since that repayment as any higher repayment will not be delivered upon by entrepreneurs: they will not invest. Thus, an optimal contract (π_j, R_j) exists, since it maximizes the continuous profit function over a compact set.*

2. *Let $\pi = \max \pi_j$. Consider an entrepreneur with $j < j^*$. Since $R_j \geq 0$, this entrepreneur will not invest, $j \notin L$. Proposition 2 implies $\pi_j = \pi$.*

3. *Consider an entrepreneur with $q_j \geq 1$ and hence $j \geq j^*$. The optimal contract must pick π_j and R_j so that $\pi_j R_j$ is maximized subject to the revelation constraint under investing,*

$$(1 - \pi_j)z + \pi_j (q_j(I + z) - R_j) \geq (1 - \pi)z + \pi(I + z)$$

or

$$\pi_j R_j \leq \pi_j(I + z)(q_j - 1) - (\pi - \pi_j)I$$

and the bound $\pi_j \leq \pi$: The solution is given by $\pi_j = \pi$ and (if $\pi_j \neq 0$) $R_j = (I + z)(q_j - 1)$.

4. *The optimal contract then solves $\max_{\pi \in [0;1]} \pi\psi^*$. The conclusion follows upon comparison with the first best solution, see proposition 1.*

•

5 Competitive Credit Markets without Random Acceptance

We next consider competitive credit markets. By assumption, we shall rule out $\pi_{i,j} \in (0,1)$ in this section, i.e. we do not allow banks to base delivery on some random device. Thus, we shall henceforth assume that $\pi_{i,j} \equiv 1$ for all banks that offer contracts. Therefore, as indicated by proposition 2, shirkers are indifferent between all banks offering at least one type of contracts, i.e., $B(j) = \{1, \ldots, m\}$ for $j \notin L$. Note that shirkers distribute themselves according to

$$\gamma_{i,j} = \frac{\gamma_j}{\lambda} \sum_{k \in L} \gamma_{i,k} \tag{2}$$

Let us calculate the expected payoff ψ_i for a bank i from the contract $C_i = (R_{i,j})_{j=1}^n$ when the contract does not contain any additional specification of repayments in the case of default. That payoff is obtained by summing all the payments received from the different types of agents next period minus the payments made to them this period, weighting them with the joint probability of the particular type choosing this particular bank. A simple calculation yields:

Proposition 4

$$\psi_i = \sum_{j \in L} \gamma_{i,j} \left(R_{i,j} - \frac{I}{\lambda} \right)$$

Proof: *Note that $R_{i,j}$ is indeed the repayment to a bank i, if $j \in L$ is an investing type visiting this bank with positive probability $\gamma_{i,j} > 0$. Put differently, if the bank would get $q_j(I+z)$ rather than $R_{i,j}$ from these agents, these agents would have chosen not to invest in the first place, since their payoff would be zero. The term $-I/\lambda = -I\,(1 + (1-\lambda)/\lambda)$ arises from the resources given to each investor plus the resources lost to the $(1-\lambda)/\lambda$ shirkers accompanying each investor. Formally,*

$$\psi_i = \sum_{j \in L} \gamma_{i,j}(R_{i,j} - I) - \sum_{j \notin L} \gamma_{i,j} I$$

implying the result with equation (2). •

This proposition shows that each investor brings a share of shirkers with him who imitate him. Of all the loans made by the bank, only the share λ reaches investors, whereas the share $1-\lambda$ are embezzled by shirkers with no chance for the bank to see any repayment. Since these extra sunk costs of lending are independent of the type of the honest entrepreneur, it now seems plausible that the contracts offered in equilibrium are pure debt contracts.

Indeed, a direct consequence is:

Proposition 5 *If there is a subgame perfect equilibrium in the game, then it can be written as an equilibrium in pure debt contracts at repayment*

$$R = \frac{I}{\lambda}$$

Proof: *Let $j \in L$ be an investor and let $i > 0$ be a bank with $\gamma_{i,j} > 0$: such that i, j must exist, if there is at least one bank. We first show, that $R_{i,j} \leq \frac{I}{\lambda}$. If indeed $R_{i,j} > \frac{I}{\lambda}$, a bank k which chose not to enter could have instead chosen to enter and to offer a slightly better contract just to agents of type j, i.e. to offer $R_{k,j}$ with $\frac{I}{\lambda} < R_{k,j} < R_{i,j}$ to agent j and $R_{k,l} = \infty$ to all other agents. As a result, investors of type j will choose this bank, bringing along the respective share of shirkers, while all other investor types will remain with the banks they would have chosen otherwise. But now, the profits to this bank are positive, $\gamma_j(R_{k,j} - \frac{I}{\lambda})$, in contradiction to free entry. This shows that $R_{i,j} \leq \frac{I}{\lambda}$.*

Now note that the same free entry condition shows that $R_{i,j} = \frac{I}{\lambda}$ for any $i \in B$, $j \in L$, for which $\gamma_{i,j} > 0$, since otherwise the bank would make negative expected profits. Hence, cross-subsidization of borrowers is impossible, since $R_{i,j} \leq I/\lambda$.

Finally we have to rule out that entrepreneurs with $j \notin L$ end up shirking just because their $R_{i,j}$ exceeds I/λ. Suppose to the contrary that for some *shirker $j \notin L$, we have $\frac{I}{\lambda} \leq (q_j - 1)(I + z)$. But then, a bank could offer an additional contract to these shirkers at a repayment $\frac{I}{\lambda}$. This would yield non–negative repayments from these entrepreneurs who become investors and would raise λ, an effect which reduces the amount of resources lost to shirkers. Overall profits for this bank increase.* •

Several remarks are necessary. Note that proposition 5 implies that it is impossible for two contracts asking for different repayments from investing entrepreneurs to be offered in equilibrium. Furthermore, although the equilibrium contracts are uniquely specified, two indeterminacies occur. First, the repayment asked from a shirker could also be higher (or even somewhat lower) than described in proposition 5 without altering the allocation of credits, since shirkers do not invest at all. Second, in equilibrium banks make zero profits from all investing entrepreneurs if the accompanying share of shirkers is accounted for. Nonetheless, banks may not offer a credit to all investing types of entrepreneurs and instead pick e.g. $R_{i,j} = (I + z)q_j$ and thus $\gamma_{i,j} = 0$ for some $j \in L$. It must be true that $\gamma_{k,j} \neq 0$, for some other bank k. Since $R_{k,j} = \frac{I}{\lambda}$ there, bank i might as well also choose $R_{i,j} = \frac{I}{\lambda}$. By our second tie-breaker assumption of a uniform random distribution of investors across their most preferred banks, bank i would now see a positive fraction of entrepreneurs of type j to apply for loans at bank i, and likewise, the other banks would receive less customers. However, this does not change the payoffs to the banks or the entrepreneurs, nor would it change the total amount invested. It is in this sense that the equilibrium does not change.

We next determine the value of λ. Provided that banks offer contracts at some repayment R, it is easy to separate investors from shirkers:

$$L = L(R) = \{j \mid (q_j - 1)(I + z) \geq R\}$$

Likewise, we can find the total fraction of the population that invests,

$$\lambda = \lambda(R) = \sum_{j \in L(R)} \gamma_j$$

Hence, let

$$G(R) = \sum_{j \in L(R)} \gamma_j \left(R - \frac{I}{\lambda(R)} \right) = \lambda(R)R - I$$

be the sum of the expected profits to the banks, given that they all charge R. Finally, let R^* be the lowest repayment, for which $G(R)$ is zero:

$$R^* = \min\{R | G(R) = 0\}$$

Obviously, R^* may not exist. We obtain the following result.

Proposition 6 *Suppose that R^* exists. In any subgame perfect equilibrium with positive entrance banks charge the repayment R^* given by*

$$R^* = \frac{I}{\lambda(R^*)}$$

Proof: *We have shown in the last proposition, that if there is a Nash equilibrium, then it can be written in the form of a pure debt contract at repayment $R = I/\lambda$. Suppose that $R > R^*$. If $G(R) < 0$, this can certainly be no equilibrium.*[8] *Hence, suppose $G(R) > 0$.*[9] *In that case, there is a value $\tilde{R}$, $R^* < \tilde{R} < R$ with $G(\tilde{R}) > 0$. A bank offering debt contracts at the repayment $\tilde{R}$ will draw the entire market (since investors are better off at lower repayments, and since shirkers imitate investors), and makes positive profits $G(\tilde{R})$, a contradiction to free entry. Thus, we must have $R = R^*$. Either with proposition 5 or via examining $G(R^*) = 0$, one sees that*

$$R^* = \frac{I}{\lambda(R^*)}.$$

•

The proof of this proposition has a flavor similar to an argument made by

[8] This could occur if the function $G(R)$ touches zero from below without crossing it.

[9] We rule out the knife-edge case where the function $G(R)$ is zero for a continuum of interest rates.

Mankiw, 1986. Note that this proposition rests on the fact that a new entering bank changes the decomposition of entrepreneurs into investors and shirkers: it is the shift of some shirkers into investors that makes the entry at the lower repayment profitable.

To summarize: if there is a subgame perfect Nash equilibrium with positive amounts of loans handed out, it must be the case that banks charge the repayment R^*. So, if there is an equilibrium, it is unique in the sense of yielding a unique allocation of resources. However, we have not provided sufficient conditions for existence. Indeed, we will show that the possibility of offering equity and debt contracts introduces a substantial problem for the functioning of the credit market. To that end, we consider a particular deviation from the candidate equilibrium at $R_{i,j} \equiv R^*$. Recall that j^* is the first index value for which $q_j \geq 1$.

Proposition 7 *Suppose that R^* exists. Suppose that the set of intermediate quality shirkers*

$$S = \{j^*, \ldots, n\}/L(R^*)$$

in the candidate equilibrium is not empty. Then, no subgame perfect equilibrium in pure strategies exists. Otherwise, there exists a Nash equilibrium at the repayment R^*.

Proof: *Consider the candidate equilibrium in which all banks chose the debt contract with repayment R^*. Let $\lambda = \lambda(R^*)$, let $L = L(R^*)$ and let $\tilde{\lambda} = \lambda(0)$. Choose some $\epsilon > 0$ sufficiently small: a new entering bank could offer a convertible debt contract at repayment $R^* - \epsilon$. This turns all $j \in S$ into investors, raising the fraction of investors from λ to $\tilde{\lambda}$. Furthermore, all previous investors $j \in L$ will strictly prefer this contract. The shirkers will mimic the investors. The bank will therefore capture the entire market. Hence, the profits of the new entrant are given by:*

$$\sum_{j \in S} \gamma_j \left((q_j - 1)(I + z) - \frac{I}{\tilde{\tilde{\lambda}}} \right) + \sum_{j \in L} \gamma_j \left(R^* - \frac{I}{\tilde{\tilde{\lambda}}} \right) - \epsilon \lambda$$

$$
\begin{aligned}
&= \sum_{j \in S} \gamma_i \left((q_j - 1)(I + z)\right) + G(R^*) - \epsilon\lambda \\
&> G(R^*) = 0
\end{aligned}
$$

for $\epsilon > 0$ sufficiently small. Hence the bank makes positive expected profit and this deviation destroys the candidate equilibrium. Therefore, no equilibrium exists.

Conversely, suppose that S is empty. Thus, entrepreneurs either invest or are of such low quality that no bank can induce them to invest without incurring losses beyond those incurred due to shirking. Hence, a newly entering bank cannot profitably change the composition of investors and shirkers, i.e. λ cannot change by offering additional contracts. Then the previous proposition above shows that a deviation cannot be profitable, since charging less than I/λ means loosing money. Hence, if S is empty, no profitable deviation is possible. •

It is worth discussing why an equilibrium may fail to exist in proposition 7. If intermediate quality levels exist, i.e. if the set S is not empty, then the debt contract in the candidate equilibrium is not attractive enough for entrepreneurs $j \in S$ in order to induce them to invest. But then, a bank could offer the capped equity contract at repayment $R^* - \epsilon$. This new contract yields higher profits than the original debt contract. However, this contract cannot be an equilibrium either. This follows directly from proposition 5. More intuitively, it follows since such a contract is dominated by a simple debt contract for high quality entrepreneurs with slightly better conditions. Assume additionally that the bank offering this debt contract just breaks even, given the enlarged set of investors. This leaves only entrepreneurs with intermediate and bad quality levels for the capped equity contract. The cross-subsidization from high quality entrepreneurs disappears. The capped equity contract now generates a loss, since it recoups less from each investing entrepreneur than the new break-even debt contract (via the self-selection of entrepreneurs), but looses the same resources to the accompanying shirkers.

Overall, the competitive credit market breaks down.

Proposition 7 indicates that the debt contract arises as the unique type of credit contract in equilibrium. If the competitive equilibrium exists, the allocation is efficient since all entrepreneurs with good projects are granted credits and invest. Hence, competitive credit markets can lead to the first best solution under the following two circumstances: only entrepreneurs with high quality or a mix between very good and bad entrepreneurs are in the market. If entrepreneurs with intermediate quality levels are present in the market, competitive credit markets break down. Monopoly credit markets can also break down: this is the case if $\psi^* < 0$ in proposition 3. Comparing proposition 3 with proposition 7, one sees that competitive markets break down more often than monopolistic markets.

The nonexistence of equilibria can lead to collapse phenomena in the credit market. Three alternatives can be considered. On the equilibrium side, mixed strategies can be examined. We will consider randomized strategies in the next section. Moreover, refinements of the equilibrium notion can be applied in the tradition of Wilson, Riley or Hellwig (see Hellwig 1987 and Kreps 1990 for surveys) which, however, looks less promising in our context.[10] On the regulatory side, one can ask which regulatory schemes can prevent a potential break down. We are focusing on regulations that still preserve competition of lenders, but that can avoid a collapse of credit markets. We consider a regulatory scheme, which resembles the separation of investment banking and commercial banking in the U.S. Given a particular condition, we will show that such a regulation can restore the functioning of credit markets under some condition. To describe the condition that we need, suppose that

[10] It can be shown that some dynamic extensions of the game that allow for removals or additions of contracts over time can yield existence and therefore avoid a collapse. However, as discussed in Hellwig 1987 and Kreps 1990 it remains unclear which dynamic game theoretic formalizations are appropriate.

R^* exists, and let $S = \{j^*, \ldots, n\}/L(R^*)$. Let

$$\bar{R} = \left(\frac{\sum_{j \in S} \gamma_j q_j}{\sum_{j \in S} \gamma_j} - 1 \right) (I + z)$$

be the average profit generated by an intermediate quality entrepreneur $j \in S$ under a pure equity contract. The condition we need is

Assumption A. 1

$$\bar{R} < \frac{I}{\lambda(0)}$$

Note that

$$\bar{R} < \frac{I}{\lambda(\bar{R})} \tag{3}$$

since $\bar{R} < R^*$ and thus $G(\bar{R}) < 0$ by the definition of R^*. Assumption 1 is a bit stronger than (3). For some special cases, e.g. if S is a singleton, that assumption can be shown to hold, but one can also find counterexamples to the conjecture that it holds in general. The regulatory scheme adds a pre-step to the game:

0. Banks have to decide which type of contracts they are offering if they enter the market. They are only allowed to offer either pure equity contracts or pure debt contracts.

1.-5. Original game.

Proposition 8

(i) *Suppose that R^* exists and that assumption 1 holds. Then, a unique subgame perfect equilibrium for the regulated credit market exists and takes the form of a pure debt contract equilibrium at the repayment R^*.*

(ii) *Suppose that R^* exists and that assumption 1 does not hold. Then, no subgame perfect equilibrium exists for the regulated credit market.*

Proof:

(i) *We have already shown that a subgame perfect equilibrium is unique and takes this form, provided it exists. This conclusion is not altered by the additional pre-step, although the argument is somewhat different. We shall skip the details. Briefly, there are only three candidate equilibria, the other two being a mixed equity - debt equilibrium and the pure equity equilibrium. The mixed debt - equity equilibrium cannot be one, because the return on equity is strictly dominated by the return on debt. The pure equity equilibrium cannot be one, because it can be destroyed by a bank offering a debt contract to the best entrepreneurs. It remains to be shown that the pure debt candidate equilibrium cannot be destroyed by an equity contract. Thus, suppose that an additional bank decides to offer a pure equity contract. It will draw all entrepreneurs* $j \in S$ *to it, leading them to invest, and generating profits* $\bar{R}$ *on average. Thus, the fraction* $\tilde{\lambda} = \lambda(0)$ *is now the fraction of entrepreneurs who are investors. The bank will also attract shirkers according to this new proportion, and thus make net profits of* $\bar{R} - I/\tilde{\lambda}$ *per entrepreneur. This will not be profitable by assumption 1.*

(ii) *The proof of (ii) follows the considerations of proposition 7. By (i) a bank can add a profitable equity contract to a pure debt contract of another bank with repayment* R^**. The combination of such a debt and equity contract is the only candidate for an equilibrium. But then a third bank can offer a pure debt contract with better conditions for entrepreneurs leaving intermediate entrepreneurs and a corresponding share of shirkers for the equity contract. This deviation from the candidate equilibrium will destroy the profitability of the equity contract.*

•

The preceding discussion can provide a new argument why the separation of financial activities can be beneficial, since limiting the number of types of contracts a financial institution can offer restores the equilibrium. Note that the regulation does not require that banks issue a specific type of contract. Hence, a bank can choose to be either an investment bank or a commercial bank at the beginning, but not both. This conclusion is related to the widely known Glass–Steagall Act of 1933, which prohibits commercial banks from underwriting, holding, or dealing in corporate securities. Today the appropriate degree of separation between commercial and investment banking is still hotly debated, see e.g. Kroszner and Rajan, 1994, for a recent study. Traditionally, most arguments in favor of such regulations rely on increased risk for bank failures, if the separation is not enforced, or on unfair advantages of banks in security business due to cost and informational advantages. The preceding discussion suggests that limiting the type of contracts a financial institution can offer is beneficial for the functioning of the credit market.

A question arises as to what should happen if assumption 1 is violated. In that case, it can be shown that the pure equity contract will indeed be profitable in the candidate equilibrium, and thus destroys it. From a regulatory perspective, this could be avoided by only permitting debt contracts. There have been many debates about the absence of a functioning venture capital market in Europe, often ascribing it to regulations rather than lacking entrepreneurial spirit. One interpretation in light of this theory is that such regulations might actually be beneficial: if a venture capital market were to develop for the same borrower classes, it could destroy existing credit markets. Clearly, other arguments need to be added in order to receive to a balanced perspective on this policy issue. Our theoretical predictions that equity markets or venture capital markets cannot coexist with pure debt contract markets is surely too sharp. We nonetheless believe that we have captured one important aspect of these markets with our theory.

6 Competitive Credit Markets with Random Acceptance

In this section, we consider what happens if banks are allowed to offer contracts with random delivery, i.e. they are allowed to offer funding lotteries $(\pi_{i,j})$ with $0 \leq \pi_{i,j} \leq 1$ which we shall call *random delivery*. Random delivery is a particular form of credit rationing, since borrowers only receive funds with a certain probability. We obtain:

Proposition 9 *Suppose that random delivery is allowed. Then, no subgame perfect equilibrium exists.*

Proof: *Suppose that $S = \{j^*, \ldots, n\}/L(R^*)$ is empty, i.e. that there are no intermediate quality shirkers in the candidate equilibrium. Otherwise, adapting the proof of proposition 7 to this context shows that no subgame perfect equilibrium exists.*

If one bank offers the debt contract $R^* = \frac{I}{\lambda(R^*)}$, which is the only candidate for an equilibrium without random delivery, another bank, say i, could enter and offer the following contracts for some small $\epsilon > 0$

$$\begin{aligned} \pi_{i,j} &= 1 - \epsilon \\ R_{i,j} &= R^* - 2\epsilon \left(\max_{j \in L(R^*)} \{q_j(I+z) - R^*\} \right) \end{aligned}$$

Clearly this contract will not be taken by shirkers since the delivery chance is lower than with the pure debt contract.

However, for investors under the pure debt contract, payoffs for this new contract are increased, provided $\epsilon > 0$ is sufficiently small:

$$\begin{aligned} \rho(i,j) &= q_j(I+z) - R^* + 2\epsilon(1-\epsilon) \left(\max_{j \in L(R^*)} \{q_j(I+z) - R^*\} \right) \\ &\quad - \epsilon \left(q_j(I+z) - R^* \right) \\ &> q_j(I+z) - R^* \end{aligned}$$

Thus, this bank makes a positive profit, since it faces only genuine investors, and the pure debt contract cannot be an equilibrium.

However, the same considerations apply to any other set of contracts, as possible equilibrium candidates. A bank can always enter and offer a slightly lower delivery probability, while slightly improving the terms for investing entrepreneurs. Therefore, no bank wants to offer a contract with the highest delivery probability. Hence, all banks try to avoid the contract with the highest delivery chance.

On the other hand, if no bank offers a contract with positive delivery chances, it is profitable to offer the pure debt contract with repayment above R^*. *Thus, no equilibrium exists.* •

The last proposition shows that banks want to avoid shirkers by lowering their delivery probability.[11] This can be achieved by being clear about the terms of the contract but being opaque about the procedure for the delivery. The regulatory actions to prevent the collapse of credit markets with random delivery chances are less clear but still possible. For instance, the danger that banks could engage in a race for lower delivery chances could provide a rationale for transparency requirements in the credit market. Transparency would ensure that there is no uncertainty under which conditions an applicant can receive a loan. For instance under the Ordover and Weiss (1981) policy proposal, active banks would be forced to lend to all borrowers at some interest rate. Such a policy requirement would be effective because banks cannot

[11] We conjecture that not even a subgame perfect equilibrium in symmetric mixed strategies of banks exists. The contracts offered under mixed strategies which have the highest delivery chance would always be chosen by the shirkers. Hence, given an equilibrium in mixed strategies, all banks would have an incentive to lower slightly the delivery probability for all contracts while improving the conditions for investors in order to avoid the shirkers. The same consideration apply to any revised support of random delivery possibilities. The profit functions are not upper-hemicontinuous and the Dasgupta-Maskin theorem (Dasgupta and Maskin 1986) cannot be used to establish existence of mixed strategy equilibria for discontinuous games.

avoid shirkers by charging very high interest rates. Thus, banks have no incentive to lower delivery probabilities on all contracts offered and equilibrium in pure debt contracts would be restored. However, such regulation would in the end deny banks to ration credits, and thus may have other disadvantages.

7 Conclusion

In this paper, we have offered a simple explanation for the prevalence of debt contracts by focusing on a simple model of credit markets with adverse selection and moral hazard. The crucial novel feature is the competition between lenders in their choice of contracts offered. We have focused on the distinguishing feature between debt and equity participation, that debt contracts are limited in their repayments upward, and entrepreneurs are the residual claimant of high returns. If an equilibrium in competitive credit markets exists, the resulting allocation is first–best. However, competition among banks in offering contracts creates three collapse possibilities, which, in turn, can provide a rationalization for regulating the number of contracts particular financial institutions are allowed to offer.

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