Productivity Gap, Collateral Constraints, and Loan Contracts

Chien-Hui Lee* and Yu-Lin Wang**

Abstract

This paper models a productivity gap as the source of informational asymmetry and explores equilibrium contracts as well as production decision of resource allocation in competitive and monopolistic credit markets. Our results show that collateral is an efficient sorting device in a monopolistic market with asymmetric information; whereas it is never used in a competitive market. In a monopolistic market, when the proportion of low-tech entrepreneurs is low enough, the optimal monopolistic contract is a separating contract or, vice versa, it is a pooling contract. Low-tech entrepreneurs face a binding collateral constraint in a separating contract, causing the problems of over-borrowing and productive resource misallocation. For a competitive market, entrepreneurs are granted the same loan contract regardless of their productivity levels and regardless that information is perfect or asymmetric.

Keywords: Productivity Gap, Collateral, Competitive Credit Market, Monopolistic Credit Market

JEL Classification: D24, D82, G31

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I. Introduction

Literature seems to conclude, in an informational asymmetry competitive credit market (hereafter abbreviated to CCM) the screening role of collateral is emphasized, whereas collateral is useless and not pledged in a monopolistic credit market (hereafter abbreviated to MCM). Besanko and Thakor (1987), for example, elaborated on the finding in an economy where lenders know less than borrowers about borrowers' default risks. Considering that most collateralizable assets support production, such as land and physical capital, whether or not loan contracts require collateralizable assets may affect production decision. Wang (2010) discussed entrepreneurs' collateral constraint in a CCM, together with their production decision for resource allocation. The finding is consistent with the result of most literature that the optimal loan contract is a separating equilibrium. The combination of collateral and interest rate, which are inversely related to each other, can effectively distinguish high-risk borrowers from low-risks ones. If there are not enough collateralizable assets for entrepreneurs who need to meet the collateral constraint, they often borrow too much and allocate productive resource inefficiently. Wang et al. (2011) examined the same issue as Wang (2010) did but adding a MCM. Not surprisingly, the optimal contract becomes a pooling equilibrium and collateral is not used to screen different risk types of borrowers. Thus, even though there is informational asymmetry in the credit market, with a monopolistic market structure, financing friction does not influence real investment decisions.

The above cited results seem to be standard in the literature. When there is asymmetric information in the credit market, a competitive equilibrium is never pooling and a monopolistic equilibrium is only pooling. Moreover, the structure of credit market seems to solely determine the role (or no role) of collateral. The purpose of this paper is to propose an alternative scenario about the source of informational asymmetry to explore other possible equilibrium in CCM and MCM. More specifically, if the informational asymmetry comes from concerning the productivity level of entrepreneurs, not their risk types as assumed in the literature, the role of collateral as well as the equilibrium contracts in CCM and MCM are completely reversed. In other words, collateral is an efficient sorting device and there is a separating contract in a monopolistic market; whereas collateral is useless and a pooling contract arises in a competitive market.

In the literature, the risk type of entrepreneurs or equivalently, the probability that a risky project succeeds, is almost the only choice for payoff-relevant borrower attributes. It is often the sole source of informational asymmetry. Bester (1985, 1987) concluded that debt contracts designed in a CCM attract high-risk borrowers to choose a package of low collateral with high interest rates. Besanko and Thakor (1987) showed that if the borrowers are endowed with sufficient collateral assets in a CCM, collateral serves as a signal to avoid adverse selection and credit rationing problems. Martin (2009) described the relationship between entrepreneurial wealth and total investment under adverse selection, and found that this relationship need not be monotonous. In particular, when the wealth of entrepreneurs is relatively low, investment is independent of the wealth and a pooling equilibrium is more likely to occur. On the contrary, when the wealth of entrepreneurs is relatively high, investment is increasing with the wealth and a separating equilibrium arises.

Different from literature over simplifying entrepreneurs' production behaviors, Wang (2010) explicitly modeled the producer's choice of resource allocation in order to execute a risky investment project. It studies the consequences for efficiency of productive resource allocation in an economy where there is an informational friction. Following the existing scenario, informational asymmetry arises from different risk types of borrowers. Wang et al. (2011) added a MCM into discussion. Although the contents of the loan contract echo those in the literature, the implications to allocating productive resource are noteworthy and share the similar idea with the empirical work such as Almeida and Campello (2007), Schäfer and

Talavera (2009), Chaney et al. (2012), Catherine et al. (2017), Doerr (2018), Epstein and Shapiro (2019) and Ersahin and Irani (2020).

Schäfer and Talavera (2009) conducted an empirical study which showed that small German businesses facing financial constraints due to less inherited capital distort the entrepreneurs' optimal investment and reduce their chances of survival. Almeida and Campello (2007) pointed out that when a company has a credit constraint, its collateralizable assets support more borrowing, which will cause the company to make further investment in the collateralizable assets. They concluded that the sensitivity of investment-cash flow in financially constrained companies is increasing in the tangibility of assets; but is not influenced by the tangibility of unconstrained companies' assets. Chaney et al. (2012) explored the impact of stochastic values of real estate on aggregate investment, because in the presence of financial constraints, firms use real estate as collateral to finance new projects. Catherine et al. (2017) found collateral constraints on firm level corporate investment in the United States cause aggregate welfare loss of 9.4% and output loss of 11%. Such losses arise in part from the misallocation of inputs across heterogeneous producers (Hsieh and Klenow, 2009; Moll, 2014; Midrigan and Xu, 2014) and in part from a suboptimal aggregate capital stock. Doerr (2018) found rising real estate prices reallocate resources towards firms that hold real estate as collateral, which are less efficient than non-holders. His results provide direct evidence that financial frictions can lead to misallocation, moreover, cause reduction in total factor productivity. Epstein and Shapiro (2019) found a significant negative relationship between financial development, in which easing collateral constraints is one example, and unemployment volatility in developing and emerging economies. Ersahin and Irani (2020) concluded that for financially constrained firms, an increase in firms' real estate collateral values increases firms' employment expenditures, which in turn affects corporate labor demand.

Probing into the production side of entrepreneurs' projects initiates an interesting issue to address: suppose there is asymmetric information regarding entrepreneurs' productivity levels, what is the impact of this informational friction on loan contracts and, further, on productive resource allocation? There is plenty of work linking productivity gaps to either research and development or economic growth, for example, Gil Moltó et al. (2005) and Fagerberg and Verspagen (2002), and to foreign direct investment, for example, Nakamura (2002) and Glass and Saggi (1998). However, treating a productivity gap as the source of informational asymmetry and associating it with different credit market structures to determine the loan contracts have never been done before.

The rest of the article is organized as follows: Section 2 provides model settings. Section 3 elaborates that the necessity of increasing collateral may distort the entrepreneur's best choice for two kinds of inputs, one of which is pledgeable and the other is not. In Section 4, we assume that the bank acts as a pricing monopoly in the credit market and determines the best loan contract. In Section 5, a perfectly competitive market is analyzed. The sixth section summarizes the main findings.

II. Model

According to Wang (2010), we assume that there are two equal-size groups of agents, called as entrepreneurs and lenders in a universally risk-neutral economy. In the beginning, all agents have general capital of K_0 units. Aside from the general capital, an entrepreneur is given with a venture investment project, but a lender is not. The venture investment project requires an input with a fixed amount of commodity $\bar{Q}$. If the project succeeds, the investor will receive a per unit return G; and he will get zero return if the project fails. Lenders deposit K_0 in banks and get a fixed income γK_0 at the end of the period. The banks simply accept deposits and provide entrepreneurs with a term loan contract. The rate of return γ is fixed which represents the gross interest rate of deposits of general capital.

General capital K can be used in any production activity and can be converted into specific capital H without cost. The assumption that H is the specific capital makes H not acceptable as collateral for the banks. According to the Cobb-Douglas (hereafter abbreviated to C-D) production function, by using the general capital K with the specific capital H, it is possible to obtain a fixed $\bar{Q}$ of commodities that entrepreneurs invest in venture investment projects:

$$\bar{Q} = H^{\alpha} K^{1\text{-}\alpha}, 0 < \alpha < 1$$

We assume that $\bar{Q}$ can only be obtained through the entrepreneurs' own production; however, for producing $\bar{Q}$, the required amount of the sum of general capital *K* and specific capital *H* is larger than the initial endowment K_0 of each entrepreneur. In order to produce a fixed quantity of commodity $\bar{Q}$, the entrepreneur must borrow the amount of loan *B* with the gross loan interest rate r. *B* units of capital thus have to satisfy the following constraint:

$$B = K + H - K_0$$

Entrepreneurs are born with one of the two types of productivity level which, for simplicity, are represented by two rates of capital depreciation, δ_1 and δ_2, $0 < \delta_2 < \delta_1 < 1$. Statistics Canada (2007) claimed depreciation estimates are important for productivity measures. As the productive efficiency of an asset declines, its physical depreciation raises. According to the finding of Statistics Canada (2007), the average depreciation rate of "computers, associated hardware and word processors," can be as high as 0.531, while the average depreciation rate of "aircraft, helicopters, aircraft engines and other major replacement parts," is as low as 0.084. Entrepreneurs who have a high (low) capital depreciation rate δ_1 (δ_2) are those with a low (high) productivity level. Without loss of generality, the depreciate rates are assumed to be the same for both capitals; they are only productivity specific, δ_i, $i = 1, 2$. After production, the value of capital becomes $(1-\delta_i)(K+H)$ at the end of period.

The specific capital *H* has no collateral value to the bank so the collateral *C* is restricted by the general capital *K*. The collateral placement constraint that we emphasize in this article is:

(6)

$$0 \le C \le K$$

The value of collateral in the end of period becomes $(1-\delta_i)C$.

Assume that both high-tech and low-tech entrepreneurs face the same probability that their risky projects succeed, $0 < P < 1$. After the project is successful, the unit income G allows the total income $G\overline{Q}$ to pay back the debt rB to the bank. However, when the project fails with probability of $1-P$, the bank will fully take over the collateral. The valuation of the collateral by the bank is βC, with $\beta \in (0,1)$, due to the transaction costs of owning and liquidating the collateral. βC is lower than the valuation of C by the borrowers.

The bank confronts a fixed pool of observationally same borrowers, including high-tech entrepreneurs and low-tech entrepreneurs. In a credit market with asymmetric information, each borrower knows his private information, but the borrowers cannot be discerned by the bank. The proportion λ of these borrowers are low-tech types and $(1-\lambda)$ are high-tech types are common knowledge. In order for each borrower to truthfully disclose his own productivity type, the incentive compatibility conditions are required by the loan contract. The loan contract, $\Phi = \{B, r, C\}$, is composed of the amount of loan B, the gross loan interest rate r, and the amount of collateral C. Assume that as long as the borrower complies with the terms of the loan contract, he can obtain a loan. In other words, with a fixed deposit rate of γ, the bank faces a completely flexible deposit supply.

Once the venture investment project succeeds, the entrepreneur will receive a net return $\pi_{Gi} = \left[G\overline{Q} + (1-\delta_i)(K+H) - rB\right]$ at the end of period. If the project fails, then the entrepreneur's net return will be $\pi_{Li} = \left[(1-\delta_i)(K+H) - (1-\delta_i)C\right]$ at the end of period.

The decision of production and borrowing can be described as a dynamic game with two stages. In the first stage, the bank designs the loan contracts to screen the borrowers; then the entrepreneur selects the contract and determines the input allocation in production in the second stage. The equilibrium can be solved by using backward induction. The equilibrium concept is defined as a subgame perfect Nash equilibrium (SPNE), when there is perfect information, and under asymmetric information, a perfect Bayesian Nash equilibrium (PBNE) is applied.

III. Collateral and Production Decision

In this section, we consider the optimal production decision of the entrepreneur. The collateral pledged in the loan contract may affect production decisions. Because one of the factors that entrepreneurs put into production can be served as collateral, the need for more collateral may cause entrepreneurs to put more general capital. Therefore, we should consider the resource allocation of entrepreneurs based on the following two situations. First, the collateral requirement does not constitute a binding constraint or there is no collateral at all. Second, the collateral requirement proved to be a binding constraint on entrepreneurs.

A. Production Choice with an Unbinding Collateral Constraint

Given a contract with an unbinding collateral constraint, $\Phi_i = \{B_i, C_i, r_i\}$, the decision problem of choosing production input of a type i entrepreneur to maximize expected returns (π_i^e) can be written as follows:

$$\text{Max.} \quad \pi_i^e(\Phi_i) = P\pi_{Gi} + (1-P)\pi_{Li}$$

$$s.t. \quad \bar{Q} = H_i^{\alpha} K_i^{1-\alpha} \tag{1}$$

$$B_i = K_i + H_i - K_0 \tag{2}$$

$$\pi_i^e(\Phi_i) \geq \gamma K_0 \tag{3}$$

$$0 \leq C_i \leq K_i \tag{4}$$

Equations (1) and (2) are C-D production functions and resources constraints. Equation (3) ensures that all types of entrepreneurs want to join the risky investment projects which are called individual rationality constraints. Equation (4) represents the constraint on collateral.

When the requirement of collateral by the contract does not exceed the amount of general capital K chosen by the entrepreneur, the entrepreneur's production decision will not be affected. This can enable factor input to meet production efficiency, for either type of the entrepreneurs. Therefore, given a C-D production function, the efficient conditions of production for each type of entrepreneurs are:[1]

$$K_i^* = \bar{Q}[(1-\alpha)/\alpha]^{\alpha}\ ,\ \ H_i^* = \bar{Q}[(1-\alpha)/\alpha]^{\alpha-1}\ ,$$
$$k_i^* = (1-\alpha)/\alpha\ ,\ \ B_i^* = K_i^* + H_i^* - K_0\ . \tag{5}$$

B. Production Choice with a Binding Collateral Constraint

When the requirement of collateral is more than the efficient level of general capital, $C_i > K_i^*$, more collateral must be added to satisfy the constraint. We re-write the entrepreneur's optimal allocation decision problem as follows:

$$\begin{aligned} Max.\ \ & \pi_i^e(\Phi_i) = P\pi_{Gi} + (1-P)\pi_{Li} \\ s.t.\ \ & (1)\text{-}(3) \\ & C_i > K_i^* \end{aligned} \tag{6}$$

If $C_i > K_i^*$, the binding collateral constraint will force the entrepreneur to raise the number of K, thus making $C_i = \hat{K}_i > K_i^*$, $\hat{H}_{i} = (\bar{Q}\hat{K}_i^{\alpha-1})^{-\alpha}$.[2] Obviously, if the entrepreneurs

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[1] $k \equiv K/H$ is the ratio of general capital to specific capital.

[2] This symbol, $\wedge$, represents the choice for collateral constrained entrepreneurs.

of type i are constrained, the ratio of general capital to specific capital is higher than the efficient one.

$$\hat{k}_i > k_i^* = (1-\alpha)/\alpha\ ,\quad \hat{B}_i = \hat{K}_i + \hat{H}_i - K_0 \tag{7}$$

Here, if the constraint on the amount of collateral is indeed binding, then the entrepreneur should select a higher proportion of k to produce $\bar{Q}$, so that the distribution of inputs of production deviates from the optimal ratio of $(1-\alpha)/\alpha$. As we will discuss in the next section, the people who are subject to binding collateral constraints are low-tech entrepreneurs in the MCM. When collateral constraints are binding, they will change their selection of input distribution to meet the constraints. The resources allocation of production is distorted by these entrepreneurs and their production is away from efficiency.

Figure 1 shows the resource allocation with and without a binding collateral constraint. The solid line represents the iso-quant of a given $\bar{Q}$. A straight line $\overline{ab}$ with vertical intercept $(B^* + K_0)$ and slope (-1) is tangent to the iso-quant $\bar{Q}$ at point *E*, according to the resource constraint, $B + K_0 = K + H$. The point *E* represents the optimal resources allocation, (H^*, K^*). Therefore, we can draw an expansion trajectory $k^* = (1-\alpha)/\alpha$ that intersects with the iso-quant $\bar{Q}$ at point *E*, indicating that the optimal ratio of production resources is $(1-\alpha)/\alpha$.

When the collateral constraint is binding the entrepreneur will produce $\bar{Q}$ with a higher ratio *k*. Drawing another expansion trajectory of the production input ratio $k^* > (1-\alpha)/\alpha$ on the left side of the row $k^* = (1-\alpha)/\alpha$ which intersects the iso-quant $\bar{Q}$ at point *F*. Point *F* is the point $(\hat{H}_i, \hat{K}_i)$ chosen by entrepreneur *i* in the face of the binding collateral constraint.

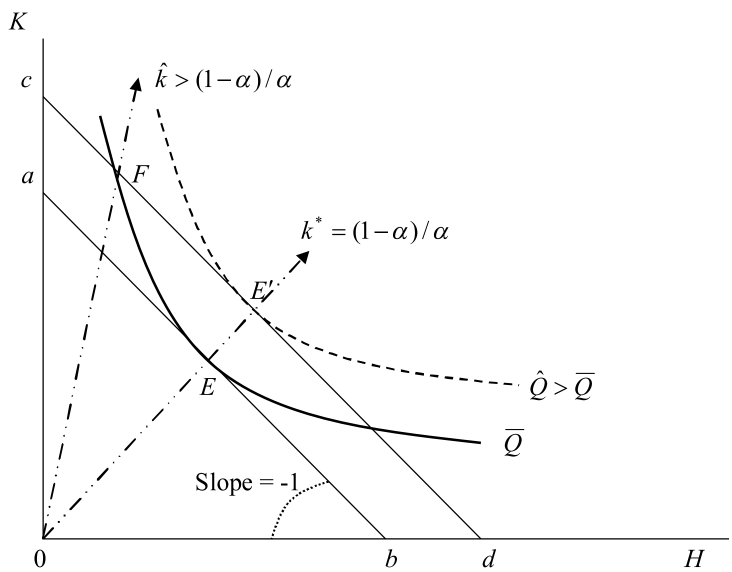

Figure 1 Production efficiency and resource allocation

Contrary to the optimal allocation of production resources (point E), entrepreneurs should invest more general capital K and reduce investment in specific capital H under collateral constraints. Therefore, under the condition that the loan amount B^* remains the same, the input allocation at point F will not be able to meet the resource constraints and fall outside the strait line $\overline{ab}$; that is, $\hat{K}_i + \hat{H}_i > B^* + K_0$.

In order to provide sufficient general capital K as collateral to obtain more financing for the investment projects, the entrepreneur will raise his loan, $\hat{B}_i > B^*$. The line $\overline{ab}$ describing the resource constraint will move outward to the straight line $\overline{cd}$ where the point F is, satisfying the resource constraint condition: $\hat{K}_i + \hat{H}_i = \hat{B}_i + K_0$. When the collateral constraint is binding, two results follow. First, entrepreneurs have excessive borrowing; second, the combination of factors is no longer production efficient. In the absence of any collateral requirement or the collateral requirement is not binding, the optimal input allocation ratio should be $(1-\alpha)/\alpha$. With the same amount of resource as point F has, the optimal ratio $(1-\alpha)/\alpha$ would have been able to raise production to point E', where $\tilde{Q} > \bar{Q}$.

IV. The Optimal Loan Contract under Monopoly

In this section, we consider the optimal loan contract in the MCM. The bank's optimization problem is to choose $\Phi_i = \{B_i, C_i, r_i\}$, $i \in \{1,2\}$, to maximize its expected profits. In order to provide a benchmark, we first use perfect information to illustrate the equilibrium of the MCM. Next, we explore the equilibrium with asymmetric information.

A. Monopolistic Equilibrium with Perfect Information

The monopolistic bank can distinguish between high-tech enterprises and low-tech entrepreneurs with perfect information. The optimal loan contract solves the following problems:

$$\begin{aligned} &Max. \quad \pi_{Bi}^{e} = Pr_i B_i + (1-P)\beta(1-\delta_i)C_i - \gamma B_i \\ &s.t. \quad (1)\text{ - }(5) \\ &\qquad\quad \pi_{Bi}^{e} \geq 0 \end{aligned} \tag{8}$$

Equations (1) to (5) are the constraints on production, resources, the rationality of the entrepreneur, the amount of collateral, and the best response decision of the entrepreneur. Equation (8) represents the rationality condition of the bank, which means that the bank will not agree to negative profits. Obviously, equation (3) holds at equality in equilibrium, $\pi_i^e(\Phi_i) = \gamma K_0$. The loan contract Φ_{im}^* is solved as:

$$B^*_{im} = K^*_{im} + H^*_{im} - K_0 ,$$

$$C^*_{im} = 0 ,$$

$$r^*_{im} = G\bar{Q}B^{*\ -1}_{im} + [(1-\delta_i)(K^*_{im} + H^*_{im}) - \gamma K_0]B^{*\ -1}_{im}P^{-1} .$$

With perfect information, collateral has no signaling effect. In addition, due to the consideration of transaction costs, the evaluation of collateral ($\beta C , 0 < \beta < 1$) by banks is lower than that of entrepreneurs who pledge collateral. The social cost of collateral is high. Therefore, for entrepreneurs of any productivity type, the optimal value of collateral required is equal to zero $(C^*_{1m} = C^*_{2m} = 0)$. To pledge collateral is no need under perfect information, so collateral will not affect production decisions.

Each entrepreneur sets the combination of general capital and specific capital to satisfy the condition of efficient production $k^* = (1-\alpha)/\alpha$.

Although the type of productivity does not interfere with the choice of collateral and loan amount, neither it affects the production decision of entrepreneur, it does interfere with the interest rate charged on loans. It is worth noting that the interest rate of high-productivity entrepreneurs is higher than the interest rate of low-productivity entrepreneurs, $r^*_{1m} < r^*_{2m}$. Our result indicates that banks will charge high-tech entrepreneurs with higher loan rate in a MCM with complete information. This only reflects the fact that the monopolist extracts the surplus of all borrowers, while the surplus of high-tech borrowers is higher than that of low-tech borrowers.

B. Monopolistic Equilibrium with Asymmetric Information

In the case of information asymmetry, every borrower knows his own type, but a monopolistic bank cannot distinguish between high-tech borrowers and low-tech borrowers. However, the bank does know that λ proportion of these borrowers is of low-tech type, while the $(1-\lambda)$ proportion is of high-tech type. In order for each borrower to truthfully reflect his own type, the conditions of incentive compatibility are required in the loan contract.

The optimal problem of the contract can be solved by the following:

$$\begin{aligned} &Max \quad \pi_B^e = \lambda \pi_{B1}^e + (1-\lambda)\pi_{B2}^e \\ &s.t. \quad (1) \text{ - } (5) \\ &\qquad \pi_{Bi}^e \geq 0 \\ &\qquad \pi_i^e(\Phi_i) \geq \pi_i^e(\Phi_j),\ \ i, j \in \{1,2\}, i \neq j\,. \end{aligned} \tag{9}$$

Equation (9) is the incentive compatibility condition. The optimal loan contract with perfect information Φ_{im}^* cannot satisfy this incentive compatibility condition. The reason is that under perfect information, high-tech or low-tech borrowers do not need collateral, while high-tech borrowers need to pay higher interest rates, so that they have the motivation to disguise themselves as low-tech borrowers and enjoy to low interest rates. This causes the need to use incentive compatibility conditions (equation (9)) to prevent any false claims about types with private information. Thus, borrowers are induced to truthfully disclose their types with incentive compatibility conditions.

The possible solutions to the bank's optimal loan contracts can be discussed firstly by considering a separating equilibrium followed by a pooling equilibrium.

a. Separating Equilibrium

By drafting contracts that meet the constraints of incentive compatibility, different types of borrowers cannot be distinguished based on interest rates alone, and banks will use collateral as a tool for screening types.

If there are separate contracts for different types of borrowers, the bank can distinguish the entrepreneur's productivity type from the loan contract selected by the entrepreneur, so that the collateral can be used as a screening tool in an asymmetric information equilibrium. We consider two possible situations: one is that the collateral requirement exceeds the volume of general capital that the borrower can provide; and the other is that collateral requirement does not. In the latter case, from the previous analysis, we know that collateral will not change the efficient allocation of resource.

(a) The loan contract without a binding constraint on collateral

Figure 2 depicts the determination of equilibrium with separating contracts. Lines L_1 and L_2 represent the isoprofit curves of low-tech and high-tech entrepreneurs with the expected profits equal to $\pi_1^e - \gamma K_0 = 0$ and $\pi_2^e - \gamma K_0 = 0$, respectively. Under perfect information, the optimal loan contract is depicted as Φ_{1m}^* and Φ_{2m}^* for low-tech and high-tech entrepreneurs, respectively, and the dot line $\pi_{B1}(\Phi_{1m}^*)$ ($\pi_{B2}(\Phi_{2m}^*)$) represents the monopolistic bank's maximum profit when it offers Φ_{1m}^* (Φ_{2m}^*) to low-tech (high-tech) entrepreneurs. Notice that $\delta_1 > \delta_2$, $r_{1m}^* < r_{2m}^*$ and $C_{1m}^* = C_{2m}^* = 0$, point Φ_{1m}^* is below Φ_{2m}^*; line L_1 is flatter than L_2 and intersects L_2 at the point s.[3] We claim the separating contracts consisting of Φ_1^s chosen by low-tech entrepreneurs and $\Phi_2^s = \Phi_{2m}^*$ chosen by high-tech entrepreneurs.

Under asymmetric information, the contract (Φ_{1m}^*, Φ_{2m}^*) is not incentive compatible because high-tech entrepreneurs would rather pretend to be low-tech ones and choose Φ_{1m}^* instead of Φ_{2m}^*. The monopolistic lender would lower its own profit and set the contract Φ_1^s for low-tech entrepreneurs and maintain the same contract $\Phi_2^s = \Phi_{2m}^*$ for high-tech entrepreneurs. The set of separating contracts (Φ_1^s, Φ_2^s) satisfies both entrepreneurs' incentive compatible constraints because low-tech entrepreneurs prefer Φ_1^s to Φ_2^s and high-tech entrepreneurs are indifferent between Φ_1^s and Φ_2^s. Thus, we have,

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[3] Appendix A shows the existence of the intersection of these two isoprofit curves L_1 and L_2.

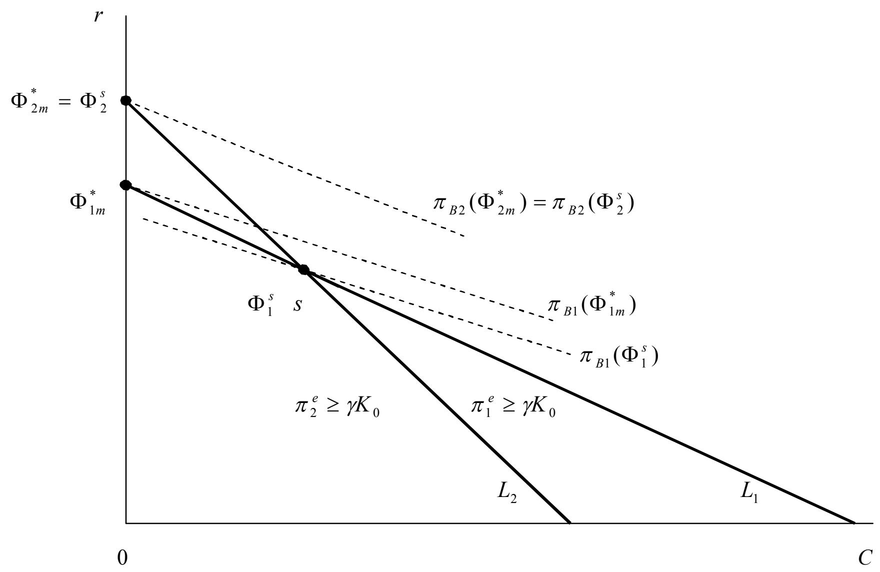

Figure 2 Separating equilibrium without binding collateral constraints

1. Low-tech entrepreneurs choose: Φ_1^s [4]

$$B^s_{1m} = B^*_{1m} = K^*_m + H^*_m - K_0 ,$$

$$r^s_{1m} = G\bar{Q}B^{s\ -1}_{1m} - \gamma K_0 B^{s\ -1}_{1m} P^{-1} ,$$

$$C^s_{1m} = (H^s_{1m} + K^s_{1m})(1-P)^{-1} ,$$

$$\pi^e_{B1}(\Phi^s_1) = Pr^s_{1m}B^s_{1m} + (1-P)\beta(1-\delta_1)C^s_{1m} - \gamma B^s_{1m} .$$

[4] See Appendix B.

2. High-tech entrepreneurs choose: Φ_2^s

$$B_{2m}^s = B_{2m}^* = K_m^* + H_m^* - K_0 ,$$

$$r_{2m}^s = G\bar{Q}B_{2m}^{s\ -1} + [(1-\delta_2)(K_{2m}^s + H_{2m}^s) - \gamma K_0]B_{2m}^{s\ -1}P^{-1} ,$$

$$C_{2m}^s = 0 ,$$

$$\pi_{B2}^e(\Phi_2^s) = Pr_{2m}^s B_{2m}^s - \gamma B_{2m}^s .$$

It is noteworthy that $(1-P)<1$ implies $C_{1m}^s > K_{1m}^*$. Low-tech entrepreneurs face a binding collateral constraint. We thus must find the optimal contract with a binding constraint on collateral requirements.

Proposition 1: There cannot have the equilibrium of separating contracts with a non-binding collateral constraint in a monopolistic market with asymmetric information.

(b) The loan contract with a binding constraint on collateral

The loan contract requires low-tech entrepreneurs to pledge more collateral than the amount of general capital they would choose from efficient production point of view, $C_{1m}^s > K_{1m}^*$. From Section 3, if the collateral constraint becomes binding, the entrepreneurs should produce $\bar{Q}$ by a higher ratio of general capital over specific capital, deviating from efficient production. To provide enough general capital *K*, the entrepreneurs borrow more, raising the cost of production. While their expected returns stay the same, an increase in cost reduces their expected profit, shown by the downward shift of L_1 to L' in Figure 3.

The monopolistic bank will require more collateral to compensate for the reduction of interest rate and prevent misrepresentation of low-tech entrepreneurs by high-tech ones. The equilibrium contract is resumed at point s' for low-tech entrepreneurs, where the collateral requirement sets at $\hat{C}_{1m}^s$. From Section 3, those collateral constrained low-tech entrepreneurs are forced to choose $\hat{K}_{1m} = \hat{C}_{1m}^s$ in production.

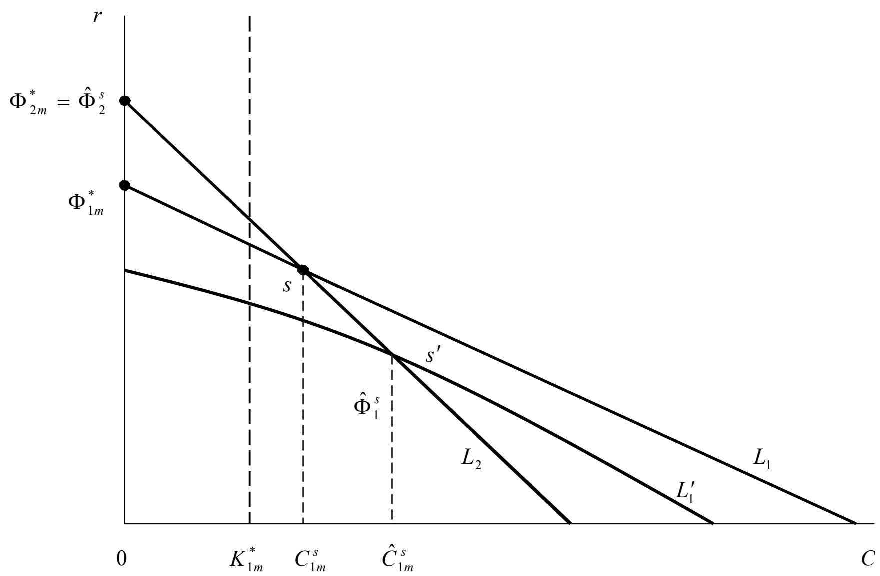

Figure 3 Separating equilibrium with binding collateral constraints

Take into account the binding collateral constraint, the equilibrium of separating contracts is as below:

1. Low-tech entrepreneurs choose:[5] $\hat{\Phi}_1^s$

$$\hat{B}_{1m}^s = \hat{C}_{1m}^s + \hat{H}_{1m}^s = \hat{K}_{1m}^s + \hat{H}_{1m}^s > B_{1m}^*,$$

$$\hat{r}_{1m}^s = G\bar{Q}\hat{B}_{1m}^{s\ -1} - [(1-\delta_1)(\hat{C}_{1m}^s P + \hat{H}_{1m}) - \gamma K_0]\hat{B}_{1m}^{s\ -1} P^{-1},$$

$$\hat{C}_{1m}^s = [G\bar{Q}P - \gamma K_0 - rP\hat{B}_{2m}^s + (\hat{H}_{2m}^s + \hat{K}_{2m}^s)(1-\delta_2)](1-P)^{-1}(1-\delta_2)^{-1},$$

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[5] See Appendix C.

$$\hat{\pi}^{e}_{B1}(\hat{\Phi}^{s}_{1}) = P\hat{r}^{s}_{1m}\hat{B}^{s}_{1m} + (1-P)\beta(1-\delta_1)\hat{C}^{s}_{1m} - \gamma\hat{B}^{s}_{1m} .$$

2. High-tech entrepreneurs choose: $\hat{\Phi}^{s}_{2}$

$$\hat{B}^{s}_{2m} = B^{*}_{2m} ,$$

$$\hat{r}^{s}_{2m} = G\bar{Q}\hat{B}^{s\ -1}_{2m} + [(1-\delta_2)(\hat{K}_{2m} + \hat{H}_{2m}) - \gamma K_0]\hat{B}^{s\ -1}_{2m}P^{-1} ,$$

$$\hat{C}^{s}_{2m} = 0 ,$$

$$\hat{\pi}^{e}_{B2}(\hat{\Phi}^{s}_{2}) = P\hat{r}^{s}_{2m}\hat{B}^{s}_{2m} - \gamma\hat{B}^{s}_{2m} .$$

Contrary to the optimal contracts of a monopolistic market being only pooling contracts in Besanko and Thakor (1987) and Wang et al. (2011), there does have a separating equilibrium where the bank can sort out borrowers of high-tech and low-tech entrepreneurs from their selections of loan contracts. Collateral serves as an effective sorting device in the MCM under asymmetric information. A salient feature makes our results distinct from those of Besanko and Thakor (1987) and Wang et al. (2011) is the asymmetric information arises from the difference of productivity level endowed by entrepreneurs in our model and lies in the probability of success of projects in theirs. The latter does not support a “single crossing property” of isoprofit curves of two types of entrepreneurs, whereas the former does. Lack of single crossing of two types’ isoprofit curves, there is impossible to find an equilibrium of separating contracts.

Because of information asymmetry, banks use collateral as a tool for screening productivity types. Low-tech entrepreneurs are willing to provide collateral. Therefore, the interest rate differential between low-tech entrepreneurs and high-tech enterprises will be greater than the interest rate differential under perfect information. Here, with a higher capital depreciation rate (or low productivity), low-tech entrepreneurs relatively lose less when their projects fail and must give up collateral to the bank. This reason is different from that in literature where high-risk borrowers are most likely to lose their collateral and choose zero collateral in equilibrium.

Proposition 2**:** There is a separating equilibrium where low-tech entrepreneurs choose a combination of high collateral and low interest rate, whereas high-tech entrepreneurs choose the same contract as they do with perfect information, a combination of zero collateral and high interest rate. Low-tech entrepreneurs face a binding collateral constraint and over borrow to produce the fixed amount of $\bar{Q}$, using a higher-than-efficiency ratio of K/H.

b. Pooling Equilibrium

The other possible choice for the monopolistic bank is to offer pooling contracts. There are two cases: one is $\Phi^{p1} = \Phi^{*}_{1m}$, which is low-tech entrepreneurs' contract under perfect information; and the other is $\Phi^{p2} = \Phi^{*}_{2m}$, which is high-tech entrepreneurs' contract under perfect information. When the bank offers $\Phi^{p1} = \Phi^{*}_{1m}$, neither entrepreneur puts up collateral and both entrepreneurs pay the same low interest rate as the one for low-tech entrepreneurs under full information. This contract is acceptable by low-tech entrepreneurs, and is particularly attractive to high-tech entrepreneurs. Both types of borrowers will accept $\Phi^{p1} = \Phi^{*}_{1m}$ and receive the loan. However, when the bank offers $\Phi^{p2} = \Phi^{*}_{2m}$, it prices the low-tech entrepreneurs out of the market by quoting a too high interest rate not satisfying their individual rationality for executing the risky projects. Only high-tech entrepreneurs take the pooling contract $\Phi^{p2} = \Phi^{*}_{2m}$ and receive the loan. We summarize the results for pooling contracts as below:

1. Both high-tech and low-tech entrepreneurs choose: Φ^{p1}

$$B^{**}_{1m} = B^{**}_{2m} = K^{**}_{m} + H^{**}_{m} - K_0 ,$$

$$C_{1m}^{**} = C_{2m}^{**} = 0 \,,$$

$$r_{1m}^{**} = r_{2m}^{**} = r_{1m}^{*} < r_{2m}^{*} \,,$$

$$\pi_{B1}^{e}(\Phi^{P1}) = Pr_{1m}^{**}B_{1m}^{**} + (1-P)\beta(1-\delta_1)C_{1m}^{**} - \gamma B_{1m}^{**} \,,$$

$$\pi_{B2}^{e}(\Phi^{P1}) = Pr_{2m}^{**}B_{2m}^{**} + (1-P)\beta(1-\delta_2)C_{2m}^{**} - \gamma B_{2m}^{**} \,,$$

$$\pi_{B}^{e}(\Phi^{P1}) = \lambda\pi_{B1}^{e}(\Phi^{P1}) + (1-\lambda)\pi_{B2}^{e}(\Phi^{P1}) \,.$$

2. Only high-tech entrepreneurs choose: Φ^{p2}

$$B_{1m}^{***} = 0 \,,$$

$$B_{2m}^{***} = K_{2m}^{***} + H_{2m}^{***} - K_0 \,,$$

$$C_{1m}^{***} = C_{2m}^{***} = 0 \,,$$

$$r_{1m}^{***} = r_{2m}^{***} = r_{2m}^{*} > r_{1m}^{*} \,,$$

$$\pi_{B1}^{e}(\Phi^{P1}) = 0 \,,$$

$$\pi_{B2}^{e}(\Phi^{P2}) = Pr_{2m}^{**}B_{2m}^{**} + (1-P)\beta(1-\delta_2)C_{2m}^{**} - \gamma B_{2m}^{**} \,,$$

$$\pi_{B}^{e}(\Phi^{P2}) = (1-\lambda)\pi_{B2}^{e}(\Phi^{P2}) \,.$$

c. Separating vs. Pooling Equilibrium

Among all possible equilibrium contracts we discussed above, the separating contracts and either one of the pooling contracts, which one will the bank choose? The answer to the question simply depends on from which contract that the bank can exploit the maximum expected profit from the borrowers.

The expected profit of the monopolistic bank offering the separating contracts is,

$$\pi_B^e(\hat{\Phi}_1^s,\hat{\Phi}_2^s)=\lambda\pi_{B1}^e(\hat{\Phi}_1^s)+(1-\lambda)\pi_{B2}^e(\hat{\Phi}_2^s)\,. \tag{10}$$

Compare Eq. (10) with the expected profit of the bank offering the pooling contract $\Phi^{p2}=\Phi_{2m}^*$ chosen only by the high-tech entrepreneurs, $\pi_{B2}^e(\Phi^{p2})=(1-\lambda)\pi_{B2}^e(\hat{\Phi}_2^s)$. Obviously, when $\lambda>0$, $\pi_B^e(\hat{\Phi}_1^s,\hat{\Phi}_2^s)>\pi_B^e(\Phi^{p2})$. In other words, even if there is only one low-tech entrepreneur in the economy, excluding his opportunity from obtaining the loan doubtlessly reduces the monopolistic bank's profit. The pooling contract Φ^{p2} that prices the low-tech entrepreneurs out of the loan market is thus dominated by the separating contracts.

Next, compare the expected profit of the bank offering the separating contracts, Eq. (10), with that of the bank offering the pooling contract $\Phi^{p1}=\Phi_{1m}^*$ chosen by both types of entrepreneurs, $\pi_{B2}^e(\Phi^{p1})$. Since $\pi_{B2}^e(\Phi^{p1})<\pi_{B2}^e(\hat{\Phi}_2^s)$ and $\pi_{B1}^e(\Phi^{p1})>\pi_{B1}^e(\hat{\Phi}_1^s)$, the magnitudes of $\pi_B^e(\hat{\Phi}_1^s,\hat{\Phi}_2^s)$ and $\pi_B^e(\Phi^{p1})$ depend on the magnitudes of λ, the proportion of the low-tech borrowers. Intuitively, the bank exploits more profits from high-tech borrowers by offering the separating contract, whereas it exploits more profits from low-tech borrowers by offering the pooling contract. If the majority of the borrowers are high-tech entrepreneurs, adopting the separating contract has an advantage over the pooling contract. There is a critical value $\bar{\lambda}$, $\pi_B^e(\hat{\Phi}_1^s,\hat{\Phi}_2^s)>\pi_B^e(\Phi^{p1})$ when $\lambda<\bar{\lambda}$. The intuition behind this result is clear. Adopting the separating contract forces the bank to sacrifice a certain profit exploited from the low-tech borrowers in exchange for exploiting the high-tech borrowers' surplus from their own contract $\pi_{B2}^e(\hat{\Phi}_2^s)$. When the proportion of low-tech entrepreneurs is low enough, giving up some neglected surplus from low-tech entrepreneurs' contract is rewarded by a significant increase in surplus from high-tech entrepreneurs' contract. This implies the optimal monopolistic contract is a separating contract when λ is low enough. On the other hand, $\pi_B^e(\hat{\Phi}_1^s, \hat{\Phi}_2^s) < \pi_B^e(\Phi^{p1})$ when $\lambda > \bar{\lambda}$. The optimal monopolistic contract is therefore a pooling contract Φ^{p1}, because it's too costly for the bank to conduct a separating contract and give up some low-tech entrepreneurs' surplus when the number of low-tech entrepreneurs is big enough.

Proposition 3: There exists a critical value $\bar{\lambda}$, $\lambda < \bar{\lambda}$, the monopolistic bank offers a separating contract (Φ_1^s, Φ_2^s); $\lambda > \bar{\lambda}$, the monopolistic bank offers a pooling contract Φ^{p1}.

V. The Optimal Loan Contract under Competition

In this section, we will focus on a CCM and determine its optimal loan contract. We first study the equilibrium of the CCM with perfect information, then discuss the equilibrium under asymmetric information.

With perfect information, in the equilibrium, the loan contract maximizes the expected return of the entrepreneur (borrower) *i*, subject to the constraint that the bank obtains zero profit on the borrower. Let $\Phi_{ic}^* = \left\{B_{ic}^*, C_{ic}^*, r_{ic}^*\right\}$ represent the equilibrium loan contract, together with the choice of production input by entrepreneur *i*, solve the following maximization problem:

$$\begin{aligned} \text{Max.} \quad & \pi_i^e = P\pi_{Gi} + (1-P)\pi_{Li} \\ s.t. \quad & (1)-(5) \\ & \pi_{Bi}^e \geq 0 . \end{aligned} \tag{11}$$

The bank's rationality condition is represented by equation (11), which means that the bank will not agree to the loan unless the expected return on the loan is not less than its opportunity cost γB_i.

In the equilibrium of the CCM, every bank obtains zero economic returns, which means that equation (10) will be held at equality.

$$Pr_i B_i + (1-P)[\beta(1-\delta_i)C_i] = \gamma B_i, \quad i \in \{1,2\}. \tag{12}$$

The zero-profit condition of the bank is represented by equation (12).

The optimal loan contract Φ_{ic}^* can be obtained by adding equation (12) together with the equations (1), (2) and (4). The SPNE with perfect information is as follows:

$$B_{ic}^* = K_{ic}^* + H_{ic}^* - K_0 ,$$

$$C_{ic}^* = 0 , \quad r_{ic}^* = \gamma P^{-1} .$$

Similar to the results of the monopolistic equilibrium with perfect information, collateral has no signaling effect, and there is no collateral requirement for all types of entrepreneurs, $C_{1c}^* = C_{2c}^* = 0$. Collateral does not interfere with production decisions.

But distinct from interest rate determination in the monopolistic equilibrium, the interest rates charged for two types of entrepreneurs are the same, $r_{1c}^* = r_{2c}^*$, in the competitive equilibrium. The reason that a bank charges the same interest rate to two types of the borrowers is because productivity differences between two types of entrepreneurs have nothing to do with their expected project returns as well as the bank's interest revenues.

The identical loan contract for both types of entrepreneurs under perfect information eliminates the incentive of disguising one's true type for obtaining the loan contract of others under asymmetric information. Therefore, there is no need to design an incentive compatible contract to induce borrowers to truthfully reveal their productivity levels. This result significantly differs from the results in Bester (1985, 1987), Besanko and Thakor (1987), Wang

(2010) and Wang et al. (2011).

Proposition 4: Entrepreneurs are granted the same loan contract in a competitive market, regardless that they are high-tech or low tech entrepreneurs and regardless that information is perfect or asymmetric.

It is the source of informational asymmetry, not the form of production function, determines equilibrium contracts in CCM and MCM, as well as the role of collateral. Wang (2010) adopted a different production function compared to that of Wang et al. (2011), but with the same source of informational asymmetry, they have the same loan contract in CCM. On the contrary, our model has the same production function as that of Wang et al. (2011), with the different source of informational asymmetry, the role of collateral as well as the equilibrium contracts in CCM and MCM are completely reversed.

VI. Conclusions

Productivity gaps among entrepreneurs are common but sometimes are hardly discovered by outsiders. In particular, when entrepreneurs need to finance their projects through business loans, lenders usually know less than borrowers about entrepreneurs' productivity level that is one of the payoff-relevant borrower attributes. The main contribution of this paper is to introduce an alternative source of informational asymmetry, a productivity gap, and to explore equilibrium contracts as well as production decision of resource allocation in CCM and MCM.

Our results show that if the informational asymmetry comes from concerning the productivity level of entrepreneurs, not their risk types as assumed in the literature, the role of collateral as well as the equilibrium contracts in CCM and MCM are completely reversed. Collateral is an efficient sorting device in a MCM with asymmetric information; whereas it is never used in a CCM. In a MCM, there exists an equilibrium with separating contracts and low-tech entrepreneurs face a binding collateral constraint, causing the problems of over-borrowing and productive resource misallocation. There also exists a pooling contract as the one for high-tech entrepreneurs under perfect information. Only high-tech entrepreneurs take this pooling contract. We further get the conclusion that when the proportion of low-tech entrepreneurs is low enough, the optimal monopolistic contract is a separating contract or, *vice versa*, it is a pooling contract.

The optimal contract for a CCM is rather simple than that for a MCM. Entrepreneurs are granted the same loan contract in a CCM, regardless of their productivity levels and regardless that information is perfect or asymmetric. All entrepreneurs pay the same interest rate and pledge no capital.

One immediate possible extension of this paper is to include both productivity and risk into the source of informational asymmetry and explore more variety of the equilibrium in both CCM and MCM. A different way of modeling a productivity gap and a variable amount of input to risky projects deserve a future study.

Appendix A. Existence of an intersection of the two isoprofit curves L_1 and L_2

Firstly, we show that isoprofit curves for type 1 entrepreneurs are flatter than those for type 2 entrepreneurs.

An isoprofit curve for type *i*, $\pi_i^e - \gamma K_0$, is written as:

$$P[G\bar{Q} + (1-\delta_i)(K_i + H_i) - rB_i] + (1-P)[(1-\delta_i)(K_i + H_i) - (1-\delta_i)C] - \gamma K_0 .$$

It is straightforward to show that the slope of isoprofit curves for type 1 entrepreneurs, m_1, is less than that for type 2 entrepreneurs, m_2, because

$$m_i = -(1-P)(1-\delta_i)/PB_i < 0 ,$$

and $0 < \delta_2 < \delta_1 < 1$ imply $|m_1| < |m_2|$.

Secondly, L_1 intersects the vertical axis at $r = r_{1m}^*$ which is below the point of $r = r_{2m}^*$, intersection of L_2 and the vertical axis.

It remains to show that the distance between the origin and the point where L_1 intersects the horizontal axis (call it C_1) is greater than the distance between the origin and the point where L_2 intersects the horizontal axis (call it C_2.) Substitute $r_i = 0$ into $\pi_i^e - \gamma K_0 = 0$, we have,

$$C_i = [PG\bar{Q} + (1-\delta_i)(K+H) - \gamma K_0]/(1-P)(1-\delta_i),$$
$$= [PG\bar{Q} - \gamma K_0]/(1-P)(1-\delta_i) + (K+H)/(1-P).$$
$$0 < \delta_2 < \delta_1 < 1 \text{ concludes } C_1 > C_2.$$

Appendix B. Find the low-tech entrepreneurs' separating contract Φ_1^s

Φ_1^s is the intersection of L_1 and L_2. That is the following two equations hold:

$$P[G\bar{Q} + (1-\delta_1)(K_{1m}^* + H_{1m}^*) - r_1 B_1^*] + (1-P)[(1-\delta_1)(K_{1m}^* + H_{1m}^*) - (1-\delta_1)C_1] = \gamma K_0, \quad \text{(A1)}$$

$$P[G\bar{Q} + (1-\delta_2)(K_{2m}^* + H_{2m}^*) - r_2 B_2^*] + (1-P)[(1-\delta_2)(K_{2m}^* + H_{2m}^*) - (1-\delta_2)C_2] = \gamma K_0. \quad \text{(A2)}$$

Without a binding collateral constraint, in equilibrium,

$$B_{1m}^* = K_{1m}^* + H_{1m}^* - K_0, \quad B_{2m}^* = B_{1m}^*, \quad H_{1m}^* = H_{2m}^*, \text{ and } K_{1m}^* = K_{2m}^*. \quad \text{(A3)}$$

Substitute Eq. (A3) into Eqs. (A1) and (A2), and let $r_1 = r_2 = r_{1m}^s$, $C_1 = C_2 = C_{1m}^s$. Simultaneously solving the resulting equations, we have,

$$r_{1m}^s = G\bar{Q}B_{1m}^{s\ -1} - \gamma K_0 B_{1m}^{s\ -1} P^{-1} \text{ and } C_{1m}^s = (H_{1m}^s + K_{1m}^s)(1-P)^{-1}.$$

Appendix C. Find the low-tech entrepreneurs' collateral-binding separating contract $\hat{\Phi}_1^s$

$\hat{\Phi}_1^s$ is the intersection of L_1' and L_2. That is the following two equations hold:

$$P[G\bar{Q}+(1-\delta_1)(K_{1m}^*+H_{1m}^*)-r_1 B_1^*] + (1-P)[(1-\delta_1)(K_{1m}^*+H_{1m}^*)-(1-\delta_1)C_1] = \gamma K_0 \text{ ,(A4)}$$

$$P[G\bar{Q}+(1-\delta_2)(K_{2m}^*+H_{2m}^*)-r_2 B_2^*]+(1-P)[(1-\delta_2)(K_{2m}^*+H_{2m}^*)-(1-\delta_2)C_2] = \gamma K_0 \text{ .(A5)}$$

With a binding collateral constraint, in equilibrium,

$$\hat{B}_{1m} = \hat{K}_{1m} + \hat{H}_{1m} - K_0 > B_{2m}^*, \quad B_{2m}^* = K_{2m}^* + H_{2m}^* - K_0, \quad \hat{K}_{1m} = \hat{C}_{1m} . \tag{A6}$$

Substitute Eq. (A6) into Eqs. (A4) and (A5) and simultaneously solve the resulting equations, we have,

$$\hat{r}_{1m}^{s} = G\bar{Q}\hat{B}_{1m}^{s\ -1} - [(1-\delta_1)(\hat{C}_{1m}^{s}P+\hat{H}_{1m})-\gamma K_0]\hat{B}_{1m}^{s\ -1}P^{-1},$$

$$\hat{C}_{1m}^{s} = [G\bar{Q}P-\gamma K_0 - rP\hat{B}_{2m}^{s} + (\hat{H}_{2m}^{s}+\hat{K}_{2m}^{s})(1-\delta_2)](1-P)^{-1}(1-\delta_2)^{-1} .$$

Note that L_1' is usually not a straight line. With a binding collateral constraint, $\hat{B}_{1m} = \hat{K}_{1m} + \hat{H}_{1m} - K_0$, $\hat{K}_{1m} = C$ and $\hat{H}_{1m} = (\bar{Q}C^{\alpha-1})^{-\alpha}$.

$$\begin{aligned}\pi_1^e &= P[G\bar{Q}+(1-\delta_1)(C_1+\hat{H}_{1m})-r\hat{B}_1] + (1-P)[(1-\delta_1)(C+\hat{H}_{1m})-(1-\delta_1)C]-\gamma K_0 \\ &= P[G\bar{Q}+(1-\delta_1)(C+\hat{H}_{1m})-r(C+\hat{H}_{1m}-K_0)] \\ &\quad +(1-P)[(1-\delta_1)(C+\hat{H}_{1m})-(1-\delta_1)C]-\gamma K_0\end{aligned} \tag{A7}$$

$$\partial\pi_1^e / \partial r = -P\hat{B}_1 ,$$

$$\begin{aligned}\partial\pi_1^e / \partial C &= P[(1-\delta_1)(1+\hat{H}_{1m}')-r(1+\hat{H}_{1m}')]+(1-P)[(1-\delta_1)(1+\hat{H}_{1m}')-(1-\delta_1)] , \\ &= (1-\delta_1)\hat{H}_{1m}' - rP(1+\hat{H}_{1m}') - (1-P)(1-\delta_1) .\end{aligned}$$

The slope of isoprofit curves for type 1 entrepreneurs, $m_1 = M / P\hat{B}_1$, where

$$M \equiv [(1-\delta_1)\hat{H}'_{1m} - rP(1+\hat{H}'_{1m}) - (1-P)(1-\delta_1)].$$

$dm_1 / dC = \{[(1-\delta_1)\hat{H}''_{1m} - rP(1+\hat{H}''_{1m})]P\hat{B}_1 - P\hat{B}'M\} / P^2\hat{B}_1^2$, which is not a constant.

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生產力差距，抵押約束和貸款契約

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摘　要

本文將生產力差距作爲訊息不對稱的根源，建立模型並藉以探討競爭性和獨占性借貸市場中的均衡契約以及資源配置的生產決策。研究結果顯示，抵押品在具有訊息不對稱的獨占性市場中是一種有效的分類工具；但在競爭性市場中則未被使用。在獨占性市場中，當低技術企業家的比例足夠低時，最佳的獨占性契約是分離契約；反之，則爲混合契約。低技術企業家在分離契約中面臨具約束力的抵押限制，從而導致過度借貸和生產性資源配置不當的問題。 對於競爭性的市場，無論生產力高低，訊息是否完美或具不對稱性，企業家都將獲得相同的貸款契約。

關鍵詞：生產力差距、抵押品、競爭性借貸市場、獨占性借貸市場

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