A Lending Rate Distribution under Asymmetric Information

Seok-Kyun Hur*

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Abstract

This paper derives an equilibrium distribution of lending rates in presence of information asymmetry between lenders and borrowers over credit risks. In a model, the borrowers are differentiated by credit risks while the lenders may choose a threshold of credit risk π by paying the cost of credit information evaluation (F). Then, the lenders can identify whether loan applicants hold credit risk greater or smaller than π. With the introduction of information asymmetry as such, the paper explains why lending rates are clustered when F is high. As an extension, allowing heterogeneity of funding costs, it also shows that such a cluster is formed on a legal ceiling and it even goes after an altered ceiling, which is consistent with Korean experiences. Thus, it is easily deduced that levying or lowering an interest rate ceiling may improve borrowers' welfare when funding costs are heterogeneous. Though, better corrective measures, such as lowering the credit information cost and/or encouraging information sharing, are available.

JEL Classification: G21, G28

I. Introduction

It does not take a state-of-art technology to reason why an individual borrower with higher credit risk is required to pay more interest payment. It is, however, not evident to figure out what an equilibrium distribution of lending rates looks like when lenders cannot assess precisely the credit risks of individual borrowers.

In a complete information setting, a competitive equilibrium distribution of lending rates is directly derived from that of personal credit risks (maybe plus funding costs).

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* School of Business and Economics, Chung Ang University, 221, Heukseok-dong, Dongjak-gu, Seoul 156-756, Korea (e-mail: shur@ cau.ac.kr). I gratefully acknowledge constructive comments and suggestions from Chang-Gyun Park, Sungbin Cho, Jaehoon Kim, Min Kyu Song, Taehoon Youn and seminar participants at Chung Ang University and Korea Development Institute. Hyun Ah Kim is also owed special thanks for her excellent research assistance. Though, all remaining errors are my own.

The situation, however, gets extricate in presence of information asymmetry and certain idiosyncracies may be observed in the lending rates distribution. In this context, the paper starts with a benchmark model, which explains how a cluster is often formed in the lending rate distribution when the information cost is substantial.

Next, the paper examines possible welfare consequences of various government interventions (for example, levying a ceiling on the lending rates) in the consumer loan market. Compared with Korean data, however, the model, only assuming the information asymmetry between lenders and borrowers, could not explain why a cluster of lending rates appear in the neighborhood of a legal ceiling and such a clustering phenomenon persists even after the level of the ceiling is changed. In this regard, I suspect that heterogeneity of funding costs across lenders, combined with information asymmetry, may induce clustering in the vicinity of the legal interest rate ceiling. Hence, I introduce heterogeneity of financial institutions in terms of funding costs and prove the conjecture. In addition, I show that such clustering may not disappear and instead move along with the changed legal interest rate ceiling.

Lastly, I briefly discuss what other welfare improving policy measures could outperform the interest rate ceiling.

II. A Benchmark Model

In this section, I provide a simple model, in which potential borrowers of heterogeneous default risks meet lenders with imperfect credit information in the loan market. Assuming the presence of an imperfect credit risk screening technology, which requires substantial cost for adoption, the model demonstrates that a cluster could be formed in the lending rate distribution[1].

For tractability, I make the following assumptions:

Assumption 1 A borrower, whose lifespan covers $t = 0$ and 1, is likely to have 2 units of endowment at the later period with probability of $1 - p$. At the other period and occasions, he will get nothing.

$$E_0 = 0,$$
$$E_1 = 0 \text{ with probability of } p$$
$$E_1 = 2 \text{ with probability of } 1 - p$$

Assumption 2 The borrower obtains utilities from consuming at either of the two periods. His spot utility function is linear and risk neutral, and his intertemporal

[1] It is also notable that uch clustering phenomenon may arise with no interest rate ceiling levied.

utility is a sum of spot utilities weighted by the time discount factor β.

$$V = C_0 + \beta C_1, \qquad 0 < \beta < 1$$

Based on Assumption 1-2, it is clear that the borrower needs to borrow from financial institutions for resolving intertemporal mismatch.

Assumption 3 In this economy, borrowers exist uniformly in an interval $(0, 1 - \varepsilon)$ ordered by the probability of default or credit risk (p). Simply set, $p \sim U(0, 1 - \varepsilon)$[2]. In case of default, a single penny will not be retrieved from the corresponding loan contract.

Assumption 4 There are infinite numbers of financial institutions (or lenders) in this economy. All of them are risk-neutral and ignore time discount. The lenders finance each loan project at an interest rate corresponding to its expected credit risk.[3]

Assumption 5 Each lender in this economy determines its own target credit risk π in an interval $(0, 1 - \varepsilon)$ by paying the cost of credit information evaluation ($F > 0$). Then, the lenders could identify whether potential borrowers hold credit risk below or beyond π.

Assumption 5 states that lenders cannot compare any pair of borrowers, both of whose credit risks are either greater or smaller than their target risk level (π). It also implies that the credit evaluation technique, though still incomplete, performs better in the proximity of π.

1. A Symmetric Information Case

For a moment I assume that all the credit information is symmetric, ignoring Assumption 5 and characterize the equilibrium lending rate applied to each borrower. At $t = 0$, the financial institutions lend $\frac{1}{1+R(p)}$ to a borrower with the default probability of p. Of course, the borrower promises that he will give in return 1 unit of endowment at $t = 1$. Since 1 is the payment of the borrower, $R(p)$ is regarded as the default-risk adjusted lending rate.

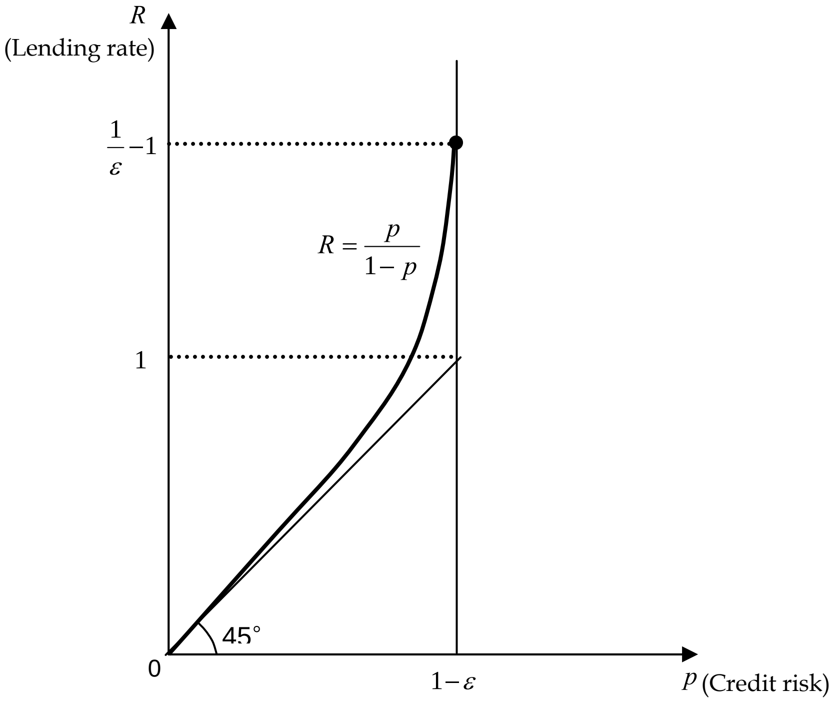
[2] $0 < \varepsilon < 1$ implies that no one in the economy is destined to default.

[3] Even though the lenders cannot assess the level of credit risk p a specific borrower or a certain loan application has, they know the credit risk distributions of their borrowers.

Considered that the lenders are risk-neutral, an actuarially fair loan rate $R(p)$ is determined from the following equation[4] (see also [Fig 1]).

$$p \times 0 + (1-p) \times 1 = \frac{1}{1+R(p)} \Rightarrow R(p) = \frac{p}{1-p}$$

[Fig 1] A Locus of Fair Loan Rates Charged by Credit Risks (p)



The distribution of lending rates, obtained from Assumption 3, is graphically represented in [Fig 2][5].

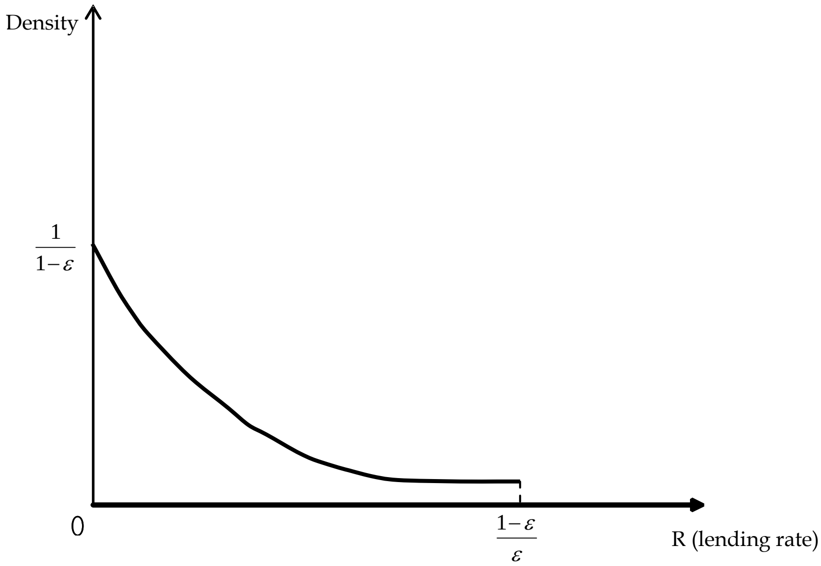
$$F(x) \equiv \Pr[R \le x] = \Pr\left[\frac{p}{1-p} \le x\right] = \Pr\left[p \le \frac{x}{1+x}\right] = \frac{x}{1+x}\frac{1}{1-\varepsilon}$$

$$f(x) \equiv \frac{dF(x)}{dx} = \frac{1}{(1+x)^2}\frac{1}{1-\varepsilon}$$

[4] If loan is provided to a borrower with the credit risk of p at the rate of $R(p)$, she/he will not decline the offer. Later it will be shown that a necessary and sufficient condition for positive loan demand is $p > 1 - \frac{1}{\beta(1+R)}$, which the fair loan rate $R(p) = \frac{p}{1-p}$ satisfies.

[5] For robustness check, it would be worthwhile to replace the uniform distribution by other probability functions, such as $f(p) = \frac{2p}{1-\varepsilon}$, $f(p) = \frac{2(1-p)}{1-\varepsilon}$, $p \in (0, 1-\varepsilon)$, or any mixture of the two distributions. These density functions of credit risk, however, converted into those of lending rate *R*, decrease either uniformly or beyond a certain level of *R*. In this regard, I believe most of the qualitative results from $f(p) = \frac{1}{1-\varepsilon}$, $p \in (0, 1-\varepsilon)$ will not vary with the choice of a density function *f*.

[Fig 2] An Equilibrium Density Distribution of Lending Rates ($f(R)$) under CI



2. An Asymmetric Information Case

Financial products, such as loans, are heterogeneous in availability as well as in applied lending rates because borrowers differ by credit risks. Hence, with symmetric information, a competitive equilibrium distribution of lending rates will simply follow that of credit risk premia[6]. However, in reality, the lending rate distribution shows several idiosyncracies, which are inferred to result from informational asymmetry between lenders and borrowers and/or from lending rate regulations. In this context, I introduce information asymmetry as indicated in Assumptions 5.

2.1 The Maximization Program of a Borrower

To begin with, I solve the borrower's maximization program. Since he does not have any endowments at *t*=0, he has to finance C_0 by borrowing from a lender. In return, he has to pay $C_0(1+\mathrm{R})=1$ at *t*=1. For simplicity, I assume that his loan payment is equal to 1 ($C_0(1+\mathrm{R})=1$). Hence, the maximization program is simply reduced to decision over loan.

$$V \equiv \max[C_0+(1-p)\beta C_1, 2(1-p)\beta]$$

[6] Due to Assumption 4, lending rates in this economy reflect only the credit risks of potential borrowers.

$$s.t.\ \ C_0(1+R)=1, C_1=2-C_0(1+R)=1$$

Depending on the direction of the inequality $(1-p)\beta < (\geq) \frac{1}{1+R}$, the consumer decides whether to get a loan or not. Rearranging this inequality, I could describe an individual demand for loan as follows:

$$C_0^* > 0\ , p > 1-\frac{1}{\beta(1+R)}$$

$$C_0^* = 0\ , p \leq 1-\frac{1}{\beta(1+R)}$$

Proposition 1 An individual loan demand function is non-increasing in the interest rate while non-decreasing in the credit risk.

$$\frac{\partial C_0^*}{\partial R} \leq 0\ , \qquad \frac{\partial C_0^*}{\partial p} \leq 0$$

The first inequality in the above predicts that the more likely consumers will opt out of the loan market, the higher gets the lending rate than their credit risks. In contrast, the second one indicates that they have also an incentive to exploit information asymmetry over their credit risks and borrow more if possible.

2.2 The Maximization Program of a Lender

Next, I represent a decision program of a lender. For a moment, I ignore the credit risk evaluation cost F and consider a case in which only one lender exists in the loan market. Then, the lender adopts the credit evaluation technique, and determines the target level of credit risk $\pi \in (0, 1-\varepsilon)$ as well as the interest rates $(R^L(\pi), R^H(\pi))$ sequentially [7]. Hence, solving backward, we obtain closed form solutions of $(\pi^*, R^L(\pi^*), R^H(\pi^*))$ as follows.

$$V(\pi^*) \equiv \max_{\pi\in(0,1-\varepsilon)} V(\pi) = \max_{\pi\in(0,1-\varepsilon)} V^H(\pi) + V^L(\pi)$$

$$V^H(\pi) \equiv \max_{R^H} \frac{\int_{\max\left[\pi, 1-\frac{1}{\beta(1+R^H)}\right]}^{1-\varepsilon} \left(1+R^H-\frac{1}{1-k}\right) C_0^*(k, R^H)\, dk}{1-\varepsilon} \tag{1}$$

[7] The lender offers different interest rates to high ($p > \pi$) and low ($p \leq \pi$) credit risk groups.

$$= \max_{R^H} \frac{\int_{\max[\pi,1-\frac{1}{\beta(1+R^H)}]}^{1-\varepsilon} \left(1 - \frac{1}{1-k}\frac{1}{1+R^H}\right) dk}{1-\varepsilon}$$

$$V^L(\pi) \equiv \max_{R^L} \frac{\int_{\max\left[0,1-\frac{1}{\beta(1+R^L)}\right]}^{\pi} \left(1+R^L-\frac{1}{1-k}\right) C_0^*(k,R^L) dk}{1-\varepsilon} \quad (2)$$

$$= \max_{R^L} \frac{\int_{\max[0,1-\frac{1}{\beta(1+R^L)}]}^{\pi} \left(1 - \frac{1}{1-k}\frac{1}{1+R^L}\right) dk}{1-\varepsilon}$$

In the above, the value function of the lender $V(\pi^*)$ is a sum of $V^H(\pi^*)$ and $V^L(\pi^*)$, each of which represents the expected profit the lender can get from providing loans at $R^H(\pi^*)$ for borrowers with credit risks greater than π^* or at $R^L(\pi^*)$ for borrowers with credit risks lower than π^*

Now it is time to introduce the cost of adopting the credit evaluation technique. What if the adoption cost F is so substantial? In that case, we cannot exclude the possibility that the lender won't adopt the credit risk evaluation technology. In response to heavy burden of F, the lender will provide loans to any applicant at a uniform interest rate R^* instead of purchasing the credit risk evaluation technique. A closed form solution of R^* is derived by solving the following maximization program.

$$V^* \equiv \max_R \frac{\int_{1-\frac{1}{\beta(1+R^H)}}^{1-\varepsilon} \left(1+R-\frac{1}{1-k}\right) C_0^*(k,R) dk}{1-\varepsilon} = \max_R \frac{\int_{1-\frac{1}{\beta(1+R^H)}}^{1-\varepsilon} \left(1-\frac{1}{1-k}\frac{1}{1+R}\right) dk}{1-\varepsilon} \quad (3)$$

Solving the *FOC* in (3), I could represent an explicit closed form solution of R^* as follows.

$$1 + R^* = \frac{exp\left(1 - \frac{1}{\beta}\right)}{\beta\varepsilon}$$

Then, plugging R^* back to the original maximization program in the above, I get the following expressions.

$$V^* = \frac{\varepsilon}{1-\varepsilon}\left(\beta\, exp\left(\frac{1}{\beta} - 1\right) - 1\right)$$

Compared with the previous decision program of the lender, (3) is more restrictive on the action set of the lender. Accordingly, $V^* \leq V(\pi^*)$. Reminded that $V(\pi^*)$does not include the credit risk evaluation cost F, F will discourage the lender from purchasing the credit evaluation technique if it exceeds the increment of the expected profit from using the credit risk evaluation technology $(V(\pi^*) - V^*)$.

2.3 An Equilibrium Lending Rate

Now, I introduce competition to the model by supposing that new lenders can enter into the loan market one by one without any frictions[8]. The following is an additional assumption required to discourage any new potential lenders from adopting the credit risk evaluation technology.

Assumption 6 The credit risk evaluation technology is costly and $F \geq V^L(\pi^*)$.

Lemma 1 confirms that Assumption 6 is stronger than $V(\pi^*) - V^* \leq F$, which guarantees that the credit evaluation technique should not be adopted only in a single lender case.

Lemma 1 $V(\pi^*) - V^* \leq V^L(\pi^*)$

Proof) By contruction, $V^* \geq V^H(\pi^*)$. Therefore, plugging $V^H(\pi^*) = V(\pi^*) - V^L(\pi^*)$, the above inequality is derived.

Proposition 2 When Assumption 6 holds, no new entrant into the lending market will purchase the credit risk evaluation technology.

Proof) Assumption 6 and Lemma 1 jointly indicate that the cost of adopting the credit risk evaluation technique (F) is no less than the value of adopting the credit risk evaluation technology $V(\pi^*) - V^*$ in a single lender case. Therefore, even in a multi-lender case, the (first) entrant in the lending market will not pay F. Instead it will choose to solve the maximization program of (3).

On the other hand, Lemma 1 states that the increment of the expected profit from using the credit risk evaluation technology is no greater than the expected profit from providing loans to a group of people with credit risk lower than any arbitrary target level π. Furthermore, the latter decreases as the number of incumbent lenders increases. Therefore, $F \geq V^L(\pi^*)$ is sufficient to prevent any new entrant from purchasing the credit risk evaluation technology.

Lemma 2 At an equilibrium, all the lenders levy the lending rate no greater than R^*.

Proof) Consider a new entrant, who requests the rate higher than R^*. Then the new

[8] Of course, any of incumbents may change its position.

entrant cannot take any loan applications.

From Lemma 2, it is conjectured that the equilibrium will be achieved in the limit of competition among the lenders. In the meantime lenders will keep lowering their lending rates until their profits are exhausted.

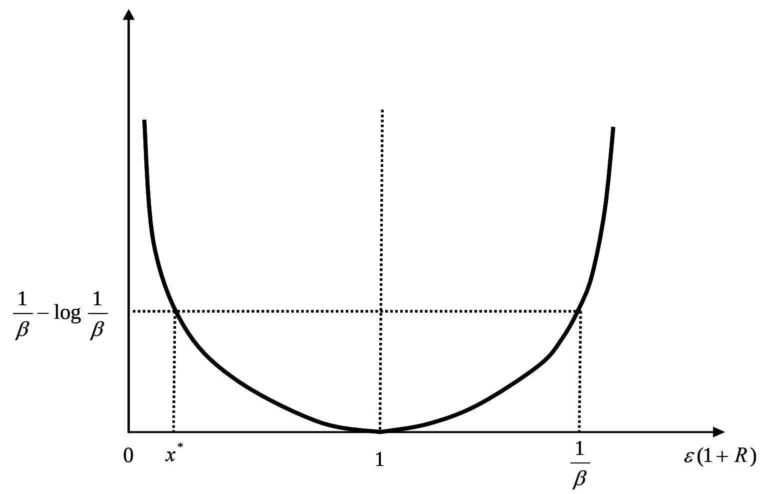
$$V_{Eq}^{*} \equiv \frac{\int_{1-\frac{1}{\beta\left(1+R_{Eq}^{*}\right)}}^{1-\varepsilon}\left(1-\frac{1}{1-k}\,\frac{1}{1+R_{Eq}^{*}}\right)dk}{1-\varepsilon} = \frac{\left(\frac{1}{\beta\left(1+R_{Eq}^{*}\right)}-\varepsilon+\log[\beta\varepsilon\left(1+R_{Eq}^{*}\right)]\right)\frac{1}{\left(1+R_{Eq}^{*}\right)}}{1-\varepsilon} = 0 \quad (4)$$

$$\Rightarrow\ \varepsilon(1+R_{Eq}^{*})-\log[\,\varepsilon(1+R_{Eq}^{*})]=\frac{1}{\beta}-\log\frac{1}{\beta}$$

Proposition 3 An equilibrium lending rate R_{Eq}^{*} in this economy satisfies $1+R_{Eq}^{*}<\frac{1}{\beta\varepsilon}$ and $\varepsilon(1+R_{Eq}^{*})-\log[\,\varepsilon(1+R_{Eq}^{*})]=\frac{1}{\beta}-\log\frac{1}{\beta}$.

Proof) See [Fig 3].

[Fig 3] Determination of the Equilibrium Lending Rate R_{Eq}^{*}



In contrast with [Fig 2], Proposition 3 indicates that the distribution of the lending rate is completely clustered at $1+R_{Eq}^{*}<\frac{x^{*}}{\varepsilon}$, where every lenders earn zero profit. In this equilibrium, potential borrowers with the credit risk lower than $1-\frac{\varepsilon}{\beta x^{*}}$ opt out of the market. In addition, the borrowers, whose credit risks range in $(1-\frac{\varepsilon}{\beta x^{*}}, 1-\frac{\varepsilon}{x^{*}})$, pay more than fundamentally due. Thus, only the remaining high risk holders in $(1-$

$\frac{\varepsilon}{x^*}, 1-\varepsilon)$ get benefits.

2.4 Policy Experiments

So far I have not assigned any role to the government. The following are the typical forms of government interventions in the consumer loan market. Based on the benchmark case, I discuss what consequences they have on the welfare of borrowers. Through these virtual experiments, I also expect to check what features the current model neglects and in which direction it could be improved.

Example 1 Levying a ceiling on the lending rate[9]

Based on the discussions so far, levying a ceiling on the lending rate is not likely to improve welfare. Instead it may lead to the collapse of loan markets for borrowers with high credit risk while deteriorating their welfare. Then, does it imply that an interest rate ceiling in reality has no positive effect? The answer is no. It is because, in reality, it is not likely to achieve perfect competition among the participants in the loan market, which is a critical assumption in our model.[10] When the market environment cannot guarantee perfect competition, it is hard to tell that the current lending rates are sufficiently low.

For example, commercial banks are, though not legally, implicitly excluded from the loan market for high credit risk holders. Once allowed to enter into the market, they would provide loans at lower rates than the incumbent private moneylenders because the funding sources of the commercial banks are much cheaper. At the same time, the commercial banks could increase profits by widening extensive margin of borrowers. On the other hand, the existing private moneylenders would lose their grips on their old clients.

Another example[11] is to allow private moneylenders to take deposits and/or issue corporate bonds, which are currently prohibited in Korea. Once admitted, these

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9 According to Helms and Reille (2004), restriction on the maximum lending rate exists in about 40 developing and transitional economies. Furthermore, the interest rate ceiling is prevalent even in developed countries including Austria, Canada (Quebec), Germany, Italy, Netherlands, Switzerland, and South Africa (Ramsay (2009)). Especially, in the case of Germany, the interest rate, which is twice as much as the average market interest rate, would be considered to be excessive by the Federal Court of Justice, although there is no explicit ceiling stipulated (Eurofinas (2010)).

10 Of course, in the model, information asymmetry is not an only source of market failure or imperfect competition, which, of course, may result from other causes, such as entry barriers.

11 A rumor runs in that some financing companies could finance accepted loan applications only by retained earnings.

financing vehicles would reduce the cost of capital born by the moneylenders and lower the lending rates.

Example 2 Providing loans at a lower rate

What if the government provides loans directly to borrowers with high credit risks at rates lower than the market instead of setting an interest rate ceiling? Then, definitely, the recipients of this new government loan program would get benefits from lessened debt burden, which, however, on the opposite side, would exhaust the fiscal capacity.[12] Additionally, it is notable that the private moneylenders would remain active in the market even after the introduction of the government loan program unless it absorbs the whole loan demand of the high credit risk holders.

Example 3 Encouraging Credit Information Sharing

What if the government takes policy measures to encourage credit information sharing through Credit Bureaus? In addition, assume that the fee the CBs are charging to the moneylenders is quite low or negligible. Then, the lenders would have more precise information on the credit risks of potential borrowers and charge different lending rates according to their perceived credit risk grades.

Example 4 Leave-it-to-the-market Approach

Non-intervention policy could not lower the lending rates. It is because in equilibrium loans provided at the rate of $1 + R_{Eq}^{*} < \frac{x^{*}}{\varepsilon}$ (see [Fig 3]) provide zero profit. Thus, any lender is not likely to get benefit from deviation.

III. Variations

In this section, I provide two adaptations of the benchmark model. The first one assumes that the cost of adopting the credit risk evaluation technique is zero ($F = 0$) while the second one introduces heterogeneous funding costs among lenders. Each of these two variations adds a more realistic feature by showing either how distortions from information asymmetry could be eliminated or why the lenders seems to implicitly collude at a lending rate higher than a competitive one.

3.1 A Race to Diversity

In this sub case, it is assumed that the cost of adopting the credit risk evaluation

[12] Government credit guarantee, full or partial, would achieve similar outcomes with less fiscal burden.

technique is zero ($F = 0$). Then, lenders determine their target level of credit risk $\pi \in (0, 1-\varepsilon)$ and provide loans to applicants at the interest rates of $R^L(\pi)$ and $R^H(\pi)$ according to their credit risks.

What does the distribution of lending rates look like in this case? To make a long story short, such deviation from Assumption 6 leads to the distribution as in [Fig 2]. Thus, distortions from information asymmetry are completely eliminated in that every borrower is guaranteed to have access to loan market and he pays what he really owes. This result is derived in the following steps.

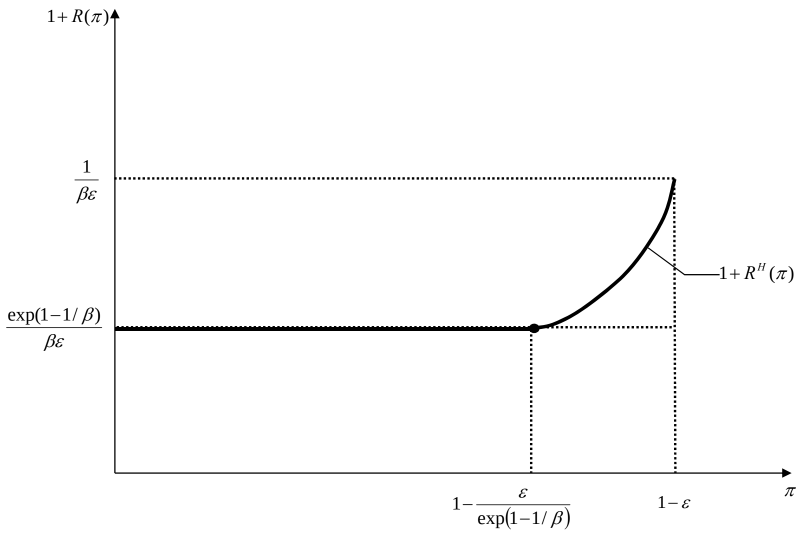
First, solving the *FOC* of the single lender's maximization program in (1), I could represent an explicit closed form solution of $R^H(\pi)$ as follows (see [Fig. 4]).

$$1 + R^H(\pi) = \frac{\exp[1-\frac{1}{\beta}]}{\beta\varepsilon}, 0 \le \pi \le 1 - \varepsilon/(\exp\left[1-\frac{1}{\beta}\right])$$

$$1 + R^H(\pi) = \frac{1}{\beta(1-p)}, \quad 1 - \varepsilon/(\exp[1-\frac{1}{\beta}]) < \pi \le 1-\varepsilon$$

It is implicitly assumed that $\exp\left[1-\frac{1}{\beta}\right] > \varepsilon$.[13] Otherwise, the latter case in the above will be meaningless.

[Fig 4] The Locus of $R^H(\pi)$



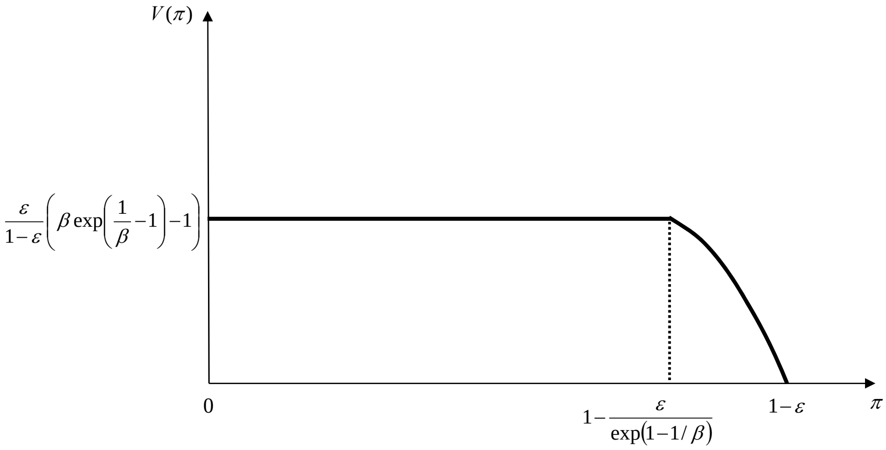
Next, plugging $R^H(\pi)$ back to the original maximization program in the above, I get the following expressions.

13 Later, Assumption 7, which is stronger than this, will be added.

$$V^H(\pi) = \frac{\varepsilon}{1-\varepsilon}\left(\beta \exp[\frac{1}{\beta} - 1] - 1\right), 0 \leq \pi \leq 1 - \varepsilon/(\exp\left[1 - \frac{1}{\beta}\right])$$

$$V^H(\pi) = \frac{1}{1-\varepsilon}\left(1 - \varepsilon - \pi + \beta(1-\pi)\log\frac{\varepsilon}{1-\pi}\right), \pi > 1 - \varepsilon/(\exp\left[1 - \frac{1}{\beta}\right])$$

[Fig 5] The Locus of $V^H(\pi)$

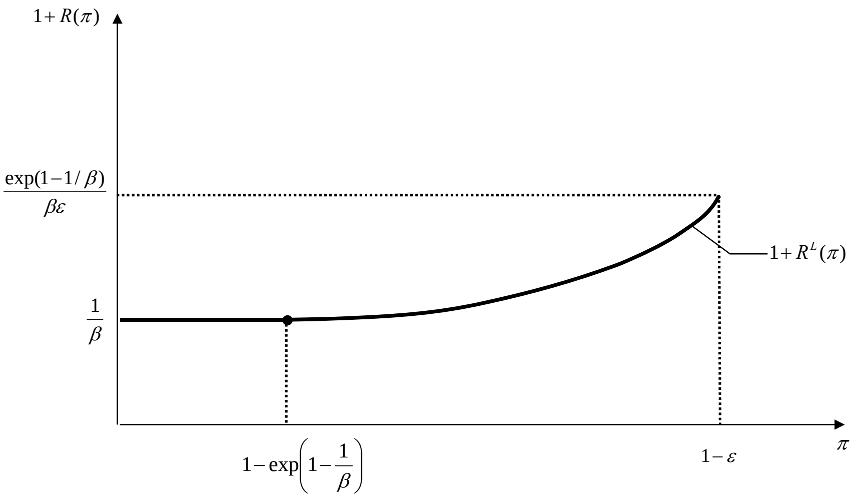


Second, solving the *FOC* of the single lender's maximization program in (2), I could represent an explicit closed form solution of $R^L(\pi)$ as follows.

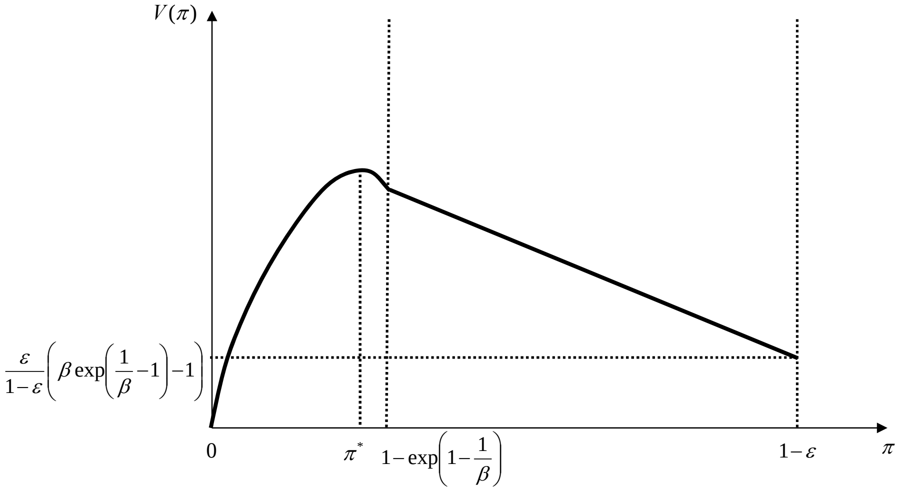
$$1 + R^L(\pi) = \frac{1}{\beta}, 0 \leq \pi \leq 1 - \exp\left[1 - \frac{1}{\beta}\right]$$

$$1 + R^L(\pi) = \frac{\exp[1 - \frac{1}{\beta}]}{\beta(1-p)}, \ \pi > 1 - \exp\left[1 - \frac{1}{\beta}\right]$$

[Fig 6] The Locus of $R^L(\pi)$



[Fig 7] The Locus of $V^L(\pi)$



Then, plugging $R^L(\pi)$ back to the original maximization program in the above, I get the following expressions.

$$V^L(\pi) = \frac{1}{1-\varepsilon}[\pi + \beta\log(1-\pi)]\,, 0 \le \pi \le 1 - \exp\left[1 - \frac{1}{\beta}\right]$$

$$V^L(\pi) = \frac{1-\pi}{1-\varepsilon}\left(\beta\exp\left[\frac{1}{\beta} - 1\right] - 1\right)\,,\ \ \pi > 1 - \exp\left[1 - \frac{1}{\beta}\right]$$

Assumption 7 The time discount factor (β) and the maximum credit risk ($1-\varepsilon$) satisfies the following inequality[14].

$$\sqrt{\varepsilon} \le \exp\left[1 - \frac{1}{\beta}\right]$$

Unlike the case of solving (1), (2) combined with Assumption 7 guarantees the uniqueness of π^*. Hence, by drawing $V^L(\pi)$ instead of $V(\pi)$, I could find an interval in which an optimal target level π^* exists.

Proposition 4 $\pi^* = \arg\max_{\pi\in(0,1-\varepsilon)} V(\pi) = \arg\max_{\pi\in(0,1-\varepsilon)} V^L(\pi)$ exists in [0,

[14] This additional assumption is more likely to hold, the more patient consumers are or the higher their maximum credit risk is.

$1-\varepsilon/(\exp\left[1-\frac{1}{\beta}\right]]$ if Assumption 7 holds.

Proof) Compare [Fig 5] and [Fig 7].

Now let's introduce competition to the economy by adding new loan providers. Then, the potential competitors will enter into the loan market as long as they can raise positive profit. In contrast with the benchmark case, potential entrants can hold the credit risk evaluation technique free of charge ($F = 0$). Thus, they set their target credit risks on either side of the incumbents' π^*s and they will keep flowing into the loan market until all the positive profit opportunities are exhausted (in other words, until the lending rate distribution approaches to that in [Fig 2]).

Proposition 5 An equilibrium distribution of lending rates in this economy is identical with that in the symmetric information case.

Proof) Suppose that the equilibrium distribution of lending rates is not equal to that in [Fig 2]. Then, it implies that there exists a group of people, who pay more than their credit risks or who rather voluntarily opt out of the loan market. Hence, by supplying loans to those people, a new loan provider could earn profit. Or any of the incumbents could earn profit by changing its policy for credit evaluation and interest rates. Such profitable opportunities will not be exhausted until the lending rate distribution will approach to that in [Fig 2].

3.2 Heterogeneous Funding Costs

The following model allows heterogeneity of funding costs. In detail, funding costs differ among the lenders by a parameter ϕ, which is uniformly distributed between 1 and $M(>1)$.

To start with a single lender case, the profit maximization program of the moneylender is represented as follows[15].

$$V(\phi) \equiv \max_R \frac{\int_{1-\frac{1}{\beta(1+R)}}^{1-\varepsilon}\left[1-\frac{\phi}{1-k}\frac{1}{1+R}\right]dk}{1-\varepsilon} = \max_R \frac{1}{1-\varepsilon}\left[\varepsilon-\frac{1}{\beta(1+R)}-\frac{\phi\log[\beta\varepsilon(1+R)]}{1+R}\right]$$

Accordingly, an optimal lending rate is set at $1+R(\phi)=\frac{\exp[1-\frac{1}{\beta\phi}]}{\beta\varepsilon}$.

Funding costs differentiated by parameter ϕ are critical in determining a lending

[15] The cost of the credit risk evaluation technique is levied as indicated in Assumption 6.

rate each lender will ask in the market. The funding cost[16] for loan provision to a borrower with credit risk k is defined as $\frac{\phi}{1-k}$. Reminded that $\phi \sim U[1, M]$, the most cost efficient lender with $\phi = 1$ is likely to lead price competition in the loan market for high credit risk holders.

For a moment, suppose that the market interest rate is set at $1 + R(1) = \frac{\exp[1-\frac{1}{\beta}]}{\beta\varepsilon}$, which also happens to be a solution of a single lender maximization program with $\phi = 1$. Then, at the market lending rate, there exist a group of lenders, whose profit still remains non-negative. Their ϕ values satisfy the following inequality.

$$1 \leq \phi \leq \frac{1 - \exp[1 - \frac{1}{\beta}]}{1 - \beta}$$

In this situation, the lender with $\phi = 1$ could take all the loan requests by lowering its lending rate slightly from $R(1)$. Of course, as the lending rate is lowered, the least cost efficient lenders (among active ones) will exit the market. Thus, one with $\phi = 1$ keep lowering the lending rate until the increments in market share cannot compensate for the revenue loss from the lowered interest rate.[17] In this context, $1 + R(1)$ may or may not be an equilibrium interest rate.

On the other hand, even the lender with $\phi = 1$ could barely survive in the market (neither do other lenders) at a lending rate x^*/ε (here x^* satisfies $x - log\, x = \frac{1}{\beta} - \log\left[\frac{1}{\beta}\right], x \equiv \varepsilon(1 + R)$). At a lower rate than this, no lender including the most cost efficient one will not stay active in the loan market.

Combining these two arguments, it is easily inferred that there exists R_{IC} ($x^*/\varepsilon \leq R_{IC} \leq R(1)$), at which the lender with $\phi = 1$ does not have any incentive to lower the interest rate. A remaining task is to show how other lenders feel at R_{IC}. Compared with the lender with $\phi = 1$, they will not get so much benefit by lowering their lending rates below R_{IC}. Therefore, R_{IC} is a Nash equilibrium interest rate in this economy.

AtR_{IC}, the private moneylenders with the following range of ϕ provide loans in the market.

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16 The funding cost is not charged for an individual borrower because moneylenders do not know the risk type of an individual borrower. Instead they are charged funding costs for a borrower pool as a whole. Of course, they are assumed to know the credit risk distribution of their clients. This is why the funding cost is defined so in the above maximization setup.

17 See the maximization program in Proposition 6 later and identify what nominator and denominator represent.

$$1 \leq \phi \leq \frac{\varepsilon - \frac{1}{\beta(1+R_{IC})}}{\frac{\log[\beta\varepsilon(1+R_{IC})]}{1+R_{IC}}}$$

In addition, the smaller ϕ is, the bigger profit the moneylender will get.[18]

Proposition 6 An equilibrium lending rate R_{IC} in this economy solves the following at $\phi = 1$.

$$V_{IC}(\phi) \equiv \max_{R_{IC}} \frac{\frac{1}{1-\varepsilon}[\varepsilon - \frac{1}{\beta(1+R_{IC})} - \frac{\phi\log[\beta\varepsilon(1+R_{IC})]}{(1+R_{IC})}]}{\frac{\varepsilon(1+R_{IC}) - 1/\beta}{\log[\beta\varepsilon(1+R_{IC})]} - 1}$$

Example 5 Interest Rate Ceiling revisited: Is it always worse-off?

Now let's discuss what will happen in presence of funding cost heterogeneity if a loan rate ceiling is newly imposed or the existing ceiling is lowered. An answer, quick and easy, is that it depends on the magnitude of the (new) ceiling. In case the ceiling is somewhere between x^*/ε and R_{IC} as in the above, the market lending rate will be lowered accordingly while guaranteeing the same accessibility to the loan market[19]. In contrast, if the ceiling is set below x^*/ε, then the loan market will collapse. The second case is most worried when the introduction of an interest rate ceiling is discussed. But, the first implies that a proper level of interest rate ceiling will improve the welfare of borrowers. Furthermore, the first case explains why a lending rate distribution may have cluster in the neighborhood of a legal ceiling and the cluster moves along with changes in the ceiling, which are observed in Korea.[20]

IV. Lending Rate Distributions in Reality: A Case of Korea

(Excerpted from an official report from the FSS on September 17th, 2010)

The Financial Supervisory Services (FSS) surveyed 14 major private moneylenders from August 9th till August 24th in 2010 in order to examine whether they observed the lowered interest rate ceiling (49% → 44% since July 21st, 2010). The survey revealed that average interest rates those private moneylenders charged for the

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[18] In presence of heterogeneity in funding costs, zero profit condition does not have to be maintained in equilibrium.

[19] On the other hand, the number of active moneylenders will be reduced. This is what economists against an interest rate cap worry about.

[20] On this issue, see the next section.

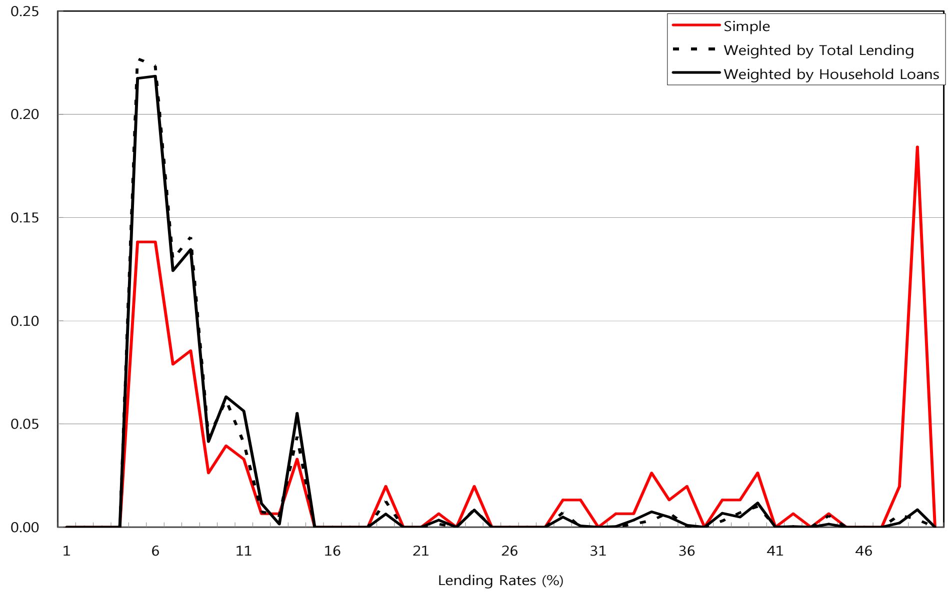
existing loans, additional loans under credit limits, and new or refinancing loans were 48.5%~49%, 43.5%~44%, and 38.0%~44.0% respectively.

Like many other countries, Korea has levied a ceiling on lending rates since October 28th, 2002 with a couple of alterations. The ceiling, originally set at 66% (annual), was lowered sequentially to 49% on October 4th, 2007 and to 44% on July 21st, 2010.[21]

To begin with, I introduce the current lending rate distribution of Korea. The data set includes the ranges of the lending rates announced by depository institutions (79 commercial banks and 10 Savings & Loans) and non-depository institutions (10 insurance companies, 15 finance companies, and 39 private moneylenders[22]). The data for commercial banks are collected from the website of Korea Federation of Banks (KFB), while data for other financial institutions are obtained from various sources.

In principle, each loan program charges different rates by overall credit risks, which reflect collateral value (if any) and borrower's credit history. Thus, in collecting the information on the lending rates, I do not distinguish collateralized loans and credit loans. It is implicitly assumed that every loan application could be ordered by overall credit risk.

[Fig 8] Lending Rate Distributions in Korea (as of July, 2010)

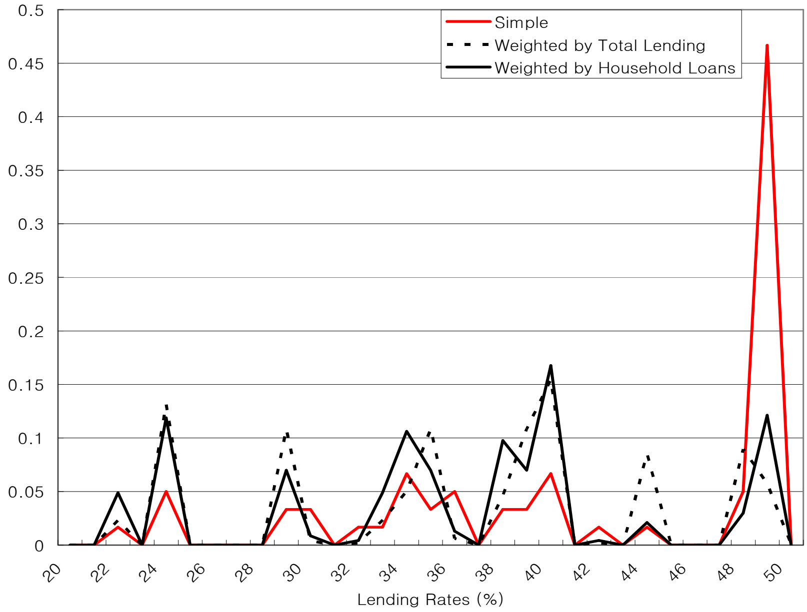


21 This ceiling is applied only to publicly registered money lenders. Unregistered ones are banned from charging more than 30 % of interest rates. Such a dual system of interest rate ceiling could cause other distortions, which, however, will not be discussed in the paper.

22 Finance companies and moneylenders are not exactly equivalent in Korea. However, they are used interchangeably for brevity afterwards.

[Fig 8][23] represents the lending rate distributions of Korea measured by three different weights. Considered that the sum of loans from commercial banks and insurance companies takes 91% of total lending and 58% of total household borrowing, the lending rate distributions weighted by market shares are dominated by the lending rates of the commercial banks and the insurance companies. In contrast, the simple distribution (red) exhibits a right hand side spike close to 49% of the legal ceiling (before July 21st, 2010), which indicates that many private moneylenders are charging interest rate to borrowers with high credit risks almost up to the legal limit.

[Fig 9] Conditional Distributions (above 20%) of Lending Rates in Korea (as of July, 2010)



[Fig 9] narrows down the focus on the distributions of the lending rates greater than 20%. As in [Fig 8], the right hand side spike close to 49% of the legal ceiling is confirmed only in a simple weight case. In addition, regardless of the weighting methods, the conditional distributions seem to be multi-modal, indicating a possibility that multiple clusters may exist in the lending market.

Reminded that data used here cover the period in which 49% is a legal ceiling, the

[23] [Fig 8] and [Fig 9] record a maximum lending rate an individual loan program of each financial institution announces. The maximum value is crucial in that the financial institutions, especially finance companies and private money lenders, tend to underreport the lending rates in order to attract potential borrowers. In addition, we are much more interested in observing and explaining the behaviors of the finance companies and the private money lenders than those of commercial banks. However, the following results will not change qualitatively even if minimum lending rates are included.

right hand side spike close to 49% in both [Fig 8] and [Fig 9] seems quite interesting. Could such clustering in the vicinity of the legal ceiling be regarded simply as a symptom showing the presence of inefficiency or insufficient competition? What if the same or a similar phenomenon is observed at a different level of the legal ceiling (e.g. 66% before 2007)? In that case we should come up with another explanation why private moneylenders are inclined to provide loans to high credit risk borrowers at the rates close to a legal limit.

In response to this question, I build a new data set based on the DART (Data Analysis, Retrieval and Transfer System) administered by the Financial Supervisory Service of Korea. The DART, which started in January 2001, provides all the public disclosures by companies listed or externally audited. Among them, I collect the financial statements of externally audited financial companies and private moneylenders[24] and calculate their average interest rates by dividing annual interest receipts by total outstanding loan. Then, I draw lending rate distributions of listed finance companies and private moneylenders for the year 2006, and 2009[25], [26] respectively and compare them. By doing so, I expect to answer whether and why the clustering in the neighborhood of 49% as in [Fig 10] and [Fig 11] could happen to other levels of legal interest rate ceiling.

Lending rates are calculated in the following way. First, I choose total loan amount (say A), loan loss provision (say B), and interest receipts (say C) from the DART database. Second, I define the following two measures as a lower and a upper boundary of average lending rate (at firm level) [27].

$$R_{upper} \equiv C/(A-B)\,,\, R_{lower} \equiv C/A\,.$$

Average lending rate distributions are calculated and graphically drawn in [Fig 10]~[Fig 11].[28] In detail, two subplots in [Fig 10], which cover 2009, exhibit several clusters in a range of 20%~46%. Reminded that 49% is the maximum interest rate the financial institutions could charge in Korea in the year 2009, it seems quite clear that the legal ceiling set an upper bound for the clusters.

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24 Though not all are listed, these listed companies represent roughly 65% of total lending provided by the whole sector.

25 The data of 2001, in which there was no ceiling, is not analyzed here due to lack of compatibility with those of the year 2006 and 2009.

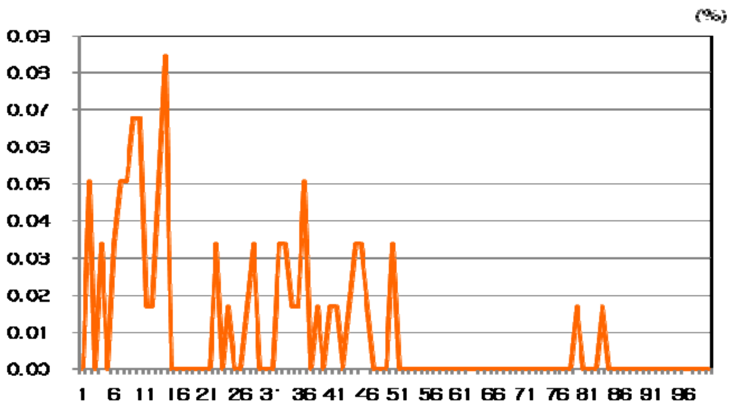
26 Each of these years marks the period of 66% ceiling and that of 49% ceiling.

27 It should be noted that these measures provide the realized rates of returns. Hence, they are not perfectly fit to our purpose.

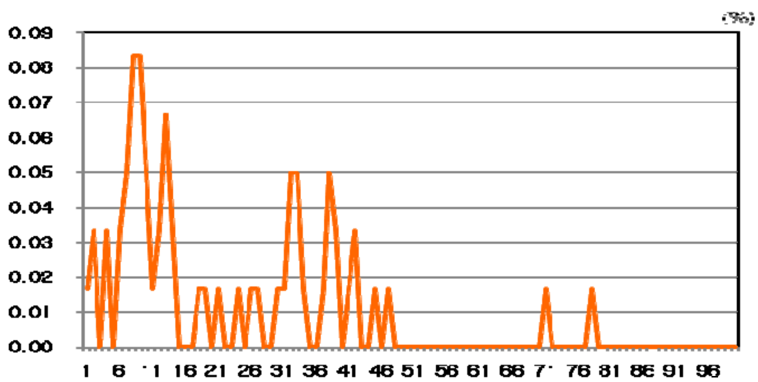
28 These figures do not consider the relative weights of the financial institutions included by their loan size. Otherwise, the spikes or the clusters in the neighborhood of the legal ceilings (49% for 2009 and 66% for 2006) would not be so noticeable as they are.

[Fig 10] The Average Lending Rate Distributions in 2009

(i) $R_{upper} \equiv C/(A-B)$



(ii) $R_{lower} \equiv C/A$

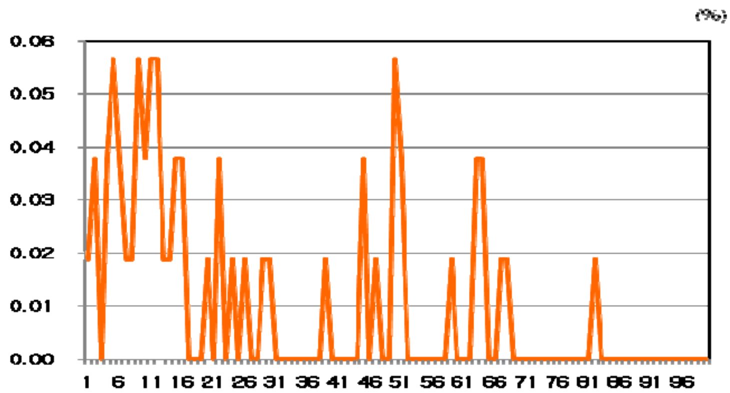


On the other hand, the two subplots in [Fig 11], which cover 2006, exhibit clusters in a range of 53%~66%. Like in 2009, an upper bound 66% is the legal interest ceiling in Korea in the year 2006. Comparing the results from 2009 and 2006, the cluster in the right tail of the lending rate distributions tends to move following the legal interest rate ceiling. As mentioned earlier, such co-movement could be understood as a sign of inefficiency under the following two scenarios[29].

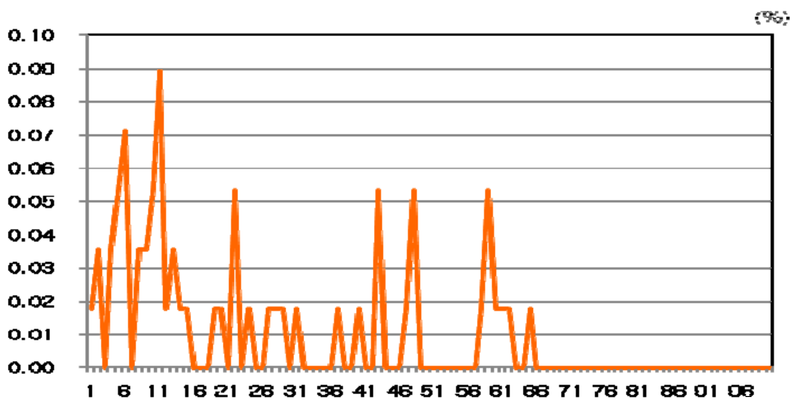
The first hypothesis behind this phenomenon is that finance companies are also heterogeneous in funding costs. One with a cheap source of funding could provide loans at an interest rate lower than others, but it would not do so if it could gain more from maintaining a high interest rate.[30] On the other hand, others with high cost of capital could not afford low interest rates. Accordingly, a cluster in the lending rate distribution may be formed in the neighborhood of the legal ceiling.

[Fig 11] The Average Lending Rate Distributions in 2006

(i) $R_{upper} \equiv C/(A-B)$



(ii) $R_{lower} \equiv C/A$



[29] Of course, these two hypotheses are not exclusive with each other.

[30] Of course, the financial institutions with cheap funding sources could increase their market share by lowering interest rates. However, in case that the interest rate elasticity of loan demand does not exceed 1, they will lose more than they gain by lowering the interest rates.

The other possible explanation would be the presence of information cost. In case the credit information acquisition cost is substantial or it differs by the magnitude of credit risk (bigger for higher credit risk groups), then the money lenders will choose to provide loans to high risk borrowers without taking any additional efforts to check their credit affordability.

In contrast with the second one, the first hypothesis of heterogeneous funding costs is confirmed. Park, Lee, Lee, and Jung (2009) estimate the funding costs of private moneylenders in Korea using accounting information. According to their report, funding costs vary from a financing company to another[31] and the composition of funding sources is largely skewed to borrowing (68.8% of total funding as of June 2009).[32] Since borrowing and lending relations are usually contracted over the counter, funding rates tend to be dispersed from a contract to another.

As in the case of Korea, the credit card industry of the US experienced a similar clustering phenomenon in the 1980s. Knittel and Stango (2003) explain why most US credit card issuers charged the maximum interest rates allowed under state laws in the 1980s. They distinguish binding ceilings from non-binding interest rate ceilings and perceive the latter as focal points for tacit collusion among the credit card providers. Furthermore, they claim that that a non-binding interest rate ceiling may have negative effects by showing that the probability of maintaining the tacit collusion would fall as the ceiling rises.

From a different perspective, Ausubel (1991) reports that credit card rates were very sticky compared with the costs of funds and major credit card providers persistently earned profits higher than the ordinary rate of return in banking during the period 1983-1988. Ausubel perceives these observations as signs of limited rationality of consumers, who make transactions with credit card without realizing that they would pay interest on their outstanding balances more likely than they expect.

Compared with Knittel and Stango (2003) and Ausubel (1991), this paper distinguishes itself in the following features. First, it allows explicitly free entry/exit to loan providers. Second, it accepts heterogeneity of financial institutions in funding costs and third, it assumes rationality of borrowers. Based on these, the paper claims that clustering may be formed either in absence of a regulatory ceiling or on the ceiling. Furthermore, in either case, it is also shown that the lowered interest rate ceiling could

31 They use write-off of bad debts instead of loan loss provision in calculating break-even-points of lending rates.

32 Other sources of funding are corporate bonds (3.9%) and equity financing (27.3%). Such small portion of financing by corporate bonds is attributable not only to tight restrictions on bond issuance but also higher funding rate (average 11.88% compared with average 9.82% of borrowing).

provide welfare gains to borrowers (with high credit risks). In this regard, the model is located in the opposite to the existing literature, which are mostly against interest rate ceilings.

V. Concluding Remarks

This paper, by assuming the substantial cost of adopting a credit risk evaluation technique, provides a partial equilibrium model, which explains why a cluster is observed in an equilibrium cross-sectional distribution of lending rates. As an extension, it examines possible consequences of various government interventions (mostly restrictions) in the consumer loan market. However, the benchmark model presented here could not explain Korean experiences, in which a cluster of lending rates appear in the neighborhood of a legal ceiling and such clustering persists even after the level of the legal ceiling is changed.

In this regard, I suspect the assumption of homogeneous funding costs, which is distant from the reality. Thus, introducing the heterogeneity of funding costs across lenders, I check whether it could induce clustering in the neighborhood of the legal interest rate ceiling. In addition, I discuss that such clustering may not disappear and would rather move along with changes in the legal interest rate ceiling. In this context, proper interest rate ceiling could improve the consumers' welfare in the credit market. However, reminded that clustering persists due to heterogeneous funding costs, a longer perspective solution for improving debtors' welfare would be guaranteeing sources of funding, cheaper and equal, to all loan providers.[33]

Another long-term policy measure would include developing credit information system and encouraging credit information sharing among various types of financial institutions. Lowered credit information acquisition cost and easier access to the existing information network will attract financial institution to adopt more improved credit evaluation techniques and make loan decisions based on them, which will eventually benefit borrowers[34].

Anyway, despite apparent limitations induced by simplification, this paper has

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[33] Or it could be an alternative to allow commercial banks to enter into the high credit risk loan market, which is currently occupied by private moneylenders.

[34] An issue of the *Economist* (Nov. 20th, 2010) claims that the recent movements towards capping microfinance interest rates (in Bangladesh and India) will reduce competition and in turn jeopardize accessibility of the poor to the financial services. It seems to be in much more favor of establishing credit bureaus for the poor and enforcing rules on capital buffers of microfinance institutions.

substantial contributions in that it provides a benchmark for understanding loan market failures caused by information asymmetry, simulating the effects of corrective policy measures on them and evaluating the efficiency of the loan market.

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