Timo Vesala

Relationship lending and competition: Higher switching cost does not necessarily imply greater relationship benefits

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Abstract

This paper studies relationship lending in a framework where the cost of switching banks measures the degree of banking competition. The relationship lender's (insider bank's) informational advantage creates a lock-in effect, which is at its height when the switching cost is infinitesimal. This is because a low switching cost gives rise to a potential adverse selection problem, and outsider banks are thus reluctant to make overly aggressive bids. This effect gradually fades as the magnitude of the switching cost increases, which *de facto* reduces the insider bank's profits. However, after a certain threshold in the switching cost, the insider bank's 'mark-up' begins to increase again. Hence, relationship benefits are a non-monotonous (V-shaped) function of the switching cost. The 'dynamic implication' of this pattern is that relationship formation should be more common under extreme market structures ie when the cost of switching banks is either very low or sufficiently high. Recent empirical evidence lends support to this prediction.

Key words: relationship lending, switching cost, banking competition

JEL classification numbers: G21, G24, D82, D43

Luottosuhteet ja pankkikilpailu: Pankkiasiakkuuden vaihtamisen kustannukset eivät välttämättä lisää suhdeluototuksen kannattavuutta

Suomen Pankin tutkimus
Keskustelualoitteita 3/2005

Timo Vesala
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Tutkimuksessa tarkastellaan luottosuhteiden muodostumisen ja pankkikilpailun välistä yhteyttä. Kilpailullisuuden mittana käytetään kustannusta, joka luotonhakijalle aiheutuu asiakkuuden siirtämisestä toiseen pankkiin (ns. vaihtokustannus). Pankin informaatioetu omien asiakkaiden riskeistä aiheuttaa ns. lukkiutumisen, joka on voimakkaimmillaan, kun vaihtokustannus lähenee nollaa. Tämä johtuu siitä, että vähäinen vaihtokustannus lisää ulkopuolisten pankkien näkökulmasta haitallisen valikoitumisen ongelmaa (adverse selection) ja vähentää näin kilpailijapankkien halukkuutta aggressiiviseen hintakilpailuun. Haitallisen valikoitumisen ongelma pienenee sitä mukaa kuin vaihtokustannus kasvaa, ja tämä tosiasiallisesti supistaa pankin voittoja. Vaihtokustannukselle on kuitenkin olemassa kynnysarvo, jota suuremmilla arvoilla haitallisen valikoitumisen ongelma häviää kokonaan ja pankin voittomarginaali vaihtokustannuksen suhteen alkaa kasvaa. Luottosuhteen tuottamien voittojen ja vaihtokustannuksen välillä on siten ei-monotoninen, V:n muotoinen relaatio. Mallin dynaaminen johtopäätös on, että luottosuhteiden muodostumisen pitäisi olla yleisintä äärimmäisten markkinarakenteiden oloissa eli ts. kun vaihtokustannus on hyvin pieni tai kun se on riittävän suuri. Viimeaikainen empiirinen tutkimus tukee tätä hypoteesia.

Avainsanat: suhdeluototus, vaihtokustannus, pankkikilpailu

JEL-luokittelu: G21, G24, D82, D43

Contents

1 Introduction

In their widely cited article Petersen and Rajan (1995) argue that credit market competition may be 'inimical' to the formation of lending relationships. The intuition is that banks with monopoly power can extract future profits from the borrower, which creates an incentive to subsidize greater loan availability at the early stages of the lending relationship.[1] However, their empirical evidence supports this hypothesis only in the case of very young firms (less than 4 years old). Instead, for firms which are not 'start-ups' but not 'old' either, there is a tendency for institutional debt being more common under the extreme market structures (either most competitive or most concentrated) than under the intermediate case. From a theoretical ground, this is surprising because the 'subsidize-first-extract-rents-later' strategy would expect to be even more profitable in the case of relatively young but already well established firms. Those firms still possess strong growth potential but do not suffer from severe risk of failure. As Cao and Shi (2001) put it: 'The difference in the loan availability between a concentrated market and a competitive market should be more pronounced for not-so-young firms than for young firms.' Our claim is that the reason behind this puzzle is not that the cross-subsidization hypothesis itself is wrong, but that the benefits from relationship lending may not be monotonously decreasing with more intense competition.

We assume pre-existing relationships between loan applicants and their 'insider banks'[2]. There are two lock-in effects in the model: First, insider banks are assumed to possess an informational advantage. They receive a 'noisy' signal about the success probability of their pre-existing customers and this information is not available to outsider banks.[3] The second lock-in effect arises from the costs that the borrowers face should they switch to another bank. Switching cost[4] captures all the pecuniary and non-pecuniary expenses[5] that are induced by the change of the supplier of finance. The magnitude of the switching cost also measures the degree of monopoly power of the insider bank. The model obeys a sequential structure: First, the borrower applies finance from his insider bank. Secondly, after observing the noisy signal, the insider bank decides whether to make an acceptable loan contract offer or not. Thirdly, if the borrower could not trade with his insider bank, he may send loan applications to outsider banks and be ready to pay the switching cost. Finally, before placing their bids, the outsider banks can observe that

[1] This argument is basically the same as the Schumpeterian view on the dynamic efficiency in R&D sector: some degree of monopoly power is needed in order for investments in highly uncertain new technologies to have a positive net present value at the *ex ante* stage.

[2] Cf. Hausbanks in Germany.

[3] This assumption can be justified by the notion that only the insider bank is likely to have access to any soft information that may generate private signals about the borrower's quality, whereas the outsider banks have to rely only on the hard information (like financial statements) which is common to everyone. Cole (1998) provide empirical evidence that banking relationships tend to produce valuable private information about the prospects of the customer.

[4] Kim et al (2003) estimate the relevance of switching costs in banking industry and conclude that the magnitude of these costs can be significant.

[5] These expenses may arise from inconvencies due to unfavorable physical location of other banks, differentiation in financial services etc.

the application comes from a borrower outside their 'captive markets'. This observation effectively reveals the fact that the borrower has been rejected by his insider lender and thereby transmits useful information.

The analysis is focused on an equilibrium that features the sequential moves postulated above.[6,7] We will show that higher switching cost does not necessarily increase the insider bank's profits and thereby benefits from relationship lending. This is because with low switching cost it is feasible also for low quality borrowers to switch banks. Threat of adverse selection then curtails price competition and discourages outsider banks to make too aggressive bids. As a result, it is easier for the insider bank to attract favorably signalling customers to stick to their existing host bank. The adverse selection effect gradually fades away as the magnitude of the switching cost increases. That, in turn, enables the outsider banks to lower their bids and it is harder for the insider bank to keep its customers. This logic holds until the switching cost is so high that only good customers can afford to go for alternative banks. After that threshold, the loan rate available from outsider banks remains constant and greater switching cost has an unambiguously positive effect on the mark-up the insider bank is able to charge. Provided that the insider information generated by the pre-existing relationship is accurate enough, we show that the insider bank actually makes highest profits when the switching cost is either very low or sufficiently high. Thus there is a non-monotonous and 'V-shaped' relationship between insider bank's profits and the magnitude of the switching cost.

Even though our analysis is static and features no intertemporal trade offs, the 'dynamic implication' of the model is a straight forward application of the Petersen-Rajan argument. According to the cross-subsidization hypothesis, higher expected profits from relationship based lending should create greater incentive for more extensive relationship formation. Therefore the V-shaped pattern implies that relationship formation should be most frequent under the extreme market structures; ie when the degree of insider bank's monopoly power (the switching cost) is very low or when it is sufficiently high.[8] This prediction is supported by the recent empirical evidence in Elsas (2005), who analyses the frequency of relationship lending in Germany. He reports that the likelihood of having a 'Hausbank relationship' *decreases* as bank concentration in local debt markets increases. This relationship holds for low and intermediate levels of concentration, whereas in highly concentrated

[6] This practice facilitates tractability since the sequential moves game is analytically simpler than a model where the informed 'insider' and uninformed 'outsiders' place bids simultaneously. Auctions with interdependent values and asymmetrically informed bidders do not feature bidding behavior in pure strategies (cf. von Thadden, 2004, and Krishna, 2002 ch. 8), which easily complicates the analysis.

[7] The sequential structure is plausible especially if one thinks that a strictly positive fraction of the switching cost has to be paid already at the time of applying loans from outsider banks, for instance, due to application costs and the effort needed to locate suitable replacement lenders.

[8] A similar justification for a static model in relationship lending context is used for instance by Cao and Shi (2001).

markets less competition seems to stimulate relationship formation.[9] As far as greater switching cost can be interpreted as a proxy for higher market concentration, the empirical results by Elsas (2005) coincide with the V-shaped pattern derived in our theoretical model. The same pattern arises also in the empirical part of Petersen and Rajan (1995, Table II, p. 423), in which there is a clear tendency for a V-shaped relationship between market concentration and credit availability for firms older than five years. Our model also provides a potential explanation why such a non-monotonous relationship does not emerge in the category of very young firms. It seems plausible that markets, including the insider lender, are likely to know almost nothing about very young firm's future success probability. We show in the supplementary section of the model that if the informational advantage of the insider bank is not substantial, then insider bank's profits are low in the competitive limit and no clear-cut V-shaped pattern arises.

A somewhat comparable result to ours is derived by Cao and Shi (2001), who elaborate the 'winner's curse' problem in a static auction theoretic model. They abstract from any informational asymmetry between bidders and postulate that all bidders may obtain 'noisy' information about the project by exerting costly project evaluation. As the number of competing banks increases, the threat of winner's curse becomes more immediate because the winner must have beaten a higher number of bids and the possible mistake in project evaluation is likely to have been larger. Banks respond to this by cutting the acquisition of costly information and participate in bidding contests less frequently. Cao and Shi then show that an increase in the number of potential bidders may sometimes reduce the number of banks that actively compete for the project and the expected loan rate rises. As a result, more intense competition can, under certain conditions, lead to higher profits and thereby more active relationship formation. In contrast to the Cao-Shi model, our results are driven by the insider bank's informational advantage and the degree of competition is measured by the level of the switching cost rather than by the explicit number of competing bidders.

There are also other models, eg Broecker (1990), Sharpe (1990)[10], Nakamura (1993) and Riordan (1993), that identify winner's curse type distortions of competition. These papers, however, are focused on studying the relationship between adverse selection problem and banking competition rather than the effect of competition on relationship formation. The broad outcome of these models is that the likelihood of a poor applicant getting finance increases as the number of banks operating in the market is higher, so that competition is likely to worsen adverse selection. This result is in line with our finding that bad loan applicants are the more likely to approach outsider banks and thereby get finance the lower is the switching cost. However, if the model is extended to allow for costly information acquisition, the 'V-shaped' profit function indicates that the marginal benefit from more accurate private information is higher under the extreme levels of the switching cost than under

[9] Also Kim et al (2004) find some evidence in their Norwegian data that banks tend to make more valuable relationship-loans in a more competitive market.

[10] von Thadden (2004) points out an error in Sharpe's analysis and presents a correct way to solve his model.

intermediate switching cost. Hence, more efficient information acquisition can potentially counterbalance the efficiency losses due to the adverse selection problem in competitive credit markets.

Other related papers include Greenbaum et al (1989), who examine loan rate offers by an 'incumbent' bank when borrowers have option to quit and start searching for competitive offers at a fixed search cost. Their focus is, however, on studying the expected remaining duration of the lender-client relationship, and how it depends on the existing length of the relationship. The current study is also related to horizontal differentiation models to the extent that the switching cost can be interpreted to reflect the degree of differentiation. Villas-Boas and Schmidt-Mohr (1999) study how differentiation affects the screening intensity of loan applicants. They find that a higher degree of differentiation (less competition) is likely to lead to less intensive screening and higher welfare. Hauswald and Marquez (2004) investigate the effect of competition on strategic information acquisition in credit markets. They conclude that increasing competition will eventually induce banks to weight lending in their 'captive' market segments (=relationship based lending) instead of so called 'transaction-lending' in more competitive market segments. A similar 'flight to captivity' pattern is also reported by Dell'Ariccia and Marquez (2004). Also Boot and Thakor (2000) argue that banks may try to escape fiercer competition by substituting transactional lending with relationship lending.

The paper is organized as follows. The main analysis is carried out in Section 2. Section 3 discusses the 'dynamic implication' of the static model according to the Petersen and Rajan's (1995) cross-subsidization hypothesis. Section 4 provides some remarks on the relationship between banking competition and the adverse selection problem. Section 5 concludes.

2 The model

In this section, we construct a static model with one-time lending decision. The model is particularly well suited to bank lending to SMEs who typically do not have access to multiple sources of external finance.[11] We assume pre-existing customer relationship between a loan applicant and its insider bank. This relationship generates 'soft information' about the quality of the loan applicant that is not observable to outsider banks. If the loan applicant cannot trade with its insider bank, he may break up the existing relationship, send applications to outsider banks and arrange a bidding game between them. The option to switch banks, however, incurs a cost, c. The switching cost describes both the *ex ante* expenses incurred by the search for suitable replacement lenders, as well as the various costs arising *ex post* from the frictions related to the

[11] According to Financial Inquiry by Bank of Finland, Ministry of Trade and Industry and EK (the report in finnish can be found at http://www.bof.fi/fin/3_rahoitusmarkkinat/3.6_Raportit/RahKysely2004.pdf) most of the small firms in industry and service sector have a customer relationship with only one bank.

change in the supplier of financial services. The magnitude of the switching cost c serves as an index for insider bank's monopoly power. We assume that there are at least two outsider banks available at this one-time switching cost expense.[12]

In our static world, it is assumed that there are no benefits from relationship building after the current financing stage; ie the outsider banks in the bidding game will not have the option of becoming insider lenders in the future. This assumption can be made without loss of generality, because loan price offers at any interim stage would anyhow depend on the ultimate realization of relationship benefits. The cross-subsidization hypothesis implies that the higher the expected future rents are the greater is the incentive to undercut loan rates at the earlier stages. Therefore we may focus on the final stage and derive a relationship between the switching cost and insider banks' ability to make profits. Once we have that relationship, the Petersen-Rajan argument can be used to discuss the availability of credit at the earlier stages under different levels of the switching cost.[13]

2.1 Players and information

Loan applicants have heterogeneous type $\theta \in \Theta = \{G, B\}$. It is common knowledge that a fraction ϕ of the borrowers are low risk (G), while the complementary fraction $1 - \phi$ are high risk (B). G stands for 'good loan applicant' and B for 'bad loan applicant'. Both types have access to an investment opportunity, the implementation of which requires external finance equal to $k = 1$. Banks, in turn, have unlimited access to frictionless financial markets where they can borrow and lend at the rate $\bar{R}$. Both banks and loan applicants are risk neutral. A high (low) risk borrower succeeds in his project with probability π_B (π_G) and fails with probability $1-\pi_B$ ($1-\pi_G$). If successful, the value of the output generated by either a high or a low risk project is q. If a project fails, it produces nothing. Since we assume that $\pi_G > \pi_B$, a low risk loan applicant is better than a high risk borrower in terms of the first-order stochastic dominance. Moreover, it is assumed that $\pi_G q > \bar{R} > \pi_B q$, which means that it is efficient to finance good borrowers but not the bad ones. The average success probability is denoted by $\bar{\pi} \equiv \pi_G \phi + \pi_B (1 - \phi)$. We assume that $\bar{\pi} q > \bar{R}$, so that it is *ex ante* efficient to grant a loan.

Each loan applicant has a pre-existing customer relationship to the most preferred bank, the *insider bank*. The insider lender has access to '*soft* 'or *'tacit'* information[14] that is not available to other banks. This information

[12] This assumption simply guarantees that the borrower can arrange a competitive bidding game at the cost c.

[13] A truly dynamic model is needed if, for instance, one wants to analyze how the evolution of private information during the lending relationship affects the duration of the relationship or client's incentive to seek alternative financiers (cf. Greenbaum et al,1989). However, empirical studies by Elsas (2005) and Cole (1998) indicate that the lenght of the relationship seems rather unimportant in terms of available relationship benefits.

[14] We note that 'soft information' is assumed to be non-verifiable in nature, so that the insider bank cannot gain by reselling it. The casual observation that banks do not typically outsource the screening of SMEs lends support to this view.

serves as a signal, $s \in S = \{b, g\}$, about the quality of the borrower's current project. However, the signal is 'noisy' in the sense that it reveals the borrower's true type only with certain probability. Formally,

$$\begin{aligned} \Pr(g \mid G) &= p_g, \ \Pr(g \mid B) = 1 - p_g, \\ \Pr(b \mid B) &= p_b, \ \Pr(b \mid G) = 1 - p_b. \end{aligned}$$

We assume that the signal is equally accurate in both cases; ie, $p_g = p_b \equiv p$. Without loss of generality, we also assume that $p \in \left(\frac{1}{2}, 1\right]$.[15] The outsider banks only know the *common prior*; ie the distribution $\Phi = \{\phi, 1-\phi\}$ over the set Θ. A fraction $\lambda = p\phi + (1-p)(1-\phi)$ of the loan applicants sends a signal g. Correspondingly, a fraction $1 - \lambda = p(1-\phi) + (1-p)\phi$ a signal b. By Bayes' rule, we derive

$$\xi_g \equiv \frac{p\phi}{\lambda} \text{ and } \xi_b \equiv \frac{p(1-\phi)}{1-\lambda}, \tag{2.1}$$

where ξ_g (ξ_b) is the probability of a project being good (bad) given a signal $s = g$ ($s = b$). Moreover, we require that the noisy signal is 'informative' in the following sense:

$$\left(\xi_g \pi_G + \left(1 - \xi_g\right) \pi_B\right) q > \bar{R} \text{ and } \left(\xi_b \pi_B + \left(1 - \xi_b\right) \pi_G\right) q < \bar{R}. \tag{2.2}$$

According to (2.2), the number of G-types erroneously identified with signal b is sufficiently low in order for the insider bank to be able to separate a pool of 'bad customers' among whom the average project has a negative net present value; ie it is efficient to finance projects with signal $s = g$ but not with $s = b$. In the Appendix we analyze the opposite case, where the signal s is 'idle' in the sense that so many G-types become erroneously identified with signal b that even in the pool of borrowers with signal b the average project has a non-negative net present value.

2.2 Sequence of moves

We now postulate the following sequential structure.

Stage 1:

A borrower first applies loan from the insider bank and sends a signal s transmitting information about his type. The signal is correct with probability p.

Stage 2:

Based on the signal $s \in S = \{b, g\}$, the insider bank either proposes a loan rate offer R_I^s to the loan applicant in a take-it-or-leave-it manner or rejects the applicant and refuses to make any offers.

[15] Note that a signal $p - x$ is equally valuable as the signal $p + x$. In the extreem case, if $p = 0$, then the insider bank knows that the signal is wrong for sure, which is as good information as having $p = 1$. The assumption that $p > \frac{1}{2}$ merely indicates that the signal is strictly better than just a flip of a coin.

Stage 3:

A borrower who could not trade with the insider bank may send applications to other banks, arrange a bidding game and be ready to switch banks. This option incurs a fixed switching cost, c. A strictly positive fraction of the switching cost is realized already at the time of applying loans form outsider banks.[16] If the switching option does not seem economically feasible, the borrower simply leaves the investment opportunity and drops out from the credit market.

Stage 4:

In a bidding game, the outsider banks place bids according to the updated, *posterior beliefs* about the quality of the project. By Bertrand argument, the lowest loan rate offer in the bidding game is given by

$$R^* = \frac{\bar{R}}{\mu\pi_G + (1-\mu)\,\pi_B}, \tag{2.3}$$

where μ is the posterior probability that the loan applicant is of type G.

Regarding the insider bank's loan rate offer R_I^s at stage 2, we have the following lemmas:

Lemma 2.1 *If the insider bank chooses to propose a loan rate offer, it will not be conditional upon the signal $s \in S = \{b, g\}$; ie $R_I^b = R_I^g \equiv R_I$.*

Proof. See Appendix A.1. ■

Lemma 2.2 *The insider bank's loan rate offer is given by*

$$R_I = \min\{q, \frac{c}{\pi_G} + R^*\}. \tag{2.4}$$

Proof. See Appendix A.2. ■

Thus the insider bank's action set can be defined as $\Omega = \{y, n\}$, where y stands for 'yes, the insider bank is willing to trade at rate R_I', while n stands for 'no trading'. A strategy profile of an insider bank prescribes conditional probabilities $F = \{f_b, f_g\}$ over action 'y' in the set Ω; ie f_b (f_g) is the probability that the insider bank proposes a loan rate offer R_I having observed $s = b$ $(s = g)$. Given the strategy profile, insider bank's profits are given by

$$V = \lambda f_g v_g + (1-\lambda)\, f_b v_b,$$

where

$$v_g = \left(\xi_g\pi_G + \left(1-\xi_g\right)\pi_B\right) R_I - \bar{R} \text{ and } v_b = \left(\xi_b\pi_B + (1-\xi_b)\,\pi_G\right) R_I - \bar{R}, \tag{2.5}$$

are the expected profits available from trading with borrowers who signal $s = g$ and $s = b$ respectively.

[16] These *ex ante* switching expenses can be thought to result from the effort of locating suitable replacement lenders and the cost of writing new applications. This assumption is convenient as we prove the existence of an equilibrium that features the postulated sequential structure.

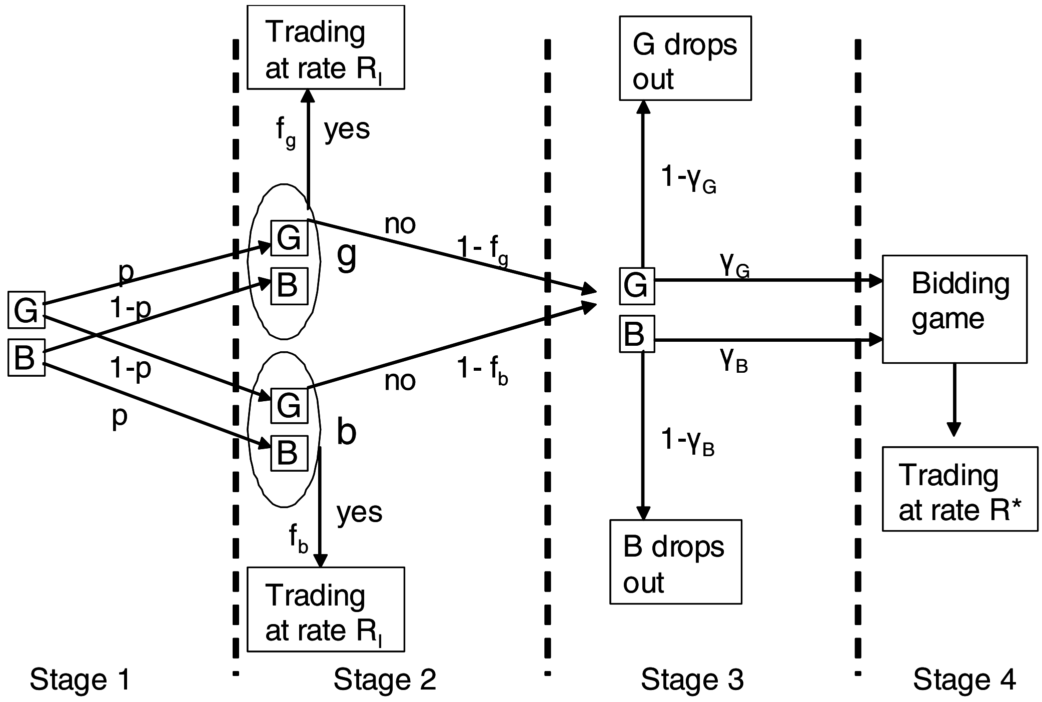

Figure 1: Sequence of moves

At stage 3, rejected borrowers decide whether to organize a bidding game or drop out. Their decision is driven by the following individual rationality constraints:

$$\pi_B (q - R^*) - c \geq 0, \qquad (\text{IR}^r_B)$$
$$\pi_G (q - R^*) - c \geq 0. \qquad (\text{IR}^r_G)$$

The probability that a loan applicant of type i stays in the market and applies loan from outsider banks is denoted by γ_i, $i = B, G$. The pair $\Gamma = \{\gamma_B, \gamma_G\}$ prescribes the 'participation profile' of rejected loan applicants at stage 3. If IR^r_i holds with strict inequality, then the borrower of type i stays in the market and arranges a bidding game with probability one; ie $\gamma_i = 1$. If IR^r_i holds with equality, the probability of participation is then given by $\gamma_i \in [0, 1]$. If IR^r_i is not satisfied, then $\gamma_i = 0$. Note that IR^r_B is stricter than IR^r_G, so that the B-types drop out from the market more easily than the G-types.

If a bidding game takes place, at stage 4, the competing bidders infer that 1) the insider bank has not made an acceptable offer to the particular loan applicant (*informational spillover*) and that 2) at least one of the individual rationality constraints, IR^r_B or IR^r_G, holds. Hence, the posterior probability μ that the loan applicant is of type G is obtained by using Bayes' rule, given the insider bank's equilibrium strategies $F = \{f_b, f_g\}$ and borrowers' willingness to stay in the market $\Gamma = \{\gamma_B, \gamma_G\}$.

Figure 1 illustrates the model's sequential structure and possible actions of each player.

2.3 Equilibrium analysis

Definition 2.3 *A perfect Bayesian equilibrium (PBE) is the insider bank's strategy profile* $F^* = \{f_b^*, f_g^*\}$*, rejected loan applicants participation profile* $\Gamma^* = \{\gamma_B^*, \gamma_G^*\}$*, outsider banks' posterior belief* μ^**, and the loan rates* $R^*(\mu^*)$ *and* R_I *such that (i)*

$$F^* \in \arg \max_{f_b \in [0,1], f_g \in [0,1]} V\left(f_b, f_g, R_I\left(R^*\left(\mu^*\right)\right)\right),$$

(ii)

$$\begin{aligned} \gamma_i^* &= 1, \text{ if } \pi_i (q - R^*) - c > 0, \\ \gamma_i^* &\in [0,1], \text{ if } \pi_i (q - R^*) - c = 0, \\ \gamma_i^* &= 0, \text{ if } \pi_i (q - R^*) - c < 0. \end{aligned}$$

(iii) the equilibrium posterior beliefs are obtained by Bayes' rule, when applicable, and (iv) the loan rates $R^*(\mu^*)$ *and* R_I *are determined by* (2.3) *and* (2.4) *respectively.*

Proposition 2.4 *A PBE defined in Definition 1 that features the sequential structure described in Section 2.2 exists.*

Proof. See Appendix A.3. ■

Usually a model with sequential moves is solved by backward induction starting from the final stage of the game. This time, however, it is convenient to start with a result concerning the insider bank's optimal strategies at stage 2. After that we jump to the stage 4 and proceed backwards.

Lemma 2.5 *Given the assumption of 'informative' signals in* (2.2)*, insider bank's optimal strategies are represented by* $F^* = \{f_b^*, f_g^*\} = \{0, 1\}$.

Proof. See Appendix A.4. ■

Thus the insider bank proposes loan contract offers only to those applicants sending a signal $s = g$, and rejects applicants identified with $s = b$. At stage 4, outsider banks' posterior belief μ depends on the insider bank's optimal strategies, which we now know to be given by $F^* = \{f_b^*, f_g^*\} = \{0, 1\}$, and rejected loan applicants' participation profile $\Gamma = \{\gamma_B, \gamma_G\}$. By Bayes' rule, we obtain

Lemma 2.6 *The outsider banks' equilibrium posterior belief* μ^* *is updated according to:*

$$\mu^* = \frac{\gamma_G (1-p)\phi}{\gamma_G (1-p)\phi + \gamma_B p (1-\phi)}. \tag{2.6}$$

Proof. See Appendix A.5. ■

The lowest bid in a bidding game, the competitive loan rate $R^*(\mu^*)$, is then determined by (2.3). At stage 3, rejected borrowers decide upon their continuation in the loan market. Given $R^*(\mu^*)$ and assumption (2.2), it is easy to see that full participation is not feasible. If $\Gamma = \{\gamma_B, \gamma_G\} = \{1, 1\}$, then $\mu^* = 1 - \xi_b$, so that

$$R^*(\mu^*) = \frac{\bar{R}}{(1-\xi_b)\,\pi_G + \xi_b \pi_B} > q.$$

Hence, neither IR_B^r nor IR_G^r is satisfied; ie full participation cannot be an equilibrium participation profile Γ^*. Since IR_B^r is stricter than IR_G^r, the B-types drop out from the market more easily than the G-types. Our next candidate for equilibrium participation profile is $\Gamma = \{0, 1\}$; ie all the B-types drop out while the G-types stay in the market. Given $\Gamma = \{0, 1\}$, $\mu^* = 1$ and $R^*(\mu^*) = \bar{R}/\pi_G$. $\Gamma = \{0, 1\}$ is consistent with the equilibrium beliefs and the equilibrium competitive loan rate only if IR_G^r is satisfied while IR_B^r is not. This is the case if

$$\pi_B(q - \frac{\bar{R}}{\pi_G}) < c \le \pi_G q - \bar{R}.$$

We define

$$c_1 \equiv \pi_B(q - \frac{\bar{R}}{\pi_G}) \text{ and } c_2 \equiv \pi_G q - \bar{R}. \tag{2.7}$$

Given $\Gamma^* = \{0, 1\}$, μ^* and $R^*(\mu^*)$, $\Gamma^* = \{0, 1\}$ is the equilibrium participation profile if the switching cost satisfies $c \in (c_1, c_2]$. If $c > c_2$, the cost of switching banks is so high that even the G-types prefer quitting to arranging a bidding contest; ie $\Gamma^* = \{0, 0\}$ for $c > c_2$.

If $c \in (0, c_1]$, the IR_B^r has to be binding, ie the B-types are indifferent between applying loans from outsider banks and dropping out. Then the participation profile is given by $\Gamma = \{\gamma_B, 1\}$ where $\gamma_B \in (0, 1)$. IR_B^r holding with equality implies that the equilibrium competitive loan rate satisfies

$$R^*(\mu^*) = q - c/\pi_B. \tag{2.8}$$

A bid slightly above this offer cannot be an equilibrium competitive loan rate because then only the G-types would participate and some bidder could gain by undercutting the loan rate offer. However, the equilibrium competitive loan rate cannot be any lower either because then IR_B^r would hold with strict inequality, so that all the B-types would participate and the winning bidder would make losses. μ^* can then be solved by equating (2.3) and (2.8) to obtain

$$\mu^* = \frac{\pi_B\left(\bar{R} - \pi_B q + c\right)}{(\pi_G - \pi_B)(\pi_B q - c)} \equiv \tilde{\mu}(c). \tag{2.9}$$

The B-type's equilibrium participation rate γ_B^* can then be determined by (2.6) to yield

$$\gamma_B^* = \frac{1-\mu^*}{\mu^*}\frac{(1-p)\,\phi}{p\,(1-\phi)} = \frac{\pi_G(\pi_B q - c) - \pi_B \bar{R}}{\pi_B\left(\bar{R} - \pi_B q + c\right)}\frac{(1-p)\,\phi}{p\,(1-\phi)} \equiv \tilde{\gamma}(c). \tag{2.10}$$

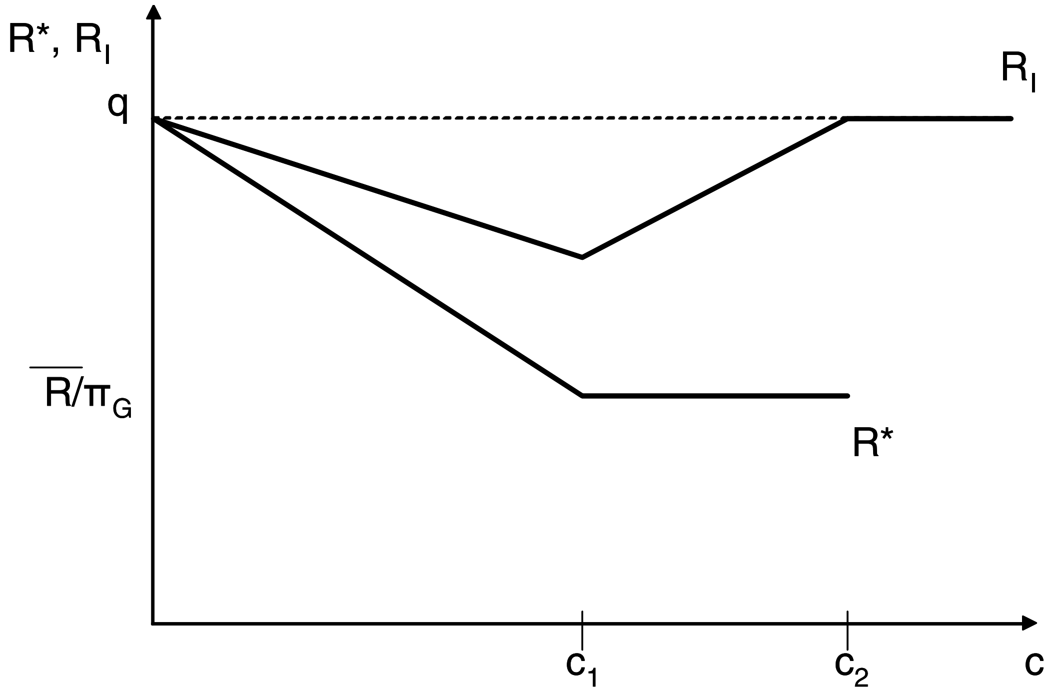

Figure 2: Equilibrium loan rates

Finally, the equilibrium loan rate offer by the insider bank at stage 2 is given by (2.4).

In summary,

Proposition 2.7 *PBE with informative signals is characterized by the 5-tuple*

$$\{F^*, \Gamma^*, \mu^*, R^*, R_I\}$$

such that $F^* = \{0,1\}$ $\forall c$ *and* $\forall c \in [0, c_1]$

$$\Gamma^* = \{\tilde{\gamma}(c), 1\}\,,\ \mu^* = \tilde{\mu}(c),\ R^* = q - \frac{c}{\pi_B} \text{ and } R_I = q - \frac{(\pi_G - \pi_B)\,c}{\pi_G \pi_B},$$

$\forall c \in (c_1, c_2]$

$$\Gamma^* = \{0,1\}\,,\ \mu^* = 1,\ R^* = \frac{\bar{R}}{\pi_G} \text{ and } R_I = \frac{\bar{R} + c}{\pi_G}.$$

For $c > c_2$, $\Gamma^* = \{0,0\}$ *so that no bidding games take place and*

$$R_I = q.$$

Figure 2 illustrates the equilibrium loan rates R_I and R^* as functions of the switching cost, which is also our index for insider bank's monopoly power. When the market is competitive, ie c is relatively low, the lowest loan rate at the bidding game has to be quite high in order to induce a sufficient number of B-types to drop out. In a sense, threat of adverse selection curtails price competition when the switching cost is low. The adverse selection effect, however, gradually fades away as the magnitude of the switching cost increases since ever greater fraction of the B-types drop out from the market. As a result, the competitive loan rate decreases. This logic continues until the threshold c_1 is reached. For $c > c_1$, the bidders know that all the remaining loan applicants have to be G-types, so that the equilibrium competitive loan rate is given by the constant $R^* = \bar{R}/\pi_G$. If the switching cost is very high, ie $c > c_2$, even the G-types choose to quit the market and no bidding games take place. Even though larger c increases the insider bank's mark-up, c/π_B, it nevertheless decreases the highest possible loan rate R_I due to the reduction in R^*. This holds until $c = c_1$, after which R^* remains constant and greater switching cost only contributes to the insider bank's mark-up. When $c > c_2$, there is no outside option available for the loan applicant and the insider bank can charge $R_I = q$ and keep all the surplus.

Note that insider bank's profits follow a similar pattern as the loan rate R_I with respect to c. Hence, insider bank's profits are a non-monotonous and 'V-shaped' function of the switching cost. Insider banks thus make highest profits under the extreme market structures; ie when the switching cots is very low or when it is sufficiently high.

3 The 'dynamic implication' of the model

In this section we will analyze the implication of our static model on insider bank's incentive to form new lending relationships. Petersen and Rajan argue that the greater is the insider bank's ability to extract surpluses at the later stages of the relationship the stronger is the bank's incentive to extend credit to new customers. Since they assume that greater market concentration implies higher profits, Petersen and Rajan conclude that relationship formation should be more extensive under concentrated than competitive market structures. However, based on their own empirical evidence, this logic seems to work only in the case of very young firms; ie with firms younger than four years. As noted by Cao and Shi (2001), it is surprising that the cross-subsidization does not emerge in the category of firms that are neither very young nor old, since these firms typically possess strong growth potential but whose survivorship is not that uncertain any more. Our study provides a theoretical explanation for this anomaly. We use the magnitude of the switching cost to measure the monopoly power of a relationship lender. We find that the benefits from relationship lending (insider bank's profits) are a non-monotonous and V-shaped function of this index. The recent empirical evidence in Elsas (2005) supports the V-shaped pattern. Elsas reports that the likelihood of having a 'Hausbank relationship' *decreases* as bank concentration in local debt markets increases. Also Table II in Petersen and Rajan's (1995, p. 423) own study indicates a tendency for a V-shaped relationship between insider bank's market power and the availability of credit for firms older than five years.

One might wonder why the V-shaped pattern does not emerge in the category of very young firms. A potential explanation for this is that there might not be very accurate private information available about the future survivorship of young start-ups. In the Appendix B we elaborate the case where the informational advantage of the insider bank is not very significant. We find that in the case of 'idle signals' relationship benefits tend to be low under competitive markets. Hence, the accuracy of the private information is an essential element in the building of the customer lock-in. In accordance with Petersen and Rajan's (1995) reasoning, lowering profits, in turn, reduce credit availability at the early stages of the lending. Moreover, in Petersen and Rajan's (1995) data, the relationship between the prevalence of institutional debt and market concentration seems to exhibit an 'inverted V-shape' in the category of relatively old (over 32 years) firms; ie firms with institutional debt are more frequent under intermediate market structures than under competitive or concentrated markets. This observation could be explained by the plausible assumption that mature firms are less dependent on bank debt than younger firms; ie they may have easier access to arms' length finance or financial markets.[17] In other words, older firms have a wider array of outside options than the young firms. The more a bank tries to extract surpluses from the firm the greater is the likelihood that the firm rather resorts to some alternative sources of finance. Therefore the V-shaped profit function of the insider bank can be consistent with the inverted V-shaped pattern of the prevalence of bank debt among mature firms.

4 Adverse selection and competition

The measure for adverse selection in our model consists of two components: Firstly, some of the B-types are erroneously identified with signal g and they get finance directly from their insider bank. This measure equals to $\lambda\left(1-\xi_g\right)=(1-p)(1-\phi)$. Secondly, for $c \le c_1$, some of the initially rejected B-types can seek finance via bidding games. The equilibrium measure for this category is $\tilde{\gamma}(c)$ given in (2.10). Combining these two components gives us the overall measure for adverse selection as a function of the switching cost (see Figure 3):

$$A(c)=(1-p)(1-\phi)+\tilde{\gamma}(c).$$

Obviously, adverse selection is more common when market the switching cost is low than when it is high. The second channel of adverse selection (some of the B-types get finance via bidding games) is decreasing in c and eventually vanishes completely for $c > c_1$, because all the B-types rather drop out than pay the switching cost. What remains is the first channel; ie some of the B-types are erroneously identified as good borrowers and get finance from the insider bank. Note that the probability of adverse selection through the first channel is $(1-p)(1-\phi)$, which is the smaller the greater is the accuracy of the signal (the larger is p). Moreover, since no bidding games will take place for $c > c_2$, those G-type customers who were erroneously identified as bad loan applicants by the insider bank will not get finance at all. Hence, there will

[17] Rajan (1992) argues that firms use arm's length finance in order to limit bank's bargaining power over their profits.

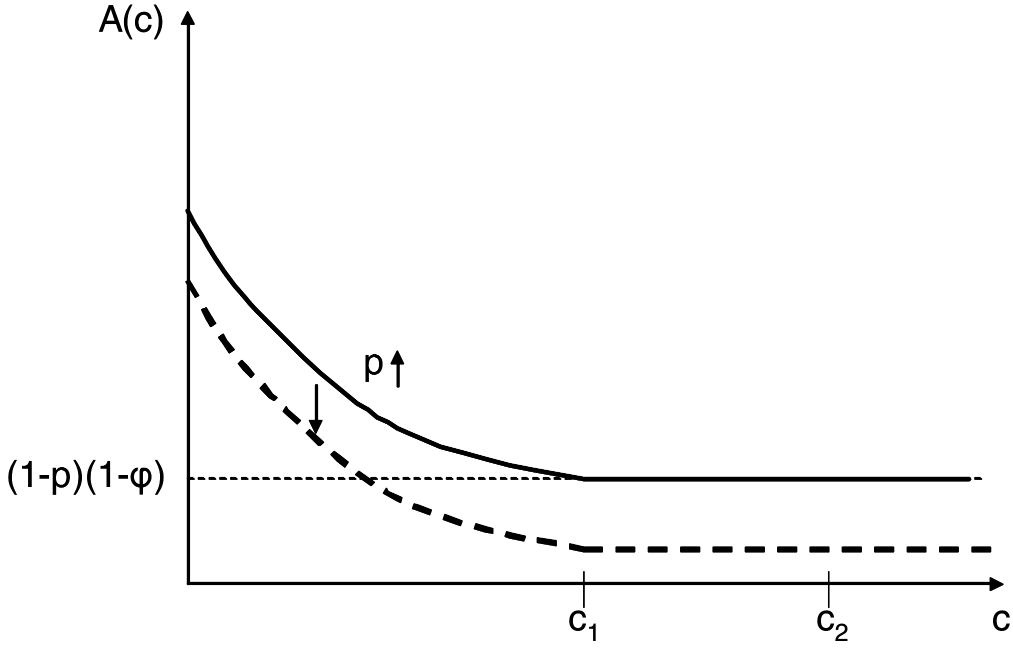

Figure 3: Extent of adverse selection

be credit rationing in the sense that not all the viable projects get finance. The measure for credit rationing under very concentrated market structures $(c > c_2)$ is given by $(1 - \lambda)(1 - \xi_b) = (1 - p)\phi$.

Our model thus produces new aspects to the discussion about the relationship between banking competition and the efficiency of resource allocation. Broecker (1990), Nakamura (1993) and Riordan (1993) – who study how competition in credit markets affects the adverse selection problem – identify a winner's curse type distortions of competition. If banks' project evaluation technologies are imperfectly correlated and if lenders cannot observe whether a loan applicant has already been rejected elsewhere, the likelihood that a poor applicant gets finance increases as the number of banks operating in the market is higher. As a result, competition is likely to worsen adverse selection and damage the efficiency of resource allocation. Our model with insider information and switching cost supports this view in the sense that adverse selection problem is most prevalent under competitive markets. On the other hand, we conclude that the allocation of financial resources is most efficient under some intermediate level of competition. This is because the extent of adverse selection remains constant for $c > c_1$, but further increase in the switching cost, ie $c > c_2$, gives rise to another source of inefficiency, namely excess credit rationing. However, if one thinks that the insider bank can invest in information acquisition, the 'V-shaped' profit function indicates the marginal benefit from more accurate private information is higher under the extreme levels of the switching cost than under the intermediate degrees of competition. More efficient information acquisition could thus counterbalance the efficiency losses due to adverse selection in competitive credit markets.

5 Conclusions

We construct a model on relationship lending where the cost of switching banks measures the degree of competition in the credit market. Besides the switching cost, customer lock-in is essentially driven by relationship lender's informational advantage compared to outsider lenders. We show that higher switching cost, which can be thought to reflect greater concentration in local credit markets, does not necessarily lead to higher equilibrium profits in relationship lending. Adverse selection problem curtails price competition when the switching cost is low by discouraging outsider banks to make too aggressive bids. Threat of adverse selection gradually fades away as the cost of switching banks increases, which *de facto* reduces insider bank's profits. However, lack of competition starts to dominate for sufficiently high levels of switching cost, so that insider bank's profits become increasing in this cost. We thereby document a 'V-shaped' relationship between insider bank's profits and the switching cost. The 'dynamic implication' of this pattern is that relationship formation should be most frequent under the extreme market structures; ie when the switching cost is very low or when it is sufficiently high.

Our finding runs counter to the Petersen-Rajan (1995) argument that competition is generally detrimental to relationship lending. The V-shaped pattern, however, is supported by recent empirical evidence in Elsas (2005) and, to some extent, in Kim et al. (2004). A clear tendency for a V-shaped relationship between availability of institutional debt and relationship lender's market power also arises in the empirical part of Petersen and Rajan's (1995) own study. This is the case especially in the category of firms older than five years. The reason why the similar tendency does not emerge in start-up financing is probably because insider lender's informational advantage is not very pronounced in that category. If the model is solved assuming sufficiently inaccurate private information by the insider lender (the case of idle signals' is analyzed in the Appendix B), infinitesimal switching cost (= intense competition) is shown to lead to low profits and no clear-cut V-shaped relationship arises.

We also find that allocation of financial resources is most efficient under intermediate market structures: low switching cost tends to augment adverse selection problem, while some of the 'good' loan applicants are left without finance when the cost of switching banks is sufficiently high. However, if insider banks can invest in the accuracy of private information, the incentive to acquire information is stronger when the expected benefits from relationship lending are higher. Therefore more efficient information acquisition can potentially counterbalance the inefficiencies in resource allocation when the switching cost is either very low or high.

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Appendix

A. Proofs

A.1 Proof of Lemma 2.1

Proof. Since $\pi_G q > \bar{R} > \pi_B q$, the insider bank wants to make sure that at least the G-types are willing to trade at the proposed loan rate offer. If this was not the case and the offer attracted only the B-types to trade, the insider bank would make losses. Thus, if the insider bank chooses to propose an offer, it is the highest possible loan rate that still induces at least the G-types to trade – regardless of the signal. ■

A.2 Proof of Lemma 2.2

Proof. The borrower is willing to trade with the insider bank only if the offer gives him at least as much utility as applying loans from outsider banks, arranging a bidding game and ultimately switching customership. Hence, the following bunch of individual rationality (IR) and incentive compatibility (IC) constraints has to be satisfied:

$$\pi_B (q - R_I) \geq 0, \quad (\text{IR}_B)$$
$$\pi_G (q - R_I) \geq 0, \quad (\text{IR}_G)$$
$$\pi_B (q - R_I) \geq \pi_B (q - R^*) - c, \quad (\text{IC}_B)$$
$$\pi_G (q - R_I) \geq \pi_G (q - R^*) - c. \quad (\text{IC}_G)$$

Both IR_B and IR_G are equally binding; ie $R_I \leq q$, but IC_G is stricter than IC_B, implying that it is more difficult for the insider bank to induce the G-type to trade; ie, a loan contract offer that is accepted by the G-type will also be accepted by the B-type. Hence the relevant constraints restricting the insider bank's pricing strategy are IR_G $(=\text{IR}_B)$ and IC_G. Since V is linear in the proposed loan rate, the insider bank wants to set as high R_I as possible. Hence the insider bank's loan rate offer is the minimum of R_Is that make IR_G and IC_G binding; ie $R_I = \min\{q, \frac{c}{\pi_G} + R^*\}$. ■

A.3 Proof of Proposition 2.4

Proof. Under the sequential practice, a G-type can trade with the insider bank with probability p and is left with the option to arrange a bidding game with probability $1 - p$. A deviation would mean sending applications immediately also to outsider banks. Given the equilibrium loan rates R_I and $R^* (\mu^*)$, trading with the insider bank produces a G-type the same utility level that is available from arranging a bidding game, trading with an outsider bank and paying the switching cost. Hence, a G-type is indifferent between obeying the sequential structure and deviating. Therefore we may say that no G-type will ever deviate. On the other hand, a B-type strictly prefers the sequential practice to deviation because it involves a chance of being erroneously identified as a G-type. Hence, there is no point for the B-type to pay the part of the switching cost that is realized immediately before it is clear that he cannot trade with the insider bank. Regarding the behaviour of insider banks, we note that they must prefer sequential structure because that guarantees them a 'mark-up' c/π_G with probability one. Moreover, a deviation where the insider bank rejects the loan applicant but participates in the bidding game is trivial because at that point all the bidders are anyhow equally well informed thanks to the informational spillover arising from the initial rejection of the loan applicant. ■

A.4 Proof of Lemma 2.5

Proof. Since by limited liability $R_I \leq q$, trading with borrowers sending a signal $s = b$ incurs losses. Therefore it would be rational to trade with those loan applicants only if such practice somehow increased the profits available from trading with those who signal $s = g$. This would happen if choosing $f_b^* > 0$ affected the outsider banks beliefs in such a way that $R^*(\mu^*)$ would increase, so that the insider bank could also charge a higher R_I. However, if $f_g^* = 1$, choosing $f_b^* > 0$ would not affect the posterior beliefs at all. If $f_g^* \in (0,1)$, then $f_b^* > 0$ would reduce the fraction of 'bad customers' among the rejected loan applicants, so that the posterior μ^* would be higher. Since $R^{*\prime}(\mu^*) < 0$, choosing $f_b^* > 0$ would unambiguously reduce the profits avaialble form trading with borrowers who signal $s = g$. The trivial case $f_g^* = 0$ and $f_b^* > 0$ is not feasible, since there would be not positive profits counterbalancing the losses incurred by trading with borrowers signalling $s = b$. Therefore we must have $f_b^* = 0$.

Refraining from financing some loan applicants who signal $s = g$ would not make sense either because that practice would only improve the average quality of rejected applicants. As a result, the posterior μ^* would again be higher and the insider bank's profits lower. Thus it is optimal to choose $f_g^* = 1$. ■

A.5 Proof of Lemma 2.6

Proof. Given insider bank's optimal strategies $\digamma^* = \left\{f_b^*, f_g^*\right\} = \{0,1\}$, the total measure for rejected loan applicants is $1 - \lambda = p(1-\phi) + (1-p)\phi$, which equals the measure for borrowers who send a signal b. The fraction of B- and G-types among the rejected loan applicants are $\xi_b(1-\lambda) = p(1-\phi)$ and $(1-\xi_b)(1-\lambda) = (1-p)\phi$ respectively. Given the participation profile $\Gamma = \{\gamma_B, \gamma_G\}$, the total measure of rejected loan applicants who stay in the market is $\gamma_B p(1-\phi) + \gamma_G(1-p)\phi$. Bayes' rule then produces the formula in (2.6). ■

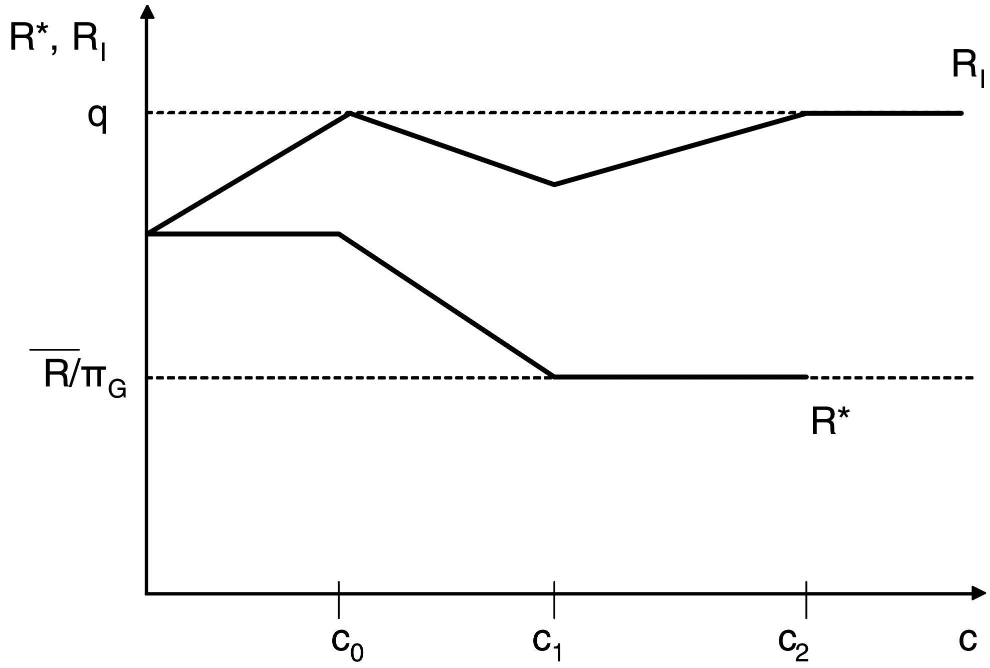

Figure 4: Equilibrium loan rates with 'idle' signals

B. Equilibrium with 'idle' signals

Signals being 'idle' means that so many G-types become erroneously identified with signal b that even in the pool of borrowers with signal b the average project has a non-negative net present value; ie

$$\left(\xi_g \pi_G + \left(1 - \xi_g\right) \pi_B\right) q > \bar{R} \text{ and } \left(\xi_b \pi_B + (1 - \xi_b) \pi_G\right) q \geq \bar{R}. \tag{5.1}$$

This fact implies that trading with any borrower would generate non-negative profits to the insider bank. Thus, in principle, the insider bank would gain by extending credit to any loan applicant, regardless of the signal. But if the equilibrium strategies were $f_g = f_b = 1$, then Bayes' rule would have no bite because bidding games would become a 'zero-probability event' and the posterior beliefs could be any distribution over the set Θ.

Unique beliefs can, however, be obtained by the following reasoning. Firstly, the insider bank knows that the more the posterior distribution weights low-quality borrowers (ie the lower is μ) the easier it is to induce the G-types to accept the proposed offer. This objective is reached if all rejected loan applicants are those identified with signal b. Thus we have $f_g^* = 1$, but $f_b^* \in [0, 1)$. The fact that trading with a borrower who sends a signal g produces higher profits than trading with a borrower who sends a signals b also supports this strategy. Secondly, since trading also with borrowers sending signal b makes profits, the insider bank wants to set f_b^* to approach unity; ie $\digamma^* = \left\{f_b^*, f_g^*\right\} = \{1 - \varepsilon, 1\}$ where ε is a strictly positive but infinitesimal number. Hence, given the optimal strategies $\digamma^* = \{1 - \varepsilon, 1\}$, the posterior beliefs are updated according to (2.6) and the competitive loan rate $R^*(\mu^*)$ is then determined by (2.3).

Equilibrium with 'idle' signals differs from the case of 'informative' signals in only one respect: Full participation among the rejected loan applicants, ie $\Gamma = \{1, 1\}$, is now feasible for sufficiently low levels of market concentration. $\Gamma^* = \{1, 1\}$ implies $\mu^* = 1 - \xi_b$ and $R^* = \bar{R}/\left[(1-\xi_b)\,\pi_G + \xi_b \pi_B\right] < q$, which are consistent with IR_B^r holding with strict inequality if

$$c < \pi_B(q - \frac{\bar{R}}{(1-\xi_b)\,\pi_G + \xi_b \pi_B}) \equiv c_0.$$

Otherwise, for $c \geq c_0$, Γ^*, μ^*, R^* and R_I, are determined by the same rules as in the case of 'informative' signals within the intervals $c \in [c_0, c_1]$, $c \in (c_1, c_2]$ and $c \in [c_2, \infty)$.

Figure 4 illustrates equilibrium loan rates R_I and R^* as functions of c. The loan rate function R_I now features, as well as the profit function would, 'double kinks'. When $c < c_0$, all rejected loan applicants stay in the market and the average quality of projects seeking finance via bidding games is constant and greater search cost only contributes to the insider bank's mark-up. However, for $c \geq c_0$, an ever increasing number of B-types start dropping out from the credit market and competing bidders are able to make more aggressive bids. As a result, also the insider bank needs to cut its loan rates as the switching cost increases. Hence, we have the first 'kink' at $c = c_0$. The second 'kink' at $c = c_1$ is due to the same reason as in the case of informative signals: For $c \geq c_1$, all the bad customers have dropped out, R^* remains constant and greater switching cost again only boosts the insider bank's mark-up.

Note that under 'idle' signals the extent of adverse selection in the credit market does not depend on market concentration. Since $f_b^* = 1 - \varepsilon$ such that $\varepsilon \to 0$, practically every loan applicant – irrespective of the signal – gets finance from the insider lender. As a result, the measure for adverse selection is simply a constant $1 - \phi$, which is the total fraction of bad customers in the market.

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