Nondiscriminating Foreclosure and Voluntary Liquidating Costs

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Since liquidation and bankruptcy are costly, researchers have tried to find out why the claimants of a troubled firm do not work out a deal to avoid these costs. In this article we show that if a creditor has to deal with multiple borrowers who might default, it may be optimal for the creditor to randomly reject requests for a loan workout. We further demonstrate that the optimal acceptance rate used by a creditor is positively related to the liquidating cost and negatively related to the default benefit. Our model is particularly relevant when analyzing the default decisions of mortgage borrowers and small business owners.

An important question in finance is why liquidation should occur when bankruptcy imposes costs on both lenders and borrowers. In the presence of significant bankruptcy and liquidating costs, avoiding bankruptcy would be in the best interests of a firm's claimants. Haugen and Senbet (1978) argue that when a firm defaults on a debt payment, as long as it is costly for debt holders to collect the payments, the debt holders should offer to reduce the debt claim in order to avoid the costs associated with bankruptcy. Under this argument, liquidation should occur only if the market value of dismantled assets exceeds the value of the ongoing firm.

However, Bulow and Shoven (1978) point out that liquidation may occur because there is a conflict of interest among a firm's various claimants and/or an asymmetry in their information and negotiating positions. Giammarino (1989) argues that it might be rational for firms to incur significant costs in the resolution of financial distress. Assuming that managers of a firm are better informed than debt holders about the asset value of the firm (or the

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likely outcome of a valuation hearing on the value of the firm), Giammarino points out that in certain circumstances, debt holders would rather appeal to a costly arbitrator than to the equity holder to present an appropriate reorganization.

Gertner and Scharfstein (1991) develop a model addressing the coordination problems among debt holders in a workout situation. They point out that when there is a group of creditors, each bears the cost of a concession but shares the benefits with other creditors. This free-rider problem reduces the incentive for a creditor to grant concessions to a distressed firm.

Chemmanur and Fulghieri (1994) believe that a bank's reputation for making a correct renegotiation versus liquidation decision is important to borrowers. They argue that borrowers should be willing to pay a higher cost (interest rate) when they know that a debt holder is willing to devote additional resources to evaluate firms in financial distress. They also argue that banks should be more willing than holders of publicly traded debt to work out a solution with a distressed borrower. Given this, firms with a higher probability of financial distress should choose bank loans over publicly traded debt (bonds). Gilson, John, and Lang (1990) support this proposition. They report that firms that owe more of their debt to banks have a higher chance of restructuring.

Thus the literature indicates that it is difficult for debt and equity holders to work out a solution when a firm is in distress if (1) there is asymmetry in their information about the value of the firm, (2) there are a large number of lenders, and (3) the lender is not a bank. However, the massive mortgage foreclosures common in many real estate markets indicate that there might be factors other than those mentioned in the literature that affect default and liquidation decisions.

In the case of mortgage defaults, both the equity holder (the property owner) and the debt holder (the bank) should share similar information about property values.[1] This should minimize the problem of asymmetric information about the value of a firm as emphasized by Giammarino (1989). For most mortgage loans, a borrower only needs to deal with one debt holder (a bank), thus avoiding the coordination problem addressed by Gertner and Scharfstein (1991) and the type of lender problem discussed by Chemmanur and Fulghieri (1994). In other words, given the literature, a bank should be more likely to work out a solution with the mortgage borrower than to

[1] A borrower has to submit an independent appraisal report (which details the location and physical attributes of the property) to a bank when applying for a mortgage. Given this, both the lender and the borrower should share similar information about the physical attributes of the property. Since both the borrower and the bank will rely on similar market transaction data (comparable sales) and opinions of independent appraisers and brokers to estimate the value of property, the property value estimated by the borrower and the bank should not differ too much. In addition, Williamson (1988) indicates that one important determinant of liquidating value is asset redeployability. Shleifer and Vishny (1992) believe that commercial land can be used for many purposes. In the event that managers are unable to pay the debt, creditors can take the assets away and redeploy them. Because of redeployability, the value of a property rarely changes when the property changes ownership.

foreclose on the property in the case of a mortgage default. However, Riddiough and Wyatt (1994:299) observe that, in dealing with mortgage defaults, many lenders take a hard-line approach and are reluctant to grant workout concessions.

Riddiough and Wyatt (1994) develop a model in which a bank minimizes the total concessions given to borrowers by choosing whether to negotiate with a borrower. In their model, a bank knows the financial situation of all borrowers. The only information asymmetry between the bank and borrowers is the bank's foreclosure costs. Given this information asymmetry, some borrowers might not apply for a loan workout if they observe that the bank rejects the loan workout requests of other borrowers. (From the rejection, a borrower will interpret that the foreclosure cost of the bank is low.) Given this, a bank might reject the workout request of one borrower in order to reduce workout requests from other borrowers.

In this article we develop a model framework in which a bank has incomplete information about a borrower's default costs and borrowers may or may not be able to fully observe a bank's policies. We define two types of borrowers: (1) distressed borrowers who will default regardless of whether a bank is willing to negotiate and (2) nondistressed borrowers who might gain from a default (because the loan exceeds the property value) but who are inhibited because the cost of having a default record is high.[2] A bank cannot distinguish between these two types of borrowers without incurring a screening cost. Because it is costly for a borrower to start a negotiation with a bank, nondistressed borrowers will make a loan workout request only if they believe that there is a reasonable chance the bank will grant concessions. In other words, a borrower will not default if she/he knows for sure that a bank will screen or will reject her/his requests.

In our first model, we assume that borrowers can fully observe a bank's policies (such as screening rate and acceptance rate). In the second model, we assume that borrowers cannot observe a bank's policies. The result of our models in general indicate that when a bank cannot costlessly identify distressed borrowers, then its optimal policies could be a coexistence of workout and rejection decisions. Furthermore, if the screening cost is sufficiently high, it may be optimal for the bank to randomly reject workout requests with an optimal rejection rate in mind. We further show that a bank is more likely to adopt this random rejection policy if borrowers cannot observe a bank's

[2] The most obvious default cost is the loss of credit rating. If a borrower defaults on a mortgage, the borrower will not be able to borrow for the next seven years. It is very difficult for a bank to assess the monetary value on the loss of credit rating to a particular borrower because only the borrower knows her/his opportunity set. A more difficult piece of information to get is the monetary value of the pride of a particular person. While it does not matter to some people to have the stigma of not being able to repay her/his debt, it matters to others. Finally, if a bank knows that a borrower still owns a lot of assets or receives a high salary income, it is unlikely that the bank will negotiate. However, it is not easy for a bank to get all the information related to the current employment and asset ownership of a borrower, especially when the borrower is applying for a mortgage workout.

screening policies directly. We believe that the setting of our model is richer and is closer to the real-world situation than Riddiough and Wyatt's model.[3]

The conclusion of an optimal random policy is, in spirit, similar to that of the costly state verification models of Townsend (1979) and Mookherjee and Png (1989). Specifically, Mookherjee and Png find conditions for random audits of insurance claims or tax returns to be optimal verification strategies, while we find conditions for a random rejection policy to be optimal for a bank. To the best of our knowledge, within the default and restructuring literature, the setting and implications of our model are unique in two aspects.

First, previous models addressed the coordination and agency issues when a distressed firm faces multiple debt holders. Our model addresses the problems when one debt holder faces many potential defaulters. In this regard, our model is most relevant to an environment where a debt holder could face a large group of potential defaulters, as in a residential property market with falling prices or an economically depressed area with many small businesses.

Second, under certain conditions, we show that a debt holder will use a random strategy to handle a loan workout request. This implies that both workout and foreclosure are possible responses to any given workout request. It also indicates that a workout or foreclosure decision could be independent of the financial standing of an applicant.

The article is organized as follows. Section 1 motivates the model in terms of the issues arising in mortgage defaults and foreclosure decisions. Section 2 sets up the formal model. Sections 3 and 4 analyze a bank's optimal decisions when a bank's policies are observable and when they are not observable, respectively. Section 5 discusses the empirical implications of our model. The last section reports our conclusions and recommends areas for future research.

1. The Case of Mortgage Default

As a general practice, lenders use a target loan-to-value ratio to decide an appropriate mortgage amount for a borrower with a good credit history. However, even with prudent underwriting practices, localized recessions that reduce property values and employment opportunities can cause massive defaults, as evidenced in Texas in 1984 and in California in 1990. When borrowers are delinquent in their mortgage payments, lenders have to decide whether

[3] In Riddiough and Wyatt's model, there is only one type of borrower (the nondistressed borrower as defined in our model). Because there is only one type of borrower, a bank does not need to incur any costs to screen borrowers. It is also assumed that there is no cost for a borrower to request a workout. Furthermore, if a bank rejects a workout request, the bank will foreclose on the property automatically (although in reality some of the borrowers will not let this happen by making back payments to the bank). In our model, we have two types of borrowers (distressed and nondistressed) and a bank has to incur a screening cost to distinguish between these two types of borrowers. We also take the position that there are costs to a borrower to apply for a mortgage workout and that a bank will not foreclose on the property automatically if it rejects a workout request. Given these, we believe that our model captures important aspects of the interaction between borrowers and banks which are outside Riddiough and Wyatt's model.

they should foreclose on the properties (and incur bankruptcy and liquidating costs) or provide concessions by lowering the interest payment and/or mortgage amount for borrowers in order to avoid bankruptcy and liquidating costs.

Default is likely to occur only when the property value is less than the mortgage balance. Under this circumstance, the borrower might exercise the "put" option (associated with the mortgage) of selling the property back to the bank at the outstanding mortgage balance.[4] By doing so, the borrower could pocket the difference between the property value and the mortgage balance.[5] However, a rational borrower would exercise the put option only if the difference between property value and mortgage amount is large enough to cover the costs associated with the loss of credit rating (a default record) and tax liabilities resulting from the default. (Borrowers are required to pay taxes on loan concessions or the difference between property value and loan balance should a liquidation occur.)

Two groups of borrowers will default on mortgages, regardless of whether or not a bank is willing to negotiate. The first group comprises the borrowers who do not have the ability to make their mortgage payments and whose property value is below the outstanding mortgage balance. The second group comprises the borrowers who can maintain the mortgage payments, but who would still choose to default because the cost of a bad credit record due to a foreclosure is less than the benefits of defaulting on a mortgage. We shall call a borrower in either group a "distressed borrower." To deal with distressed borrowers, it would be in the interest of a lender to restructure the debt in order to avoid bankruptcy and liquidating costs.

Nondistressed borrowers are those who can keep up with mortgage payments but for whom the cost of a default (loss of credit rating and the tax liabilities resulting from default) exceeds the benefit (the difference between the property value and the mortgage balance). A nondistressed borrower will default only if she/he believes that there is a reasonable chance that the bank will grant concessions to her/his loan workout request. By pretending to be a distressed borrower, a nondistressed borrower can try to extract concessions and avoid having a default record. We refer to this type of borrower as the

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[4] Kau and Kim (1994) argue that it might be optimal for borrowers to delay the exercise of the default option. In other words, a borrower might not exercise the "put option" as soon as it is in the money. However, even if we consider the option value of defaulting, it should not change the implications of our analyses. Since the delay in exercising the option requires that the borrower pays down the principal component of the mortgage continuously, there is also an incentive for borrowers to exercise the default option as soon as possible. Given this, although borrowers might not exercise the option at the point where the property value just falls below the mortgage balance, they will not delay the exercise of the put option indefinitely and will for sure exercise the option before the terminal date of the mortgage.

[5] This argument basically assumes no personal liability in a loan default. It is possible that a lender will seek a deficiency judgment in court for the difference between the mortgage balance and the liquidating price of the property. In practice, besides the fact that a few states prohibit deficiency judgments on certain types of mortgages by statute, the costs of pursuing deficiency judgments in court, the costs of collecting payments from defaulters, and the ability of defaulters to declare personal bankruptcy mitigate the power of a deficiency judgment.

pretender. The bank should reject the workout request from a pretender if the bank can identify which applicant is a pretender. However, without incurring a screening cost, the bank cannot separate pretenders from distressed borrowers.[6]

It is costly for a nondistressed borrower (pretender) to request a loan workout. A bank will not make a decision on foreclosure or workout until a borrower is already in the initial stage of default (late on several mortgage payments). A late payment record also affects a borrower's credit rating, although it is not as serious as a default record caused by a bank's foreclosure on the mortgage.[7] Given this credit rating problem, plus the damage to a borrower's relationship with the bank and the cost of the negotiation process, a nondistressed borrower (pretender) will not request a loan workout if she/he knows for sure that a bank will screen the application or the probability of a rejection is high.

Therefore, when a nondistressed borrower knows that it is difficult and costly for a bank to detect whether she/he is a pretender, there is an incentive for her/him to request a loan workout by pretending to be a distressed borrower. If the request is granted, the borrower earns concessions without paying the price of having a default record in his/her credit history. If the request is denied, the borrower will make up the mortgage payments to prevent the bank from liquidating the property. In other words, when a bank correctly rejects a workout request, the pretender will make up the late payments and will not default on the mortgage. Consequently the bank can avoid paying both the concession cost and the liquidating cost.

When the average screening cost is sufficiently high, a bank will have an incentive to minimize the total screening costs by discouraging borrowers from applying for loan workouts. Realizing that a pretender will not ask for a loan workout if the pretender believes that the bank will reject her/his workout request, the bank has an incentive to reject a significant number of workout requests. However, there are costs for banks to use this policy. When a bank rejects a mortgage request from a nonpretender (distressed borrower) and forecloses on the property, it incurs significant foreclosure and liquidating costs that could be avoided if it had negotiated with the distressed borrower. Riddiough and Wyatt (1994), using information provided by Curry, Blalock, and Cole (1991), indicate that foreclosure costs in the

[6] Similar types of asymmetric information problems between borrowers and banks have been discussed previously in the literature. For example, LeRoy (1996) shows that lenders can offer a menu of points and interest rates to separate heterogeneous borrowers who have private knowledge of their likely prepayment schedule. The costs of dealing with the asymmetric information problem between banks and borrowers can be significant. Sharpe (1990) points out that competition could drive banks to lend more to new (and possibly lower quality) firms in order to learn more about the borrowers.

[7] This condition is important according to arguments provided by Mooradian (1994). Mooradian indicates that, if it is costless for an inefficient firm to mimic an efficient firm in a restructuring, efficient and inefficient firms are equally likely to continue or to liquidate. In his model, Chapter 11 procedures impose costs on inefficient firms that otherwise would mimic efficient firms. In practice, Franks and Torous (1989) propose that the bargaining process of Chapter 11 could cause violations of absolute priority in favor of stockholders.

form of legal fees, banker's sales commissions, and property management and maintenance fees (including real estate taxes) can easily exceed 10% of the property value at the time of default. In addition, Crockett (1990) also points out that banks might want to avoid having too many foreclosures on properties in a short period. In a distressed market, the capacity of the market to absorb sales of distressed assets is limited in a given period, so the disposition of properties could contribute to a downward spiral in property values and increase the degree of distress in the market.[8] When this happens, banks might face more potential defaulters as more borrowers hold a negative equity in their properties.

2. Our Framework

Let B, V, and L be the mortgage balance, market value of the property, and liquidating value of the property of a typical borrower. A borrower will default only if the market value of the property is below the mortgage balance. By defaulting, a borrower earns the default benefit $B - V$.[9] If the bank elects to work with the borrower, the bank will grant the borrower the default benefit as a concession. Under this circumstance, the borrower receives the default benefit without suffering a bad credit rating (a default record). However, if the bank elects not to work out but to foreclose and liquidate the property, the borrower will have a default record that will prevent her/him from borrowing in the near future.

If a bank decides to liquidate the property, the net proceeds (after deducting administrative costs) from the sale of the property is L. Thus $V - L$ equals the liquidating costs for the bank. As explained in note 5, we assume that it is difficult for a bank to recover the liquidating costs from the borrower by seeking a deficiency judgment in court. It is assumed that $B > V > L$. Otherwise there would be no benefits from defaulting.

In our models, a bank has two possible policies for handling loan workout applications. It can either screen the applications (a screening policy) or reject applications randomly (a random rejection policy), or mix them with a probability θ of being screened and a probability $1 - \theta$ of being subjected to the random rejection policy. We denote the bank's mixed policy as (θ, k) throughout the article, where k represents the acceptance rate when the random rejection policy is used. Therefore a screening policy is represented by $\theta = 1$. A random rejection policy has an acceptance rate k and a screening rate $\theta = 0$. When a bank uses a screening policy for a workout request, it incurs a screening cost C regardless of whether the applicant is a pretender or a distressed borrower. When a bank uses a random rejection policy, it

[8] This argument is similar to the illiquidity argument used by Shleifer and Vishny (1992:1359) to illustrate the credit constraints of steel and chemical firms.

[9] In our analysis, we ignore the option-value issues discussed in note 4.

does not incur a screening cost but may incur a cost by rejecting a distressed borrower or by accepting a pretender.

Throughout the article we assume that the bank and borrowers are risk neutral and model the set of borrowers by the unit interval $[0, 1]$. Borrowers in $[0, \underline{\alpha})$ are distressed and those in $[\underline{\alpha}, 1]$ are nondistressed, where $\underline{\alpha}$ is the percentage of distressed borrowers. A distressed borrower will always file a workout application regardless of a bank's policy, while a pretender will file a workout application only if the expected benefit (which will be modeled formally in the forthcoming subsections) from the loan workout application is positive. In our two models, we assume that B, V, L, C, and $\underline{\alpha}$ are common knowledge among the bank and borrowers.

We are now in a position to model a bank's optimal policies under various parameters. We will first start our analyses with a simple model in which we assume a borrower can fully observe a bank's policies. That is, a borrower knows both the screening rate θ and the acceptance rate k used by a bank and acts accordingly. While in reality a borrower might not be able to observe a bank's policies, this simple model provides some benchmark results that can be used to compare with the results of our second model, in which we assume that a bank's policies are not observable to outside borrowers.

3. A Model with Observable Policies

In this simple model, a borrower can observe a bank's screening rate $\theta \in [0, 1]$ and acceptance rate $k \in [0, 1]$ for workout requests. Given a bank's mixed policy (θ, k), pretender t's expected benefits from an application for a workout is

$$A(\theta, k, t) = (1 - \theta)k(B - V) - wt, \tag{1}$$

where $t \in [\underline{\alpha}, 1]$ and $[\underline{\alpha}, 1]$ represents the set of nondistressed borrowers. Since $[0, \underline{\alpha})$ is the set of distressed borrowers, $\underline{\alpha}$ is the minimum percentage of borrowers who will apply for a loan workout.

A pretender will file a loan workout application if $A(\theta, k, t) > 0$. We define wt as pretender t's cost of initiating a loan workout request, where w is a constant and is the highest cost for a pretender to initiate a loan workout request. These costs include a late payment record, a bad relationship with the lending bank, and administrative burdens. We assume that wt is pretender t's private information. However, the distribution of these costs among pretenders is assumed to be common knowledge between the bank and borrowers. From Equation (1) it is clear that whether a pretender will apply for a loan workout depends on the magnitudes of the screening rate θ, the acceptance rate k, the default benefit, and her/his cost of initiating a loan workout. The percentage of borrowers who will apply for a loan workout will be the percentage of distressed borrowers $\underline{\alpha}$ plus a portion of the pretenders who will apply for the loan workout.

Define $\bar{\alpha}$ as the maximum percentage of borrowers who will apply for a loan workout when the bank does not screen ($\theta = 0$) and accepts all applicants ($k = 1$). For notational simplicity, let

$$\bar{\alpha} = \frac{B - V}{w} \leq 1. \tag{2}$$

Naturally, we assume $\underline{\alpha} < \bar{\alpha}$ to make our model nontrivial, where $\underline{\alpha}$ is the percentage of distressed borrowers. Let $\alpha(\theta, k)$ represent the percentage of borrowers who will apply for a loan workout and be a continuous function of θ and k. Under this circumstance, $\underline{\alpha} \leq \alpha(\theta, k) \leq \bar{\alpha}$ and the set of pretenders (nondistressed borrowers who will apply for a workout) is $[\underline{\alpha}, \alpha(\theta, k))$, where

$$\alpha(\theta, k) = \max\{\underline{\alpha}, (1 - \theta)k\bar{\alpha}\}. \tag{3}$$

When a bank screens a workout applicant, the bank's payoff from correctly identifying a pretender is $B - C$. The bank's payoff from correctly identifying a distressed borrower is $V - C$. In both cases, the bank needs to incur the screening cost C. Thus a bank's expected payoff from the screening policy is

$$g_1(\theta, k) = \frac{\alpha(\theta, k) - \underline{\alpha}}{\alpha(\theta, k)} B + \frac{\underline{\alpha}}{\alpha(\theta, k)} V - C, \tag{4}$$

where $\frac{\alpha(\theta,k) - \underline{\alpha}}{\alpha(\theta,k)}$ is the percentage of workout applicants who are pretenders and $\frac{\underline{\alpha}}{\alpha(\theta,k)}$ is the percentage of workout applicants who are distressed borrowers.

When a bank uses the random rejection policy to handle workout applications, the bank's payoff from accepting a workout request is the market value of the property V. The bank's payoff from rejecting a workout request will be either the mortgage balance B (if the applicant is a pretender) or the liquidating value L (if the applicant is a distressed borrower). Thus a bank's expected payoff from the random rejection policy is

$$g_2(\theta, k) = kV + (1 - k)\left(\frac{\alpha(\theta, k) - \underline{\alpha}}{\alpha(\theta, k)} B + \frac{\underline{\alpha}}{\alpha(\theta, k)} L \right). \tag{5}$$

The first term on the right-hand side of Equation (5) is the payoff of a bank when it accepts a workout request (with a probability k). The second term is the payoff of the bank when it rejects a workout request (with a probability $1 - k$).

The bank will use a screening rate θ to decide if it will screen an applicant. When a bank does not screen an applicant (with a probability $1 - \theta$), it will use the random rejection policy. Given this, the bank's expected payoff from a workout application is

$$g(\theta, k) = \theta g_1(\theta, k) + (1 - \theta) g_2(\theta, k). \tag{6}$$

Note that $(1-\alpha(\theta, k))$ percent of borrowers will not apply for a loan workout. For those pretenders who do not apply for a loan workout, the bank's payoff is B. Consequently the total expected payoff of a bank is

$$G_0(k, \theta) = \alpha(\theta, k)g(\theta, k) + (1-\alpha(\theta, k))B, \tag{7}$$

where

$$0 \leq k \leq 1 \quad \text{and} \quad 0 \leq \theta \leq 1.$$

The first term on the right-hand side of Equation (7) is the expected payoff to the bank from borrowers who request a loan workout. The second term is the expected payoff to the bank from borrowers who do not request a workout. Figure 1 illustrates a bank's expected payoffs under various scenarios.

We are now in a position to examine a bank's optimal policies that maximize $G_0(k, \theta)$ in relation to the magnitudes of the default benefit $(B-V)$ and the liquidating cost $(V-L)$. Specifically, we will examine three cases that are mutually exclusive and exhaust all possibilities: (1) $B-V \geq V-L$, (2) $B-V \leq \frac{\alpha}{2\bar{\alpha}-\underline{\alpha}}(V-L)$, and (3) $\frac{\alpha}{2\bar{\alpha}-\underline{\alpha}}(V-L) < B-V < V-L$.

Proposition 1. *When a bank's policies (θ and k) are observable, a bank's optimal policies (θ^*, k^*) are as follows:*

Case 1 (when $B-V \geq V-L$): A bank will adopt a random rejection policy with $\theta^* = 0$ and $k^* = \frac{\underline{\alpha}}{\bar{\alpha}}$ if $C > V-L$. Under this optimal random rejection policy, $\alpha(\theta^*, k^*) = \alpha(0, \frac{\underline{\alpha}}{\bar{\alpha}}) = \underline{\alpha}$ and no pretender will apply for a loan workout. If $C<V-L$, the bank will screen some of the applicants (with $\theta^* = 1-\frac{\underline{\alpha}}{\bar{\alpha}}$) and accept the rest of the applicants (with $k^* = 1$).

Case 2 (when $B-V \leq \frac{\alpha}{2\bar{\alpha}-\underline{\alpha}}(V-L)$): A bank will adopt a policy with $\theta^* = 0$ and $k^* = 1$ if $\frac{\underline{\alpha}}{\bar{\alpha}}C > B-V$. The bank will screen some of the applicants (with $\theta^* = 1-\frac{\underline{\alpha}}{\bar{\alpha}}$) and accept the rest of the applicants (with $k^* = 1$) if $\frac{\underline{\alpha}}{\bar{\alpha}}C < B-V$.

Case 3 (when $\frac{\alpha}{2\bar{\alpha}-\underline{\alpha}}(V-L) < B-V < V-L$): A bank will adopt a random rejection policy with $\theta^* = 0$ and $k^* = \frac{\alpha(B-L)}{2\bar{\alpha}(B-V)} = \frac{\alpha w}{2(B-V)}\{1+\frac{V-L}{B-V}\}$ if $C > \frac{(V-L)-\frac{\alpha(B-L)^2}{4(B-V)\bar{\alpha}}}{1-\frac{\underline{\alpha}}{\bar{\alpha}}}$. The bank will screen some of the applicants (with $\theta^* = 1-\frac{\underline{\alpha}}{\bar{\alpha}}$) and accept the rest of the applicants (with $k^* = 1$) if $C < \frac{(V-L)-\frac{\alpha(B-L)^2}{4(B-V)\bar{\alpha}}}{1-\frac{\underline{\alpha}}{\bar{\alpha}}}$.

Furthermore, in all three cases, when a bank's optimal policy is to screen part of the applicants and accept the rest of the applicants, $\alpha(\theta^*, k^*) = \alpha(1-\frac{\underline{\alpha}}{\bar{\alpha}}, 1) = \underline{\alpha}$ and no pretenders will apply for a loan workout.

Proof. See the appendix. ∎

Thus a bank's optimal policy (θ^*, k^*) always takes one of the following two forms: $(0, k^*)$ or $(1-\frac{\underline{\alpha}}{\bar{\alpha}}, 1)$. In other words, a bank will either randomly reject applicants or screen enough applicants to deter pretenders from applying for a loan workout. We will discuss the intuition of Proposition 1 in the following two subsections.

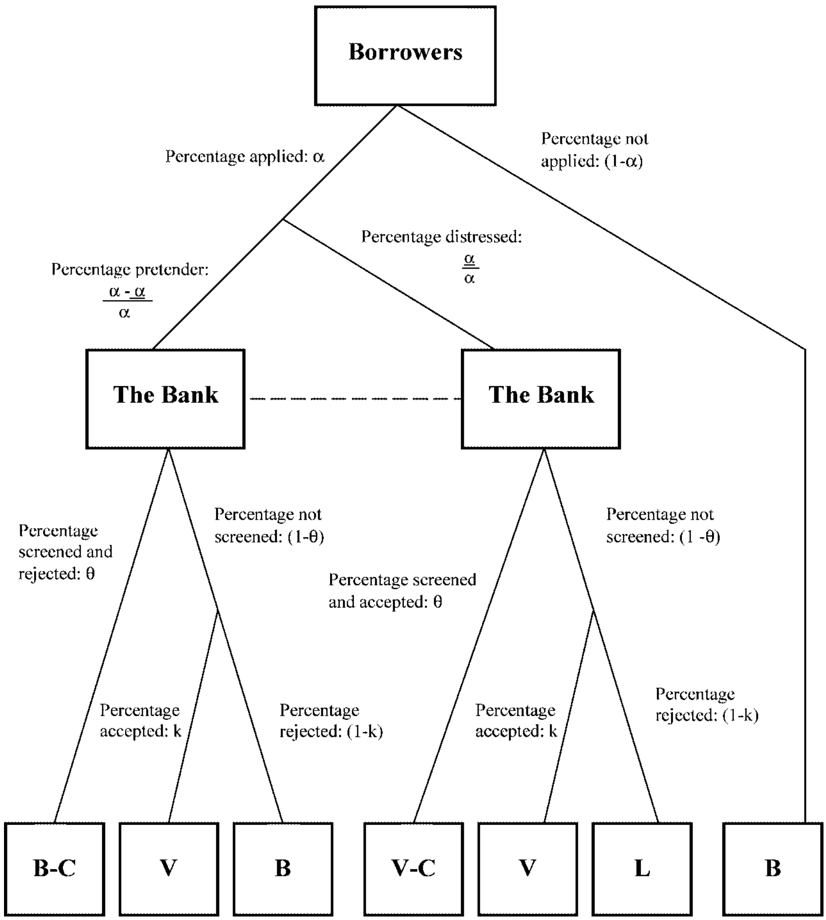

Figure 1
A bank's expected payoffs under various scenarios
When a borrower applies for a loan workout, the bank will decide to either screen (based on a screening rate θ) or randomly accept or reject (based on an acceptance rate k) the request of the workout applicant. The dotted line between the two banks indicates that the bank cannot distinguish pretenders from distressed borrowers when making screening and random decisions. B, V, L, and C are the mortgage balance, market value of property, liquidating value of property, and screening costs, respectively.

3.1 When a bank does not screen

When a bank's optimal policy is $(0, k^*)$, a bank uses a random rejection policy (when $k^* \neq 1$) to deter pretenders. Proposition 1 indicates that a bank will adopt a random rejection policy when the screening cost C is sufficiently large.

Case 1 of Proposition 1 indicates that, when the default benefit is larger than the liquidating cost, the necessary and sufficient condition for a bank to adopt a random rejection policy is when the screening cost is also larger than the liquidating cost. In case 1, when a bank uses an acceptance rate that equals the maximum percentage of distressed borrowers among total applicants ($k^* = \frac{\underline{\alpha}}{\bar{\alpha}}$), no pretenders will apply for a loan workout. Since the use of the random rejection policy alone can already deter all pretenders, it is unnecessary for the bank to screen workout applicants ($\theta = 0$). It should be noted that when all applicants are distressed borrowers (as in case 1), the cost for a bank to use a random rejection policy is to pay the liquidating cost when it mistakenly rejects a distressed borrower. On the other hand, the benefit to a bank to use the random rejection policy is the avoidance of the screening cost. Clearly, when the liquidating cost is lower than the screening cost, a bank will be better off using a random rejection policy to handle its workout applications.

We should also note that, while no pretenders apply for a loan workout in case 1, the bank still knowingly uses the random rejection policy to reject workout applicants. The bank must do so because if it decides to accept all workout applications, pretenders will pretend to be distressed and apply for a loan workout because they can observe a bank's policies. Given this, a bank will have to carry out the random rejection policy in order to deter pretenders.

When the liquidating cost is significantly larger than the default benefit (note that $\frac{\underline{\alpha}}{2\bar{\alpha}-\underline{\alpha}} < 1$) , the cost of rejecting a distressed borrower is much higher than the cost of granting concessions. Case 2 of Proposition 1 indicates that a bank will not screen if the screening cost is much higher than the default benefit (note that $\frac{\underline{\alpha}}{\bar{\alpha}} < 1$). In addition, since a bank does not screen, it will accept all applicants because it would rather grant the default benefit than incur the liquidating cost. Case 3 of Proposition 1 reports bank policies similar to those reported in case 2. However, since the difference between the liquidating cost and the default benefit is not as large as that reported in case 2, the bank will not accept all the workout applicants when the random rejection policy is adopted. Under both circumstances, a bank's optimal policy is a trade-off between benefits and costs.

Finally, from Proposition 1, it is clear that a bank's acceptance rate under the optimal random rejection policy is a function of the percentage of distressed borrowers ($\underline{\alpha}$), the percentage of pretenders among total workout applicants ($\frac{\underline{\alpha}}{\bar{\alpha}}$, where $\bar{\alpha} = \frac{B-V}{w}$), the liquidating cost ($V - L$), and the default benefit ($B - V$). The bank will use a higher acceptance rate when there is a higher percentage $\underline{\alpha}$ of borrowers who are distressed and a higher application cost w for pretenders to apply for a loan workout. Under these circumstances, since more applicants will be distressed borrowers, the benefits of rejecting a few pretenders would be outweighed by the costly liquidations forced unnecessarily upon the many distressed borrowers. Consequently the bank will accept more workout applicants. When a bank faces a higher liquidating cost $V - L$ or a lower default benefit $B - V$, the cost of rejecting a distressed borrower (by incurring liquidating cost $V - L$) will be high and the cost of making concessions to a pretender (by granting default benefit $B - V$) will be low. Under these circumstances there is also an incentive for a bank to use a high acceptance rate for workout applications.

3.2 When a bank adopts a screening policy

A pretender will not apply for a loan workout when she/he realizes that the chance to be screened is sufficiently high. Proposition 1 indicates that a bank will use a screening policy when the screening cost is sufficiently low. In addition, when a bank adopts a screening policy, the optimal policy will be $(\theta^*, k^*) = (1 - \frac{\alpha}{\bar{\bar{\alpha}}}, 1)$. The intuition for this policy is simple. We know that when a bank screens applicants at a rate equal to the maximum percentage of pretenders among total applicants (or when $\theta = 1 - \frac{\alpha}{\bar{\bar{\alpha}}}$), no pretenders will apply for a loan workout. Since no pretenders will apply for a loan workout, the bank will accept all the remaining applicants (with $k = 1$).

Case 1 of Proposition 1 indicates that, when the default benefit is larger than the liquidating cost, the necessary and sufficient condition for a bank to adopt the screening policy $(1 - \frac{\alpha}{\bar{\bar{\alpha}}}, 1)$ is when the screening cost is also lower than the liquidating cost. The intuition for this policy is straightforward. We know that if a bank screens enough applicants (in this case, $\theta = 1 - \frac{\alpha}{\bar{\bar{\alpha}}}$), no pretenders will apply for a loan workout and the bank will correctly accept the applications from the rest of the applicants (in this case, distressed borrowers). Given this, the cost for the bank to adopt this policy is the screening cost. On the other hand, the payoff of a screening policy is the avoidance of the payments of the default benefit or the liquidating cost. Given this, the bank will be better off screening applicants if both the default benefit and the liquidating cost are higher than the screening cost.

It should be noted that even if the bank knows that no pretenders will apply for a loan workout under this screening policy, the bank will still have to carry out the screening policy. This is true because of our assumption that borrowers can observe a bank's policy directly. If a bank cheats and does not screen enough applicants, then pretenders will act accordingly and apply for a loan workout.

We should note that, under some circumstances, some pretenders will still apply for a loan workout when a bank uses a random rejection policy. However, when a bank uses a screening policy, no pretenders will apply for a loan workout. In other words, the use of the screening policy $(1 - \frac{\alpha}{\bar{\bar{\alpha}}}, 1)$ can deter all pretenders from applying for a loan workout. However, the use of a random rejection policy $(0, k^*)$ might not be able to achieve the same effect. This is true because when a random rejection policy is used, a bank balances the savings of the screening cost against the costs of rejecting distressed borrowers and accepting pretenders. Under such circumstances it might not be optimal for a bank to use an acceptance rate that is sufficiently low to prevent all pretenders from applying if the liquidating cost is too high. However, when a screening policy is used, a bank's benefit is the avoidance of the liquidating cost or the default benefit. Given this, as long as the screening cost is low enough, a bank can afford to use a high screening rate to deter all pretenders.

In this section we derive a bank's optimal policies when its policies can be observed by borrowers. We have four observations. First, a bank will adopt a random rejection policy when the screening cost is sufficiently high. Second, a bank's optimal policy will be either to randomly reject applications (and not screen any applicants) or to screen a portion of applicants (and accept the rest of the applicants). Third, under certain conditions, a bank will knowingly reject the applications from distressed borrowers when a random rejection policy is used. Fourth, when the screening cost of a bank is sufficiently low, no pretenders will apply for a loan workout and the bank will accept all workout applications (but will still screen a portion of them even if the bank knows that they are all distressed). In the next section we will see if these observations change when we assume that a bank's policies are not observable.

4. A Model with Unobservable Policies

We now move to the case where borrowers cannot directly observe a bank's policies. That is, we will keep all assumptions the same as in Section 3, except that now a bank's policies cannot be directly observed by pretenders. Under this model framework, the expected payoff of a bank is

$$\begin{aligned} G_0(\theta,k,\alpha) = \alpha\Bigg\{&\theta\left(\frac{\alpha-\underline{\alpha}}{\alpha}B+\frac{\underline{\alpha}}{\alpha}V-C\right)\\ &+(1-\theta)\left[kV+(1-k)\left(\frac{\alpha-\underline{\alpha}}{\alpha}B+\frac{\underline{\alpha}}{\alpha}L\right)\right]\Bigg\}+(1-\alpha)B, \end{aligned} \tag{8}$$

where $G_0(\theta, k, \alpha)$ represents the bank's expected payoff if the bank adopts policy (θ, k) and if α percent of borrowers apply for a loan workout. A bank will maximize its expected payoff given the α selected by borrowers.

Definition 1. *An equilibrium of the above game is a bank's policy (θ^*, k^*) and a percentage of borrowers α^* who will apply for a loan workout such that*

$$(\theta^*, k^*) \in \arg\max_{(\theta,k)} G_0(\theta, k, \alpha^*) \tag{9}$$

and

$$\alpha^* = \alpha(\theta^*, k^*) = \max\{\underline{\alpha}, (1-\theta^*)k^*\bar{\alpha}\}. \tag{10}$$

We next characterize the set of equilibria under various screening costs. We examine two mutually exclusive cases: (1) $B - V \le \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V-L)$ and (2) $B - V > \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V-L)$.

Proposition 2. *When a bank's policies are not directly observable by the borrowers, the equilibrium is characterized as follows*:

Case 1 (*when* $B - V \leq \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V - L)$): *If* $C \geq (1 - \frac{\underline{\alpha}}{\bar{\alpha}})(B - V)$, *then the equilibrium is a mixed policy* $(0, 1)$ *and* $\alpha^* = \bar{\alpha}$. *If* $C < (1 - \frac{\underline{\alpha}}{\bar{\alpha}})(B - V)$, *then the equilibrium is* $\theta^*(C) = \frac{(1-\frac{\underline{\alpha}}{\bar{\alpha}})(B-V)-C}{B-V-C}$, $k^* = 1$, *and* $\alpha^* = \frac{\underline{\alpha}(B-V)}{B-V-C}$.

Case 2 (*when* $B - V > \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V - L)$): *If* $C > \frac{V-L}{B-L}(B - V)$, *then the equilibrium is* $\theta^* = 0$, $\alpha^* = \frac{\underline{\alpha}(B-L)}{B-V}$, *and* $k^* = \frac{\alpha^*}{\bar{\alpha}} = \frac{\underline{\alpha}}{\bar{\alpha}}\frac{B-L}{B-V}$. *If* $C < \frac{V-L}{B-L}(B - V)$, *then the equilibrium is* $\theta^*(C) = \frac{(1-\frac{\underline{\alpha}}{\bar{\alpha}})(B-V)-C}{B-V-C}$, $k^* = 1$, *and* $\alpha^* = \frac{\underline{\alpha}(B-V)}{B-V-C}$.

Proof. See the appendix. ■

The implications of Proposition 1 and Proposition 2 are similar in three areas. First, when a bank's policies are not observable, the bank's optimal equilibrium policy also takes one of the following two forms: $(0, k^*)$ or $(\theta^*, 1)$. Second, when a bank's policies are not observable, the bank's acceptance rate ($k^* = \frac{\underline{\alpha}}{\bar{\alpha}}\frac{B-L}{B-V}$) under the random rejection policy is also higher when there is a higher percentage $\underline{\alpha}$ of borrowers who are distressed, a higher application cost w for pretenders to apply for a loan workout, a higher liquidating cost $V - L$, or a lower default benefit $B - V$. Third, when a bank's policies are not observable, it is also more likely for a bank to adopt a random rejection policy when there is a high screening cost, a low default benefit $B - V$, or a low liquidating cost $V - L$. However, there are also three important insights derived from Proposition 2 that deserve attention.

First, when a bank's policies are observable (as in Proposition 1), the screening rate θ is independent of the screening cost and can be used as a tool to deter pretenders. However, when pretenders cannot observe a bank's policies (as in Proposition 2), a bank cannot use the screening rate θ as a tool per se to deter pretenders. Consequently there is less incentive for a bank to screen applicants when the screening cost is high. Under this circumstance, the screening rate θ used by a bank will be a decreasing function of the screening cost C.

In addition, when a bank adopts a screening policy, the bank will screen fewer applicants when its policies are not observable than when they are observable. When a bank's policies are observable, the bank will use a screening rate $\theta^* = 1 - \frac{\underline{\alpha}}{\bar{\alpha}}$. (Under this screening rate, all applicants will be distressed borrowers.) However, when a bank's policies are unobservable, the screening rate is $\theta^* = \frac{(1-\frac{\underline{\alpha}}{\bar{\alpha}})(B-V)-C}{B-V-C}$. Clearly this rate is smaller than the screening rate in the case of observable policies where $\theta^* = 1 - \frac{\underline{\alpha}}{\bar{\alpha}}$.

This is true because, in the case of observable policies, a bank can screen enough applicants (at $\theta^* = 1 - \frac{\underline{\alpha}}{\bar{\alpha}}$) to deter all pretenders from applying for a loan workout. However, in the case of unobservable policies, pretenders cannot ascertain if a bank will for sure carry out a screening policy with $\theta^* = 1 - \frac{\underline{\alpha}}{\bar{\alpha}}$ (as in the case of observable policies). In other words, a bank should choose not to screen if it knows that no pretenders will apply. Hence, in equilibrium, the screening rate must be low enough to provide an incentive for some pretenders to apply so that the bank has an incentive to screen. Consequently the screening rate used by a bank in the case of unobservable policies will be lower than the screening rate used in the case of observable policies.[10]

Of greater importance, in the case of observable policies, when the screening cost is small enough, a bank will not reject applications from pretenders because no pretenders will apply for a loan workout. This is true because pretenders are able to observe a bank's screening rate and make their decisions accordingly. However, in the case of unobservable policies, no matter how low the screening cost is (as long as it is not zero), a bank could accept or reject applications from pretenders. This is true because, when a bank's policies are not observable, the percentage of borrowers who will apply for a loan workout is $\alpha^* = \frac{\underline{\alpha}(B-V)}{B-V-C}$. Clearly, as long as the screening cost C is positive, $\alpha^* = \frac{\underline{\alpha}(B-V)}{B-V-C} > \underline{\alpha}$. This means that some pretenders will always apply for a loan workout. This result suggests that the unobservability of a bank's policies creates an environment in which some pretenders will apply for a loan workout, even if the screening cost is low.

Second, it is interesting to note that a bank is more likely to adopt the random rejection policy in the case of unobservable policies than in the case of observable policies. We can see this result by comparing the magnitude of the screening costs that are required for the bank to adopt the random rejection policy. Define C_1^* and C_2^* as the critical cost levels for a bank to adopt a random rejection policy when its policies are observable and not observable, respectively. In other words, in the case of observable policies, a bank will adopt a random rejection policy when $C > C_1^*$. In the case of unobservable policies, a bank will adopt a random rejection policy when $C > C_2^*$.

Corollary 1. *Under any circumstance, $C_2^* \leq C_1^*$. That is, it is always easier for a bank to adopt a random rejection policy when the bank's policies are not observable than when they are observable.*

Proof. See the appendix. ■

Corollary 1 indicates that the critical screening cost for a bank to adopt a random rejection policy is lower in the unobservable case C_2^* than in the observable case C_1^*. We can also use Figure 2 and Figure 3 to demonstrate this result. Figure 2 plots the level of the screening cost C^* that is required for a bank to adopt a random rejection policy based on results derived from Propositions 1 and 2, holding the liquidating cost $V-L$ constant. Figure 3 also plots the level of the screening cost C^* that is required for a bank to adopt a random rejection policy based on results derived from Propositions 1 and 2, holding the default benefit $B-V$ constant.

[10] We thank Professor Sheridan Titman for pointing out this intuition.

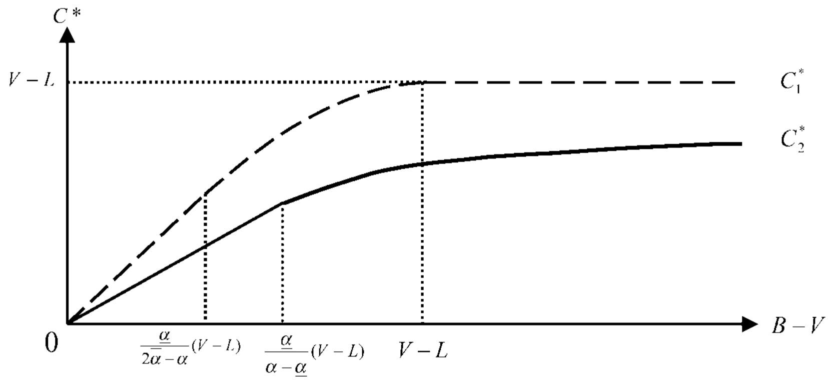

Figure 2
The level of critical screening costs when holding $V-L$ constant
This figure plots the critical value C^* based on the results derived from Proposition 1 and Proposition 2. The dotted curve C_1^* is based on the result derived from Proposition 1 by holding $V-L$ constant. Between 0 and $\frac{\underline{\alpha}}{2\bar{\alpha}-\underline{\alpha}}(V-L)$, C_1^* is a straight line with a slope of $\frac{\bar{\alpha}}{\underline{\alpha}}$, which is greater than 1. The line between $\frac{\underline{\alpha}}{2\bar{\alpha}-\underline{\alpha}}(V-L)$ and $V-L$ is increasing and concave, where $C_1^*=((V-L)-\frac{\alpha(B-L)^2}{4(B-V)\bar{\alpha}})/(1-\frac{\underline{\alpha}}{\bar{\alpha}})$. For the line on the right of $V-L$, $C_1^*=V-L$. When a bank's policies are observable, a bank will adopt a random rejection strategy if the screening cost is higher than the critical value C_1^*. The solid line C_2^* is based on the result derived from Proposition 2 by holding $V-L$ constant. Between 0 and $\frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V-L)$, C_2^* is a straight line with a slope of $(1-\frac{\underline{\alpha}}{\bar{\alpha}})$, which is less than 1. The line beyond $\frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V-L)$ is increasing and concave, with $C_2^*=\frac{V-L}{B-L}(B-V)$. When a bank's policies are not observable, a bank will adopt a random rejection strategy if the screening cost is higher than the critical value C_2^*.

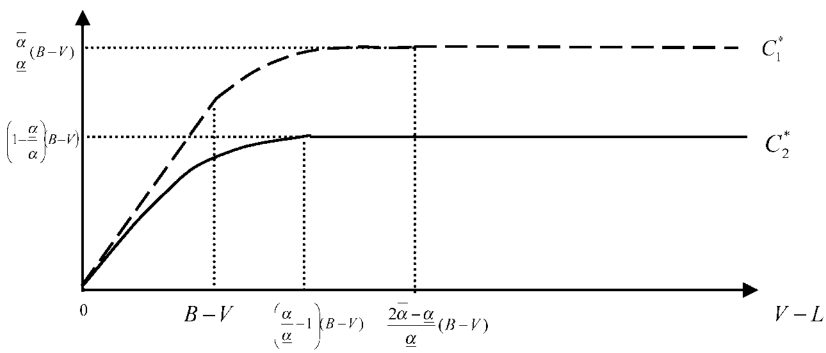

Figure 3
The level of critical screening costs when holding $B-V$ constant
This figure plots the critical value C^* based on the results derived from Proposition 1 and Proposition 2. The dotted curve C_1^* is based on the result derived from Proposition 1 by holding $B-V$ constant. Between 0 and $B-V$, C_1^* is a straight line with a slope of 1. The line between $B-V$ and $\frac{2\bar{\alpha}-\underline{\alpha}}{\underline{\alpha}}(B-V)$ is increasing and concave, where $C_1^*=((V-L)-\frac{\alpha(B-L)^2}{4(B-V)\bar{\alpha}})/(1-\frac{\underline{\alpha}}{\bar{\alpha}})$. For the line on the right of $\frac{2\bar{\alpha}-\underline{\alpha}}{\underline{\alpha}}(B-V)$, $C_1^*=\frac{\bar{\alpha}}{\underline{\alpha}}(B-V)$. When a bank's policies are observable, a bank will adopt a random rejection strategy if the screening cost is higher than the critical value C_1^*. The solid line C_2^* is based on the result derived from Proposition 2 by holding $B-V$ constant. The line between 0 and $(\frac{\bar{\alpha}}{\underline{\alpha}}-1)(B-V)$ is increasing and concave, where $C_2^*=\frac{V-L}{B-L}(B-V)$. The line after $(\frac{\bar{\alpha}}{\underline{\alpha}}-1)(B-V)$ is constant, where $C_2^*=(1-\frac{\underline{\alpha}}{\bar{\alpha}})(B-V)$. When a bank's policies are not observable, a bank will adopt a random rejection strategy if the screening cost is higher than the critical value C_2^*.

As we can see, in both figures the critical screening cost C_1^* is always higher than the critical screening cost C_2^*. This result indicates that a bank is more likely to use the random rejection policy when its policies are not observable. This result makes intuitive sense. When borrowers cannot observe a bank's policies directly, they cannot know for sure if the bank will carry out a screening policy. Given this, the screening rate θ^* cannot be used as a tool per se to deter pretenders. Consequently there is greater incentive for the bank to rely more on the random rejection policy.

Third, under any circumstance, a bank's expected payoff should be higher when its policies are observable than when they are not observable. To see this, we know that when a bank's policies are observable, the bank maximizes Equation (7) to select the optimal policies (θ^*, k^*). When a bank's policies are not observable, the optimal policy is in fact a point in Equation (7), which the bank tries to maximize in the observable case. Given this, it is clear that the payoff derived in the observable case should be at least as high as that derived in the unobservable case. This result indicates that a bank is better off in an environment where its policies are observable.

5. Empirical Implications

Our models provide several testable empirical implications. First, they predict that a bank is more likely to negotiate with borrowers when the liquidating cost is high. Given this, holding everything else constant, our model predicts that a bank will be more likely to negotiate with a borrower and has more incentive to accept loan workout requests in states with tough foreclosure laws. This is true because the liquidating cost of a bank will be higher in those states. Similarly, our model implies that, holding everything else constant, a bank is more likely to negotiate with (and accept the workout request from) the borrower of a commercial property than the borrower of a single-family residence. This is the case because the liquidating cost (the time required to sell the property and the availability of potential buyers) of a commercial property is, in general, higher than that of a single-family residence.

Second, our research indicates that a bank is less likely to use the screening policy when the screening cost is high. This suggests that the type of ownership matters in a bank's workout decision. Holding everything else constant, our model predicts that a bank will be more likely to negotiate with a borrower if the property is owned by a single owner than if the property is owned by multiple owners (for example, a partnership). This is the case because the screening cost for a single owner could be much lower than that for the owners of a partnership. It is well known in the default literature that it is more difficult to restructure public debt than a bank loan. The implication of our model seems to complement this finding. Similarly, our model predicts that large banks (that presumably can handle the screening process more efficiently) are less likely to use the random rejection policy when compared to small and local banks (that presumably have a higher screening cost per applicant than large banks).

Finally, this article predicts that a bank will use a higher acceptance rate in a market with a higher percentage of distressed borrowers and a higher application cost for pretenders to apply for a loan workout. Given this, we predict that a bank will use a higher acceptance rate in a more depressed property market than in a less depressed property market. This is the case because in a more depressed market (where the property value is significantly less than the mortgage balance), the probability of having a distressed borrower apply for a loan workout is higher than the probability of having a pretender apply for a loan workout. Similarly, our model also implies that a bank might use a high acceptance rate in a market concentrated with young and well-educated borrowers. (We can probably describe this kind of market as a newly established suburban neighborhood.) This is the case because the cost of applying for a loan workout (including the credit loss due to late mortgage payments, among others) should be greater for this type of borrower.

6. Conclusion

This article argues that it may be optimal for a bank to randomly reject loan workout requests from borrowers, as long as the bank has to deal with multiple borrowers who might default and finds it too costly to screen every borrower. In this situation, a bank could adopt a nondiscriminating foreclosure policy and would incur voluntary liquidating costs. This model can best be used to describe the situation of mortgage and small business defaults. The implication of our model is that deadweight costs of bankruptcy are relevant to the capital structure decision when one invests in real estate or small businesses.

Our model can be generalized to explain similar strategies used by public and private agencies for other matters. For example, Mookherjee and Png (1989) demonstrate that, in a costly state verification context, random audits of insurance claims or tax returns could be optimal. Our result provides a complementary explanation for the random auditing policy used by the Internal Revenue Service (IRS). It is possible that the IRS's auditing cost is higher than the potential tax revenues received through the auditing. However, the use of a random auditing policy could send a message that, regardless of how reasonable a tax return appears to be, no one can escape from an IRS audit. Consequently the random auditing policy could be optimal for the IRS because of the reduction in the number of potential cheaters.

Our models also point out several possible areas for future research. First, we know that a bank is more likely to use the random rejection policy when a bank's policies are not observable than when they are observable. Given this, it might be optimal for a bank to design and publicize a model that determines if the bank will negotiate with the borrowers ex ante. This model could be a score system that relies on the past history, personal information, and financial characteristics of the borrower as well as on property and loan characteristics at the time of the workout request. Under this system, pretenders will not apply for a loan workout if they have a score below the critical value, because they know that the bank will not negotiate with them. However, this method will also attract pretenders to apply for a loan workout. Since the model parameters are known to pretenders, some of the pretenders who might not apply for a loan workout will now apply if they know that they meet the criteria set by the bank for a loan workout.

Another alternative to discourage pretenders from applying for a loan workout is to use a penalty system. That is, any pretender caught cheating will be fined a fee to cover the bank's screening cost. Under this circumstance, a bank will have more incentive to use the screening policy since the penalty will in fact reduce its true screening cost. In addition, if this system is in place, pretenders will be less likely to apply, since they know that the bank is more likely to use a screening policy. However, there is also a cost to adopt this policy. If the amount of the penalty is large enough, this added cost might trigger a pretender to default when the bank tries to collect the penalty from her/him.

In addition, in our model the concessions made by a bank are viewed as pure costs to the bank that cannot be recouped at a later date. Future research could explore alternative arrangements regarding the concessions that might increase a bank's willingness to negotiate. One possible arrangement is to allow banks to take an equity stake in the distressed firms. [See James (1995) and Berlin and John (1996) for a discussion of the issues related to when banks should take an equity stake in debt restructuring.)

Finally, it might be optimal for a bank to design a mortgage contract that charges a higher interest rate ex ante by committing to renegotiate ex post. Under this contract, a bank guarantees that it will approve all workout requests from borrowers (by reducing the amount of mortgage balance to the market value of the property). This is equivalent to saying that a bank sells a put option on a mortgage, which allows a borrower to sell the property to the bank any time at the outstanding mortgage balance. (Clearly this concept is not applicable to a nonrecourse loan, where a borrower is not personally liable for payment of the debt.) Under this contract, since all borrowers will be able to obtain default benefits, it will not be necessary for a bank to distinguish between pretenders and distressed borrowers. Consequently, the bank will not need to incur any screening costs or liquidating costs when dealing with mortgage defaults. To compensate for granting concessions to all borrowers in workout requests, the bank can charge a higher interest rate or initial loan points at the origination of the loan. However, more research has to be done to check if such a contract is, indeed, feasible.

Appendix

Proof of Proposition 1. When the screening rate (θ) and random rejection rate (k) are observable, we have

$$\alpha(\theta, k) = \max\left\{\underline{\alpha}, (1-\theta)k\bar{\alpha}\right\}. \tag{11}$$

Given a pair (θ, α), we can solve k uniquely by Equation (11), which is $k = \frac{1}{\bar{\alpha}}\frac{\alpha}{1-\theta}$. Under this circumstance, replacing k by $\frac{1}{\bar{\alpha}}\frac{\alpha}{1-\theta}$, the expected payoff of a bank $G_0(k, \theta)$ can be rewritten as a function of θ and α, or

$$G_0(\theta, \alpha) = \theta[\underline{\alpha}V - \underline{\alpha}L - \alpha C] + \frac{1}{\bar{\alpha}}\alpha^2 V - \frac{1}{\bar{\alpha}}[(\alpha-\underline{\alpha})B + \underline{\alpha}L] + \underline{\alpha}L - \underline{\alpha}B + B \tag{12}$$

subject to

$$0 \le \theta \le 1 - \frac{\alpha}{\bar{\alpha}} \quad \text{and} \quad \underline{\alpha} \le \alpha \le \bar{\alpha}. \tag{13}$$

Given this, if we can solve the optimal pair (θ, α) for $G_0(\theta, \alpha)$, then we can obtain the optimal pair (θ, k) for $G_0(\theta, k)$ via Equation (11). That is, given a pair (θ, α), k can be determined by solving $k = \frac{1}{\bar{\alpha}}\frac{\alpha}{1-\theta}$. Therefore, instead of working on $G_0(\theta, k)$, we will work on $G_0(\theta, \alpha)$, which is easier to deal with.

Let

$$G_0^*(\alpha) = \max_{0\le\theta\le 1-\frac{\alpha}{\bar{\alpha}}} G_0(\theta, \alpha). \tag{14}$$

If $\alpha \ge \frac{\underline{\alpha}}{C}(V-L)$, then $\underline{\alpha}V - \underline{\alpha}L - \alpha C \le 0$. Therefore, θ must be zero to achieve the maximum $G_0^*(\alpha)$. Given this,

$$\begin{aligned} G_0^*(\alpha) &= \frac{1}{\bar{\alpha}}\alpha^2 V - \frac{1}{\bar{\alpha}}\alpha[(\alpha-\underline{\alpha})B + \underline{\alpha}L] + \underline{\alpha}L - \underline{\alpha}B + B \\ &= -\frac{B-V}{\bar{\alpha}}\alpha^2 + \frac{B-L}{\bar{\alpha}}\underline{\alpha}\alpha + \underline{\alpha}L - \underline{\alpha}B + B. \end{aligned} \tag{15}$$

If $\alpha < \frac{\underline{\alpha}}{C}(V-L)$, then θ must equal $1 - \frac{1}{\bar{\alpha}}\alpha$ to achieve the maximum $G_0^*(\alpha)$. Given this,

$$\begin{aligned} G_0^*(\alpha) &= \left(1 - \frac{1}{\bar{\alpha}}\alpha\right)[\underline{\alpha}V - \underline{\alpha}L - \alpha C] + \frac{1}{\bar{\alpha}}\alpha^2 V - \frac{1}{\bar{\alpha}}\alpha[(\alpha-\underline{\alpha})B + \underline{\alpha}L] + \underline{\alpha}L - \underline{\alpha}B + B \\ &= -\frac{B-V-C}{\bar{\alpha}}\alpha^2 + \frac{B-V}{\bar{\alpha}}\underline{\alpha}\alpha - C\alpha + \underline{\alpha}V - \underline{\alpha}B + B. \end{aligned} \tag{16}$$

Define

$$G_0^* = \max_{\underline{\alpha} \le \alpha \le \bar{\alpha}} G_0^*(\alpha). \tag{17}$$

Finding the optimal pair (θ, α) for $G_0(\theta, \alpha)$ requires two steps. First, we need to find the optimal α that maximizes $G_0^*(\alpha)$. Second, given the optimal α, we need to find the optimal θ that maximizes $G_0(\theta, \alpha)$ subject to the constraint $0 \le \theta \le 1 - \frac{\alpha}{\bar{\alpha}}$. We are now in a position to prove the three cases in Proposition 1.

Case 1: If $B - V \ge V - L$, we have $2(B - V) \ge B - L$. From Equation (15), we know

$$\frac{dG_0^*(\alpha)}{d\alpha} = -2\frac{B-V}{\bar{\alpha}}\alpha + \frac{B-L}{\bar{\alpha}}\underline{\alpha} \le 0. \tag{18}$$

If $C \le V - L$, then the maximum point of α in Equation (16) is $\underline{\alpha}$ because

$$\frac{dG_0^*(\alpha)}{d\alpha} = -2\frac{B-V-C}{\bar{\alpha}}\alpha + \frac{B-V}{\bar{\alpha}}\underline{\alpha} - C < 0. \tag{19}$$

The corresponding maximum expected payoff of a bank is

$$\frac{\underline{\alpha}^2}{\bar{\alpha}}C - \underline{\alpha}C + \underline{\alpha}V - \underline{\alpha}B + B \tag{20}$$

and the corresponding policy a bank uses can be seen from Equation (16), which is $\theta = 1 - \frac{\underline{\alpha}}{\bar{\alpha}}$ and $k = \frac{1}{\bar{\alpha}} \frac{\underline{\alpha}}{1-\theta} = 1$.

If $C > V - L$, then again the maximum point is $\underline{\alpha}$ because $G_0^*(\alpha)$ is determined by Equation (15) and, following Equation (18), is a decreasing function of α. The corresponding maximum expected payoff of a bank is

$$\underline{\alpha}L - \underline{\alpha}B + B + \frac{\underline{\alpha}^2(V-L)}{\bar{\alpha}}. \tag{21}$$

Combining Equations (20) and (21), we obtain

$$G_0^* = \max\left\{\frac{\underline{\alpha}^2}{\bar{\alpha}}C - \underline{\alpha}C + \underline{\alpha}V - \underline{\alpha}B + B, \underline{\alpha}L - \underline{\alpha}B + B + \frac{\underline{\alpha}^2(V-L)}{\bar{\alpha}}\right\}. \tag{22}$$

Unlocking Equation (22) by comparing Equations (20) and (21), we obtain the result for case 1.

Furthermore, under case 1, when the optimal policy of a bank is to randomly reject applicants, the percentage of borrowers who will apply for a loan workout request is

$$\alpha(\theta^*, k^*) = \max\left\{\underline{\alpha}, \alpha\left(0, \frac{\underline{\alpha}}{\bar{\alpha}}\right)\right\} = \max\left\{\underline{\alpha}, (1-0) \times \frac{\underline{\alpha}}{\bar{\alpha}} \times \bar{\alpha}\right\} = \underline{\alpha}. \tag{23}$$

This indicates that no pretenders will apply for a loan workout under this optimal policy.

Case 2: If $(2 - \frac{\underline{\alpha}}{\bar{\alpha}})(B - V) \le \frac{\underline{\alpha}}{\bar{\alpha}}(V - L)$, we have $2(B - V) \le \frac{\underline{\alpha}}{\bar{\alpha}}(B - L)$. From Equation (15), we know

$$\frac{dG_0^*(\alpha)}{d\alpha} = -2\frac{B-V}{\bar{\alpha}}\alpha + \frac{B-L}{\bar{\alpha}}\underline{\alpha} \ge 0. \tag{24}$$

Thus the maximum point of α in Equation (15) is $\bar{\alpha}$. The corresponding maximum expected payoff of a bank is

$$\underline{\alpha}L - \underline{\alpha}B + B + \frac{\bar{\alpha}^2(V-L)}{\bar{\alpha}} = B - (B - V)\bar{\alpha}. \tag{25}$$

From Equation (16), we know that

$$\frac{dG_0^*(\alpha)}{d\alpha} = -2\frac{B-V-C}{\bar{\alpha}}\alpha + \frac{B-V}{\bar{\alpha}}\underline{\alpha} - C. \tag{26}$$

If $C \le B-V$, $\frac{dG_0^*(\alpha)}{d\alpha} < 0$. The maximum point of α in Equation (16) is $\underline{\alpha}$. The corresponding maximum expected payoff of a bank is

$$\frac{\underline{\alpha}^2}{\bar{\alpha}}C - \underline{\alpha}C + \underline{\alpha}V - \underline{\alpha}B + B \tag{27}$$

and the corresponding policy the bank uses can be seen from Equation (16), which is $\theta = 1 - \frac{\underline{\alpha}}{\bar{\alpha}}$ and $k = 1$.

If $C > B-V$, then

$$\frac{d^2G_0^*(\alpha)}{d\alpha^2} = -2\frac{B-V-C}{\bar{\alpha}} > 0. \tag{28}$$

Therefore, under any circumstance, the maximum point will be either $\bar{\alpha}$ or $\underline{\alpha}$. But $\alpha = \bar{\alpha}$ implies that $\theta = 0$ and $k = 1$, thus $G_0^*(\bar{\alpha})$ is dominated by Equation (25) and cannot be optimal. Therefore, combining Equations (25) and (27), we obtain

$$G_0^* = \max\left\{\frac{\underline{\alpha}^2}{\bar{\alpha}}C - \underline{\alpha}C + \underline{\alpha}V - \underline{\alpha}B + B, B - (B-V)\bar{\alpha}\right\}. \tag{29}$$

Unlocking Equation (29) by comparing Equations (25) and (27), we obtain the result for case 2.

Case 3: If $\frac{\underline{\alpha}}{2\bar{\alpha}-\underline{\alpha}}(V-L) < B-V < V-L$, the maximum point α^* for Equation (15) must satisfy

$$\left.\frac{dG_0^*(\alpha)}{d\alpha}\right|_{\alpha=\alpha^*} = -2\frac{B-V}{\bar{\alpha}}\alpha^* + \frac{B-L}{\bar{\alpha}}\underline{\alpha} = 0, \tag{30}$$

which implies $\alpha^* = \frac{\underline{\alpha}(B-L)}{2(B-V)}$. The maximum expected payoff for Equation (15) is

$$\underline{\alpha}L - \underline{\alpha}B + B + \frac{\underline{\alpha}^2(B-L)^2}{4(B-V)\bar{\alpha}}. \tag{31}$$

The proof of this case is similar to that of cases 1 and 2. From Equation (16), we know

$$\frac{dG_0^*(\alpha)}{d\alpha} = -2\frac{B-V-C}{\bar{\alpha}}\alpha + \frac{B-V}{\bar{\alpha}}\underline{\alpha} - C. \tag{32}$$

If $C \leq B - V$, $\frac{dG_0^*(\alpha)}{d\alpha} < 0$. The maximum point of α in Equation (16) is $\underline{\alpha}$. The corresponding maximum expected payoff of a bank is

$$\frac{\underline{\alpha}^2}{\bar{\alpha}}C - \underline{\alpha}C + \underline{\alpha}V - \underline{\alpha}B + B \tag{33}$$

and the corresponding policy the bank uses can be seen from Equation (16), which is $\theta = 1 - \frac{\underline{\alpha}}{\bar{\alpha}}$ and $k = 1$.

If $C > B - V$, then

$$\frac{d^2 G_0^*(\alpha)}{d\alpha^2} = -2\frac{B - V - C}{\bar{\alpha}} > 0. \tag{34}$$

Therefore, under any circumstance, the maximum point is either $\bar{\alpha}$ or $\underline{\alpha}$. But $\alpha = \bar{\alpha}$ implies that $\theta = 0$ and $k = 1$, thus $G_0^*(\bar{\alpha})$ is dominated by Equation (31) and cannot be optimal. Therefore, combining Equations (31) with (33), we obtain

$$G_0^* = \max\left\{\frac{\underline{\alpha}^2}{\bar{\alpha}}C - \underline{\alpha}C + \underline{\alpha}V - \underline{\alpha}B + B, \underline{\alpha}L - \underline{\alpha}B + B + \frac{\underline{\alpha}^2(B-L)^2}{4(B-V)\bar{\alpha}}\right\}. \tag{35}$$

Unlocking Equation (35) by comparing Equations (31) and (33), we obtain the result for case 3.

Proof of Proposition 2. Case 1: When $B - V \leq \frac{\underline{\alpha}}{\bar{\alpha} - \underline{\alpha}}(V - L)$, then

$$\underline{\alpha}(B - L) - \alpha(B - V) \geq 0. \tag{36}$$

From Equation (8), we have

$$\begin{aligned} G_0(\theta, k, \alpha) &= \alpha\left\{\theta\left(\frac{\alpha - \underline{\alpha}}{\alpha}B + \frac{\underline{\alpha}}{\alpha}V - C\right)\right. \\ &\qquad \left. + (1-\theta)\left[kV + (1-k)\left(\frac{\alpha - \underline{\alpha}}{\alpha}B + \frac{\underline{\alpha}}{\alpha}L\right)\right]\right\} + (1-\alpha)B \\ &= \theta((\alpha - \underline{\alpha})B + \underline{\alpha}V - C) + (1-\alpha)B \\ &\quad + (1-\theta)\big[k(\underline{\alpha}(B-L) - \alpha(B-V)) + (\alpha - \underline{\alpha})B + \underline{\alpha}L\big]. \end{aligned} \tag{37}$$

From Equation (37), it is clear that $k^* = 1$ is the solution for any possible equilibrium. Therefore, to find an equilibrium set, we can set $k = 1$. Under this circumstance, a bank's expected payoff is

$$G_0(\theta, 1, \alpha) = \theta((\alpha - \underline{\alpha})(B - V) - \alpha C) + \alpha V + (1-\alpha)B. \tag{38}$$

If $C \geq (1 - \frac{\underline{\alpha}}{\bar{\alpha}})(B - V)$, to maximize $G_0(\theta, 1, \alpha)$ for any fixed α, θ^* should be zero. To be consistent, we must then have $\alpha^* = (1 - \theta^*)k^*\bar{\alpha} = \bar{\alpha}$.

If $C < (1 - \frac{\underline{\alpha}}{\bar{\alpha}})(B - V)$, then any point α that satisfies the condition

$$(\alpha - \underline{\alpha})(B - V) - \alpha C > 0 \tag{39}$$

cannot be an equilibrium point. This is true because if this α is an equilibrium point, then the bank will screen every applicant. This policy is not consistent with α. The same argument applies to any α such that

$$(\alpha - \underline{\alpha})(B - V) - \alpha C < 0. \tag{40}$$

Thus, in equilibrium, α^* must satisfy

$$(\alpha^* - \underline{\alpha})(B - V) - \alpha^* C = 0, \tag{41}$$

which implies that $\alpha^* = \frac{\underline{\alpha}(B-V)}{B-V-C}$ and, to be consistent, $\theta^* = 1 - \frac{\alpha^*}{\bar{\alpha}}$.

Case 2: When $B - V > \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V - L)$. Let $\alpha' = \frac{\underline{\alpha}(B-L)}{B-V}$. When $B - V > \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}(V - L)$, we know that $(B - V) > \frac{\underline{\alpha}}{\bar{\alpha}}(B - L)$ and this implies $\underline{\alpha} < \alpha' < \bar{\alpha}$. In order to check if a given α is an equilibrium point, we need to check three cases separately: $\alpha > \alpha'$, $\alpha < \alpha'$, and $\alpha = \alpha'$.

First, we note that there exists no equilibrium involving α such that $\alpha > \alpha'$. This is true because $\alpha > \alpha'$ implies

$$\underline{\alpha}(B - L) - \alpha(B - V) < 0, \tag{42}$$

which, following Equation (37), implies that $k^* = 0$. But $k^* = 0$ will also imply that the equilibrium point α should be $\underline{\alpha}$, which is inconsistent with our assumption that $\alpha > \alpha'$.

Second, if $\alpha^* < \alpha'$ is an equilibrium point, then

$$\underline{\alpha}(B - L) - \alpha(B - V) > 0, \tag{43}$$

which, following Equation (37), further implies that $k^* = 1$ and, to be consistent, $\theta^* = 1 - \frac{\alpha^*}{\bar{\alpha}}$. This requires that $C = (1 - \frac{\underline{\alpha}}{\alpha^*})(B - V)$.

Finally, if α' is an equilibrium point, to be consistent, $C \geq (1 - \frac{\underline{\alpha}}{\alpha'})(B - V)$. Otherwise the same argument in case 1 implies that $\theta^* = 1$, which is inconsistent with α' being an equilibrium point.

To summarize, we have

(1) If $C > (1 - \frac{\underline{\alpha}}{\alpha'})(B - V)$, then $\theta^* = 0$, $\alpha^* = \alpha'$, and $k^* = \frac{\alpha'}{\bar{\alpha}}$.
(2) If $C = (1 - \frac{\underline{\alpha}}{\alpha'})(B - V)$, then $\alpha^* = \alpha'$ and (θ^*, k^*) satisfies $(1 - \theta^*)k^* = \frac{\alpha'}{\bar{\alpha}}$.
(3) If $C < (1 - \frac{\underline{\alpha}}{\alpha'})(B - V)$, then $\alpha^* = \frac{\underline{\alpha}(B-V)}{B-V-C}$, $k^* = 1$ and $\theta^* = 1 - \frac{\alpha^*}{\bar{\alpha}}$.

Since $1 - \frac{\underline{\alpha}}{\alpha'} = \frac{V-L}{B-L}$, we obtain the results reported in Proposition 2.

Proof of Corollary 1. As in Proposition 2, we also divide the proof into two mutually exclusive cases: $\frac{B-V}{V-L} \leq \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}$ and $\frac{B-V}{V-L} > \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}$.

Case 1 (when $\frac{B-V}{V-L} \leq \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}$): This is also the condition for case 1 of Proposition 2. From Proposition 2, we know that $C_2^* = (1 - \frac{\underline{\alpha}}{\bar{\alpha}})(B - V)$. From Proposition 1, we know that

$$C_1^* = \begin{cases} \dfrac{\bar{\alpha}}{\underline{\alpha}}(B - V), & \text{if } \dfrac{B-V}{V-L} \leq \dfrac{\underline{\alpha}}{2\bar{\alpha} - \underline{\alpha}}. \\ \dfrac{(V - L) - \frac{\underline{\alpha}(B-L)^2}{4(B-V)\bar{\alpha}}}{1 - \frac{\underline{\alpha}}{\bar{\alpha}}}, & \text{if } \dfrac{\underline{\alpha}}{2\bar{\alpha} - \underline{\alpha}} < \dfrac{B-V}{V-L} \leq 1. \\ V - L, & \text{if } 1 < \dfrac{B-V}{V-L} \leq \dfrac{\underline{\alpha}}{\bar{\alpha} - \underline{\alpha}}. \end{cases} \tag{44}$$

Thus, if $\frac{B-V}{V-L} \leq \frac{\underline{\alpha}}{2\bar{\alpha}-\underline{\alpha}}$, then

$$C_1^* - C_2^* = \left(\frac{\bar{\alpha}}{\underline{\alpha}} + \frac{\underline{\alpha}}{\bar{\alpha}} - 1\right)(B - V) > B - V > 0. \tag{45}$$

If $\frac{\underline{\alpha}}{2\bar{\alpha}-\underline{\alpha}} \le \frac{B-V}{V-L} \le 1$, then

$$C_1^* - C_2^* = \frac{(V-L) - \frac{\underline{\alpha}(B-L)^2}{4(B-V)\bar{\alpha}}}{1-\frac{\underline{\alpha}}{\bar{\alpha}}} - \left(1-\frac{\underline{\alpha}}{\bar{\alpha}}\right)(B-V)$$

$$\ge \frac{\left[1-\left(1-\frac{\underline{\alpha}}{\bar{\alpha}}\right)\frac{\underline{\alpha}}{\bar{\alpha}}\right](V-L) - \frac{1}{2}(V-L)}{1-\frac{\underline{\alpha}}{\bar{\alpha}}} \ge \frac{1}{4}(V-L) > 0. \tag{46}$$

If $1 \le \frac{B-V}{V-L} \le \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}$, then

$$C_1^* - C_2^* = V - L - \left(1-\frac{\underline{\alpha}}{\bar{\alpha}}\right)(B-V) \ge 0. \tag{47}$$

Note that if $\underline{\alpha} < \frac{1}{2}\bar{\alpha}$, then this case might be vacuous.

Case 2 (when $\frac{B-V}{V-L} > \frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}}$): This is also the condition for case 2 in Proposition 2. From Proposition 2, we know that $C_2^* = \frac{V-L}{B-L}(B-V)$. From Proposition 1, we have

$$C_1^* = \begin{cases} \dfrac{(V-L) - \frac{\underline{\alpha}(B-L)^2}{4(B-V)\bar{\alpha}}}{1-\frac{\underline{\alpha}}{\bar{\alpha}}}, & \text{if } \dfrac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}} < \dfrac{B-V}{V-L} \le 1. \\ V-L, & \text{if } 1 < \dfrac{B-V}{V-L}. \end{cases} \tag{48}$$

Thus, if $\frac{\underline{\alpha}}{\bar{\alpha}-\underline{\alpha}} < \frac{B-V}{V-L} \le 1$, then

$$C_1^* - C_2^* = \frac{(V-L) - \frac{\underline{\alpha}(B-L)^2}{4(B-V)\bar{\alpha}}}{1-\frac{\underline{\alpha}}{\bar{\alpha}}} - \frac{V-L}{B-L}(B-V)$$

$$= \left[\frac{\frac{V-L}{B-V} - \frac{\underline{\alpha}(B-L)^2}{4(B-V)^2\bar{\alpha}}}{1-\frac{\underline{\alpha}}{\bar{\alpha}}} - \frac{V-L}{B-L}\right](B-V) > \frac{1}{4}(B-V) > 0. \tag{49}$$

Note that if $\underline{\alpha} > \frac{1}{2}\bar{\alpha}$, this case might be vacuous.

If $\frac{B-V}{V-L} > 1$, then

$$C_1^* - C_2^* = V - L - \frac{V-L}{B-L}(B-V) = \left(1-\frac{B-V}{B-L}\right)(V-L) > 0. \tag{50}$$

Thus we have shown that, under all circumstances, $C_1^* \ge C_2^*$. This means that it is easier for a bank to adopt a random rejection policy when its policies are not observable than when they are observable.

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