

CREDIT REPUTATION EQUILIBRIUM AND THE
THEORY OF CREDIT MARKETS

by

Chester S. Spatt*

Revised August 1985

*Carnegie-Mellon University.

I gratefully acknowledge stimulating conversations with Ken Dunn, Phil Dybvig, Marty Eichenbaum, Dennis Epple, Ravi Jagannathan, Steve Matthews, John McConnell, Tom Palfrey, Dan Peled and Steve Ross, helpful comments of seminar participants at the State University of New York at Buffalo, Carnegie-Mellon University, the University of Chicago, the University of Minnesota, the University of Pennsylvania, and Princeton University, and financial support from the National Science Foundation and the Subcommittee on Monetary Research of the Social Science Research Council. The usual disclaimer applies.

1. Introduction

The issue of under what conditions economic agents have an incentive for "honesty" in the credit market is a basic issue in banking and finance. This paper examines why some consumers are more likely than others to repay loans in the credit market. By developing an explicit "reputation" model that generates honest behavior by some borrowers and dishonesty by others, more powerful predictions can be obtained than by assuming this behavioral pattern. Credit markets have an especially rich set of empirical regularities and therefore, appear to be an especially fruitful market context in which to study the rational basis of honest behavior and misrepresentation.

A variety of stylized facts about credit markets will be explored in the model analyzed in this paper. Economic agents value having a reputation for good credit and therefore, resist defaulting even though it is short-run optimal not to repay a loan. Past default decisions of a borrower influence the market's perception of the characteristics of the agent and therefore, future borrowing opportunities. Access to the credit market and the resulting terms are determined by a borrower's credit history. Borrowers take these effects into account in their default decisions. Defaults occur despite borrower liquidity when the loan is due and repayments occur even on unsecured loans, despite a lack of collateral. Borrowers with high current returns typically repay and those with very low

returns default. Banks use the credit history of a borrower in determining whether to offer a loan, the interest rate to charge and the necessary security. Borrowers who have defaulted are often denied access to the market or quoted a higher interest rate than those who repaid.

This paper explains these observed phenomena by a dynamic game with asymmetric information. In the model the borrower has a short-term project in each period that can be financed with a short-term loan. The borrower decides in each period whether to undertake the project, and chooses a loan contract (a specification of the interest rate and collateral requirement) from those offered. The repayment default decision is made once the borrower observes the realized return from the project. The firm's future probability distribution of returns is modeled as conditional upon its most recent observation of returns, where the higher the current return the more favorable is the borrower's future rate of return distribution. The decision whether to default signals information about the borrower's future rate of return distribution in that the current realized return is not directly observable by banks. The future punishment of the banks upon default is either a higher interest rate or an outright credit denial (when there is no rate that can be charged to earn banks a competitive return). These punishments have greater cost to those with more favorable future opportunities (and current return). Under some circumstances this yields the equilibrium result of voluntary repayment by

those with good draws, demonstrating their future credit worthiness, and default by those with low current returns (despite adequate liquidity).

The learning by a competitive banking sector of the borrower's credit history results in market "punishment" of defaulters that is ex post rational and a "competitive" market response. In models of credit default (e.g., Stiglitz and Weiss [1983]) the lender has a long-run relationship with the borrower so that the treatment of defaulters can be designed to induce repayment. Yet, less favorable treatment of defaulters need not result from punishment by a bank with (e.g., ex post) monopoly power over the borrower. The game formalized here is one in which the terms available in the marketplace reflect anticipated defaults. In each period there are two banks (the banks are distinct in each period) so that applying a modified Bertrand undercutting argument implies that banks earn zero expected profits period is too high.¹ A competitive-like solution is the equilibrium of the game. In the model, the learning by the market rather than deliberate "punishment" by an individual bank, disciplines the borrowers (for this reason distinct banks are assumed in each period). The correlation in borrower returns and the lack of observability of these returns by the lender play central roles in the modeling strategy.

The main complexity in the modeling is that the competitive response of the banking, which is determined endogenously as an

equilibrium market response to the credit history, must have the correct incentive characteristics. The analysis focuses upon a two-period setting. Secured credit is the only type of credit the market will supply at the second date (all borrowers would default on unsecured credit in the second period). However, under the conditions derived unsecured credit will be offered in the first period. The moral hazard problem of default on the unsecured contract is resolved by introducing private information on the lender's subsequent opportunities and the use of end game enforcement.

The central purpose of this paper is to use a reputation approach to understand the behavior of lenders in punishing defaulters when the lender lacks a long-run contractual relationship with the borrower. This is a powerful paradigm for understanding behavior in the credit market and other contexts. The endogenous incentive to maintain a reputation has been previously shown in game theoretic environments with exogenous uncertainty (e.g., Kreps and Wilson [1982] and Milgrom and Roberts [1982]) or an infinite horizon (e.g., Dybvig and Spatt [1980]).

This research is also closely connected to several other strands in the literature. The role of learning in competitive markets has been used to understand observations in other settings (e.g., the analysis of managerial compensation of Holmstrom [1983], labor markets of Harris and Holmstrom [1982]

and insurance markets of Palfrey and Spatt [1985]). Adverse selection and moral hazard issues have also been studied in credit markets (e.g., Stiglitz and Weiss [1981, 1983]). Analytic credit evaluation models have been derived (e.g., Spence [1974]) and also tested empirically.

The analysis in this paper is somewhat topical in light of the considerable interest in repayment and default issues in international banking (e.g., the feared domino effects of country defaults). In fact, Eaton and Gersovitz [1981] and Sachs [1983] examine credit repudiation in international finance, but exogenously assume that those who default are indefinitely denied credit. (An interesting survey of models of international lending and related models is Crawford [1984].) Because our model uses enforcement at the horizon it is not directly applicable to international issues, but our reputation modeling strategy (compared to the standard long-run contracts approach) could prove quite useful in international markets. An infinite horizon reputation approach is briefly discussed in the concluding section.

In Section 2 I develop the basic model and some preliminary results. I examine voluntary repayment and default in Section 3. In Section 4 I consider the impact of usury ceilings and in Section 5 discuss the nature of mixed strategy equilibria. I conclude in Section 6.

2. The Model and Basic Results

Our model is a dynamic game with asymmetric information. The model is set up as a two period model and all consumers and banks are assumed risk neutral. The model has two dates within each period (there is no discounting within the period). In each period the consumer can borrow at the initial date to undertake a project that costs 1 and returns either α or δ at the second date in the period, where $\delta > \alpha$. Consumers are assumed to maximize expected intertemporal consumption applying a discount factor of β ($0 < \beta \leq 1$) to the second period (as illustrated by the case in which the market interest rate is zero, but the model terminates with probability $1-\beta$ after the first period). In the first period there is a uniform prior on a two point distribution of returns (.5 probability on each of the two points). The transition structure for the probability distribution is given by

$$\begin{aligned} q &= \text{Prob}(r_2 = \delta | r_1 = \delta) = \text{Prob}(r_2 = \alpha | r_1 = \alpha) \\ \text{and} \\ 1-q &= \text{Prob}(r_2 = \delta | r_1 = \alpha) = \text{Prob}(r_2 = \alpha | r_1 = \delta), \end{aligned}$$

where r_i denotes the realized return in period i and the retention probability q satisfies $.5 < q < 1$.² Therefore, the stochastic generating process is a positive first order Markovian process.³ If there is no loan in a period then the consumer still draws a realization, but does not observe it. In each period the borrower faces a two-stage decision process; the arguments of the strategies at both stages are the credit history and all past returns and at the second stage also includes the current return. At the first date in each period the consumer

decides whether to undertake the project and if so, which financing option to select from those offered by the banks. At the second date in a period the borrower decides whether to default after observing his current return realization. In much of our analysis we restrict attention to pure strategy repayment and default decisions. (We motivate this restriction in Section 5.)

The analysis assumes there are two banks in each period (see footnote 1). The banks are distinct in different periods so that there is no role for a bank to "punish" a borrower who previously defaulted at that bank. In our two-period world the game has five players, i.e., the borrower and two banks per period. Each bank observes the borrower's credit history (past borrowing decisions and defaults), but not the borrower's actual returns. The strategy of a bank is whether to offer a loan contract (in its period) and the terms (interest rate and collateral requirement). This strategy is a function of the credit history. The banks play prior to the borrower at the first date in each period.

Summarizing the timing of player moves, first, banks move simultaneously and offer the borrower loan contracts. Second, the borrower makes his investment choice and financing decision. Next, nature selects a return realization using the hypothesized stochastic specification. Finally, the borrower makes his repayment decision. The same sequence of moves then occurs in

the second period.

The set of feasible contracts is specified exogenously. Two different kinds of contracts are allowed. An unsecured contract specifies a gross interest rate, but lacks enforcement provisions. Repayment occurs under this contract only to enhance the borrower's reputation. There are no direct transaction costs associated with the unsecured contract. Under a secured loan the bank takes over the project in the event of non-payment of the gross interest (principal plus net interest), but foreclosure costs the bank c ($0 < c < \alpha$).⁴ Direct transaction costs occur under the secured contract when there is a positive probability of default.

Banks earn zero expected profit on any offered secured loan contract in that the contemporaneous rival would undercut any contract earning positive expected profit. (The same argument would apply to a situation of one bank per period with a potential entrant.) The gross interest rate on the secured contract is denoted by R^* and must satisfy $1 \leq R^* \leq \beta$. In the event of favorable return the borrower repays in order to make some current profit and develop a favorable credit reputation. In the case of an unfavorable return I restrict attention to the case in which the consumer defaults⁶ and then the lender receives $\alpha - c$. Because the expected return on the secured contract equals cost, $p R^* + (1-p) (\alpha - c) = 1$, where p is the bank's prior probability on the high realization so that

$$R^* = \frac{1-(\alpha-c)}{p} + \alpha - c.$$

As expected, the gross interest rate increases in the anticipated probability of default (so the interest rate is higher after a default than a repayment) and decreases in the amount the bank collects in the event of foreclosure. The gross interest rate is independent of δ (provided there is a feasible market clearing rate). If $p\delta + (1-p)(\alpha-c) < 1$, then there is no market clearing interest rate on secured (or unsecured) debt. If $p \geq [1-(\alpha-c)]/[\delta-(\alpha-c)]$, then the marketplace can provide a secured contract that breaks even.

The values of the exogenous parameters can be divided into several cases. The assumption $1 \leq \alpha \leq \delta$ implies that in the unique equilibrium the project is undertaken each period under a secured loan with gross interest equal to 1, the borrower does not default and the contract is costless in equilibrium.⁵ This equilibrium solution is clearly optimal because there are no foreclosure costs or credit denials for this efficient project. The condition $\alpha < \delta \leq 1$ implies that there is a unique Nash equilibrium in which no loans are undertaken (the fair odds condition cannot hold for any secured or unsecured contract since $p\delta + (1-p)\alpha < 1$ for $0 \leq p < 1$). The optimality of this equilibrium is implied by the inefficiency of the project. If $.5\delta + .5(\alpha-c) < 1$, then no secured (or unsecured) contract can initially finance the project not previously undertaken. Under this condition the banks will not offer financing. Therefore,

$\alpha < 1 < \delta$ and $.5\delta + .5(\alpha - c) \geq 1$ are assumed throughout the remainder of the analysis. Then, in the final (i.e., second) period only secured debt will be offered (unsecured debt will not be offered by any bank in the final period since all borrowers would default). Under our conditions financing is used in the last period when the favorable distribution of returns is anticipated. The supplemental condition $(1-q)\delta + q(\alpha - c) > 1$ must hold for the borrower to be able to obtain second period financing when the unfavorable distribution is anticipated. A denial of secured credit in the second period occurs when $(1-q)\delta + q(\alpha - c) < 1$ and the unfavorable distribution is anticipated (i.e., as shown in Section 3 after a default). When a secured loan is offered in the last period its interest rate is determined as above.

If secured debt is exogenously precluded, then no unsecured loans are issued in any finite horizon model. In the last period the borrower always defaults on an unsecured loan so that the loan would not be issued. The next to last period is then effectively the final period. By backwards recursion these non-collateralized instruments cannot be offered in any period of a finite horizon world.

3. Voluntary Repayment and Default

This section examines when unsecured debt is used in the first period. Borrower payments under unsecured debt are "voluntary." The second period banks draw inferences about the

return distribution from the period 1 default decision. The market response to default produces a more substantial penalty among those borrowers with a relatively favorable distribution (e.g., these are more likely to repay the full contractual rate in the future and they would also find a denial more costly). We derive the conditions for a separating equilibrium in which only those borrowers who obtain a good draw actually repay.⁷ (In Section 2 it was demonstrated that necessary conditions for the use of unsecured debt in period one include $.5\delta + .5(\alpha - c) \geq 1$ and $\alpha < 1 < \delta$. These conditions are imposed throughout the remainder of our analysis.)

Under a voluntary payment contract no consumer will repay a portion of the loan while being identified with the inferior distribution in the future.⁸ Therefore, in a separating equilibrium those who default make no payment under an unsecured contract. The amount paid by those who signal the favorable distribution yields the bank nonnegative expected profit. Using a standard Bertrand undercutting argument this gross interest rate must yield zero expected profit, i.e., the gross interest rate equals the reciprocal of the probability of repayment. Therefore, the gross interest rate on the unsecured contract in the first period must be 2 (recall the .5-.5 prior over first period realizations).

First consider the case $(1-q)\delta + q(\alpha - c) \geq 1$ (strengthening $.5\delta + .5(\alpha - c) \geq 1$) so that the project is always financed in the

second period. If the borrower defaults in a separating equilibrium, then the interest rate on the period two secured loan is

$$R_2 = \frac{1}{1-q} (1-(\alpha-c)) + (\alpha-c),$$

while those who repay face a subsequent interest rate of

$$R_1 = \frac{1}{q} (1-(\alpha-c)) + (\alpha-c).$$

The present worth of the expected gain to repayment by those who receive a good draw in period one is

$$\beta q (R_2 - R_1) = (1-(\alpha-c)) \beta q \left(\frac{1}{1-q} - \frac{1}{q} \right)$$

The analogous expression for those who receive the bad draw in period one is

$$(1-(\alpha-c)) \beta (1-q) \left(\frac{1}{1-q} - \frac{1}{q} \right).$$

The penalty to default must be larger for those with favorable future opportunities. The separating conditions that guarantee repayment by those with the favorable future opportunities and default by others are given by

$$(1-(\alpha-c)) \beta q \left(\frac{1}{1-q} - \frac{1}{q} \right) \geq 2 \quad (1)$$

and

$$(1-(\alpha-c)) \beta (1-q) \left(\frac{1}{1-q} - \frac{1}{q} \right) \leq 2. \quad (2)$$

The first condition can be rewritten as

$$q \geq \frac{2 + \beta [1-(\alpha-c)]}{2 + 2\beta [1-(\alpha-c)]} \equiv k^*,$$

where $\frac{3}{4} < k^* < 1$.

Condition (1) holds provided that the unconditional returns are correlated enough. Notice that condition (2) holds generally⁹ so that those with bad draws always want to default when $(1-q)\delta + q(\alpha-c) \geq 1$.

In a sense this explains default without relying on illiquidity. Adequate liquidity is guaranteed by endowing each agent with enough additional resources at the second date in each period to repay the loan. Then, the separating condition (2) rather than liquidity considerations explains default by those with a poor realization. To guarantee that the agent with the good return repays we impose the separating condition (1),

$$(1-(\alpha-c)) \beta q \left(\frac{1}{1-q} - \frac{1}{q} \right) \geq 2.$$

In this solution there is a reputation rationale for repayment of unsecured debt prior to the final period. If this separating equilibrium is feasible, then the unsecured contract dominates the secured alternative (which imposes positive expected foreclosure cost).

Decreasing α or increasing c increases the market punishment to default, potentially resulting in satisfaction of condition (1) only after the shift. A small increase in foreclosure cost (or decline in return in the bad state) in some circumstances results in an incentive for the borrower to repay an unsecured first period loan in the event of a favorable return. These changes in α or c can actually make the consumer better off by making first period unsecured debt (with zero transactions costs) viable.

The analysis of a market-based disciplining effect of credit reputation assumes that the project is financed in the market. Extra resources available in the first period in principle could be used to finance the project in the second period rather than to consume in the first period. However, it is costly for consumers to save because of the discounting (e.g., consumers would pay to avoid holding consumable resources in the event of their own premature death). If this cost of savings exceeds the expected cost of foreclosure of second period debt, then all financing is external. The condition

$$1 - \beta \geq \beta q c \tag{3}$$

implies that c is small enough so that external financing is attractive, even in the case of an unfavorable second period opportunity set. Even for those who default, it is cheaper to finance through the market if condition (3) holds. Discounting

is clearly necessary for (3) to hold. Under condition (3) the external financing arrangements are not disrupted by a consumer maximizing expected consumption. An alternative to (3) is to directly assume that it is too costly to store the good between periods. For example, if the goods is perishable then none of the good is saved and all financing occurs through the market.

Next we examine when the project is not financed in period two in the event of a bad realization in period one, i.e., $(1-q) \delta + q (\alpha - c) < 1 \leq .5\delta + .5(\alpha - c)$.¹⁰ As earlier there is a greater penalty to default by those with favorable opportunities. A borrower with the good return repays if

$$\beta q (\delta - R_1) \geq 2,$$

$$\text{or} \quad \beta (\delta q + (1-q) (\alpha - c) - 1) \geq 2. \quad (4)$$

A borrower with the bad return defaults if

$$\beta (1-q) (\delta - R_1) \leq 2$$

or

$$\frac{1}{q} \beta (1-q) (\delta q + (1-q) (\alpha - c) - 1) \leq 2. \quad (5)$$

Unlike condition (2), condition (5) does not hold for all values. However, the separating conditions (4) and (5) are consistent for some parameter values. If the separating solution is feasible, then unsecured debt drives secured debt out of the market in the first period. This analysis again assumes that financing by the market is optimal in the second period, provided that some form

of financing is optimal.

The sequence of contracts obtained in either type of separating equilibrium (i.e., with no credit denial in period two or a credit denial only in the bad state) is efficient subject to the informational constraints imposed by the environment. In particular, long-term contracts would not improve the equilibrium allocations. The potential departures from unconstrained efficiency are the contract enforcement costs (on unsecured credit), the use of savings rather than market financing of projects, and inefficient project selection (e.g., a credit denial that is inefficient given the available information). In our separating solutions the only actual departures from first best efficiency arise from the second period enforcement costs on secured loans. Second project financing occurs only when efficient and the resulting enforcement costs cannot be avoided in the final period by the use of long-term contracts. In contrast, if secured contracts are used in both periods (e.g., when a separating equilibrium is not feasible), then the equilibrium sequence of contracts need not be informationally constrained Pareto efficient.

4. Usury Laws

Governments often impose a ceiling on the interest rate charged on any loan agreement. The reputation model analyzed in this paper is useful in identifying several effects of a usury law, some of which are not readily apparent.

Consider the impact of a usury law in the first period of a two-period world. The interest rate on an unsecured contract is above that on the secured loan. If the usury ceiling is below the unsecured rate, then the unsecured contract is infeasible. Consumers would be forced to use the costly secured contract. In fact, suppose the observed interest rate on the secured contract is strictly below the usury ceiling. Then, the usury law is costly even though there is no outright denial of financing and the usury ceiling does not hold with equality on the observed (i.e., secured) contract. Alternatively, if the usury rate is high enough then it is not binding, and if it is below the secured rate then a traditional denial of market financing occurs (more costly self-financing could arise though).

Next consider potential effects of a usury law that is fully anticipated, but imposed only in period two. If the usury rate is low enough, then all second period market financing will be eliminated. This transforms the first period into the final period so that a secured contract must be used at that date. Both the second period denial and the first period requirement of security can hurt the borrower. When $(1-q) \delta + q (\alpha - c) \geq 1$, a somewhat higher usury rate in the second period will lead to a denial of financing only in the bad state in situations in which financing would otherwise be available in both states in period two. This increases the punishment to default and can make feasible a previously infeasible unsecured loan in period one.

The usury law in this case acts as a way to precommit the market. To verify that the usury ceiling can make an unsecured loan feasible in the previous period we note the consistency of the following conditions:

$$(1-q) \delta + q (\alpha - c) \geq 1 \quad (a),$$

$$\frac{1}{q} (1 - (\alpha - c)) + (\alpha - c) \leq \text{Usury Rate} < \frac{1}{1-q} (1 - (\alpha - c)) + (\alpha - c) \quad (b),$$

$$(1 - (\alpha - c)) \beta + q \left[\frac{1}{1-q} - \frac{1}{q} \right] < 2 \quad (c),$$

$$\beta (q\delta + (1-q) (\alpha - c) - 1) \geq 2 \quad (d),$$

$$\beta \frac{(1-q)}{q} [q\delta + (1-q) (\alpha - c) - 1] \leq 2 \quad (e),$$

$$\text{and } 1 - \beta \geq \beta + q c \quad (f).$$

Condition (a) guarantees that there would be no second period denial without the usury law and condition (b) implies there is a denial of credit in the second period only in the bad state under the usury law. Condition (c) establishes the infeasibility of an unsecured first period loan without the usury law, while conditions (d) and (e) establish the feasibility of the period one unsecured loan in the presence of a period two usury law. Condition (f) guarantees the use of external (market) finance. These conditions are clearly consistent. For example, let $q = .9$, $1 > \alpha > c > 0$, $\alpha - c \approx 0$, $\delta = 70/3$, $.1 < \beta < .25$ and $(1 + 1/9) < \text{Usury Rate} < 10$. The consumer is actually better off in some circumstances with the usury law, because the law precommits the financial market to deny credit to a borrower who defaults. This

increases the effective punishment of default and makes the unsecured contract viable in the above example. This contrasts sharply with the usual perceived impact of usury laws and illustrates the power of the modeling approach. The usury law is beneficial provided the expected savings in foreclosure costs in the first period (as a result of making the unsecured debt viable) exceeds the expected second period cost of the denial of credit, i.e.,

$$\frac{1}{2} c > \frac{1}{2} \beta (1-q) (\$ - R_2)$$

or $c > \beta [\$ (1-q) + q (\alpha - c) - 1] .$

In our numerical example this reduces to $.75 c > \beta$, which is satisfied for some parameter values.¹¹

The example above can be extended so that the usury ceiling applies to the first period as well as the second period. The first period gross interest rate on the unsecured contract is 2 (since the default rate is .5) so that the usury law is not binding in the first period provided Usury Rate ≥ 2 . Therefore, the example of the usury law facilitating the use of unsecured credit and in some instances being beneficial extends to the case of a uniform usury ceiling through time.

5. Mixed Strategies

This section considers the possibility of equilibria with mixed strategies. The manner in which mixing arises is for agents to randomize their repayment decision on the unsecured first period debt. The probability of repayment in such a

solution depends upon the project's realized return in the first period.

When a pure strategy equilibrium exists with the banks earning zero profits, such a solution will drive out or be comparable to any solution with mixing. Since the banks earn zero profits in all equilibria, the cost of any inefficiency is borne by the borrower. Competition among banks will then drive the solution toward one with the minimal degree of inefficiency. In the model specified earlier the borrower can pick an initial contract that induces a path which yields him the greatest expected discounted consumption. If a pure strategy equilibrium exists and yields zero profits to the banks, then no potential solution with mixing can dominate and in many situations the pure strategy equilibrium strictly dominates any alternative with mixing. This motivates focusing upon pure strategies as long as the pure strategy separating equilibrium exists. The pure strategy equilibrium developed earlier is attractive because inefficient internal finance of the project is never used and the project is undertaken if and only if it is optimal to do so. No potential equilibrium with mixing can be more desirable to the borrower and in many situations mixing is strictly dominated.

The use of mixed strategies raises the possibility of an ex post adverse selection problem. In particular, if a borrower with the favorable opportunity set plays a mixed strategy and one with the unfavorable distribution defaults, then a borrower who

defaults could be either type and retains private information about his type. Then, a pooling contract in the second period to those who default would be broken in some circumstances in which the borrower can partially or wholly finance the period two project from foregone consumption. For example, those with the favorable distribution who mixed might use some internal financing in period two in order to undercut the pooled interest rate.

To avoid this ex post adverse selection problem we assume that the good perishes between periods. Then the appropriate second interest rate for those who default in period one reflects the used mixing strategies of those with favorable opportunities and those with the unfavorable distribution. Punishment to default is necessary to ensure that the borrower will sometimes repay. This punishment will be more costly for those with the more favorable distribution so that both types of agents cannot be simultaneously indifferent between repayment and default. Therefore, at most one of the two types can mix. We now suppose $(1-q) \delta + q(\alpha - c) < 1$ so that an ex post denial of credit to an agent with the bad second period distribution is efficient. Under a mixed strategy solution all the agents whose second period type cannot be inferred from their payment decision are either all given ex post profitable credit or denied credit (depending on the parameter values). This is inefficient relative to the information that is actually available to the borrower. Since the borrower effectively chooses the form of the

equilibrium and ex ante bears the inefficiency, mixing is dominated.

If instead $(1-q) \delta + q (\alpha - c) \geq 1$, then a borrower with unfavorable opportunities cannot mix. This follows from an argument analogous to footnote 9. By a continuity and monotonicity argument, we can show that there is one mixing probability for those with the favorable return distribution consistent with those agents being indifferent between repayment and default. Then, the first period aggregate repayment probability is below .5 and the market clearing rate on first period unsecured debt must exceed 2 (the rate in the pure strategy solution). Those who repay in the mixed solution are known to have received a good draw so that the interest rate on the second period loan is the same as in the pure strategy equilibrium. The mixing of agents with low future default rates with the set of defaulters reduces the second period interest rate for defaulters from that in the pure strategy solution. This mixed solution entails a higher first period rate on the unsecured debt and a lower second period secured interest rate in the event of default (compared with the pure strategy equilibrium). Because the mixed strategy solution in this case imposes no ex ante costs (compared to the pure strategy solution), it is a plausible alternative solution.

I have not ruled out an interesting mixed strategy solution arising when the pure strategy solution cannot support unsecured debt in the first period. It also would be interesting if mixed

strategies were useful in some situations in circumventing policy restrictions such as a usury law.

6. Conclusion

The model explains a variety of stylized aspects of credit markets. For example, the analysis suggests that borrowers with high returns repay loans and those with low returns default. These features are obtained in a setting in which repayment is voluntary and borrowers always have adequate liquidity to repay. The market adjusts in a natural manner, charging a higher interest rate or denying credit to those who default. These results are obtained without a long-run relationship between the borrower and a particular lender.

Various extensions seem natural. An analysis of the n -period model should explicitly show the potential for defaulters to rehabilitate themselves, i.e., those who default by repaying a subsequent loan can obtain favorable terms in the future, and allow analysis of the determination of collateral requirements and the length of credit denials. The effects of various public policies toward credit markets (besides usury laws) such as restrictions on credit remedies can be addressed in this sort of model. It also would be interesting to consider alternative stochastic specifications that produce richer signaling structures.

Finally, it would be interesting to contrast our finite

horizon model of credit market reputation with an infinite horizon specification (with only unsecured contracts). (This approach would be especially natural in international debt markets.) An example of consistent endogenous beliefs by banks and borrowers about the punishment strategies of other banks in such a setting occurs when banks believe that all other banks will deny credit indefinitely to anyone who has defaulted in the past. Then there is no potential punishment associated with a second default and if each bank only exists for a single period there will be an equilibrium in which defaulters are shut out of the market (see Dybvig and Spatt [1980] in another context). Less stringent market punishment such as more limited credit denials or higher interest rates to defaulters could also be viable.

Footnotes

1. The market structure could be set up in a variety of equivalent ways. The Bertrand competition argument will apply, even if the consumer had previously borrowed from other banks in the market, provided there are at least two banks in the market in each period who have not issued a loan to the consumer earlier. The competition eliminates any monopoly power of the earlier lending institution.
2. In the 2-period environment the stochastic structure is identical to one in which the borrower does not know his true type, but realizations are identically, independently distributed. The first period distribution is his prior and the second period distribution is an updating of the prior to reflect the first period realization. The stochastic structure in the text is then obtained if it is equiprobable that the project has a high return with probability q and $1-q$.
3. The positive correlation is used so that repayments signal a favorable return distribution and a high future repayment probability.
4. The forms used for the contracts are selected for simplicity, though they are somewhat stylized. Reputation induced repayments can only occur on the unsecured contract, but the secured contract prevents the solution from unravelling.
5. This equilibrium is unique when $1 \leq \alpha < \delta$. In the last period a secured contract with $R^* = 1$ is the only equilibrium possibility (unsecured debt is not feasible in the final period). There is no punishment during the last period to any earlier default. Therefore, only secured debt is viable in the next to last period. By induction the proposed equilibrium is unique.
6. In the final period a consumer with the low return would default even in the absence of liquidity constraints. In the initial period the consumer defaults as long as the reputational gain from repayment is less than the interest rate to be repaid net of the project's return. The net cost of repayment is the $[2-(\alpha-c)]-\alpha$. In cases in which those who have defaulted in period one are not denied credit in period two, default is trivially optimal for those with the low first period return (footnote 9 later examines explicitly the analogous point for the unsecured contract).
7. In any equilibrium there must be a positive probability that the borrower will repay his first period loan. Further, in the case in which credit is never denied in the second period, footnote 8 shows that those with a low return default.
8. In Section 3 I restrict attention to deterministic repayment

strategies (i.e., pure strategies). (Mixed strategies are discussed in Section 5.) One potentially interesting sort of pure strategy is a partial payment strategy. In any separating solution the borrowers labelled as inferior have an incentive to completely default. The borrowers identified as possessing favorable future opportunities repay to at least a degree. Any partial payment made by these borrowers must enable the lender to earn its competitive return in equilibrium. Then, without loss of generality interpret the borrower's payment as the full payment required. A more interesting role for partial payments could arise in a model with a richer distribution of first period returns (e.g., the level of the partial payment might serve as a fully revealing signal).

9. Condition (2) can be verified in that

$$(1-(\alpha-c)) \beta (1-q) \left(\frac{1}{1-q} - \frac{1}{q} \right) \leq (1-(\alpha-c)) \beta \left(1 - \frac{1-q}{q} \right) < 1 < 2.$$

10. We are also assuming that internal finance is costly enough so that the project will be financed externally, if at all. Condition (3), i.e., $1 - \beta \geq \beta q c$, is sufficient for this assumption.

11. In practice I suspect that the traditional effects of the usury ceiling will be more important than the intertemporal reputation effects described here.

References

Crawford, V., "International Lending, Long-Term Credit Relationships, and Dynamic Contract Theory," Department of Economics, University of California at San Diego Discussion Paper No. 84-14, Aug. 1984.

Dybvig, P. and C. Spatt, "Does It Pay to Maintain a Reputation? Consumer Information and Product Quality," unpublished manuscript, July 1980.

Eaton, J. and M. Gersovitz, "Debt with Potential Repudiation: Theoretical and Empirical Analysis," *Review of Economic Studies* 48 (1981), 289-309.

Harris, M. and B. Holmstrom, "A Theory of Wage Dynamics," *Review of Economic Studies* 49 (July 1982), 315-333.

Holmstrom, B., "Managerial Incentive Problems - A Dynamic Perspective," in *Essays in Economics and Management in Honour of Lars Wahlbeck*, pp. 209-230.

Kreps, D. and R. Wilson, "Reputation and Imperfect Information," *Journal of Economic Theory* 27 (Aug. 1982), 253-279.

Milgrom, P. and J. Roberts, "Predation, Reputation, and Entry Deterrence," *Journal of Economic Theory* 27 (Aug. 1982), 280-312.

Palfrey, T. and C. Spatt, "Repeated Insurance Contracts and Learning," *Rand Journal of Economics*, forthcoming, 1985.

Sachs, J., "Theoretical Issues in International Borrowing," NBER Working Paper Series No. 1189, Aug. 1983.

Spence, A. M., *Market Signaling: Informational Transfer in Hiring and Related Screening Processes*, Cambridge, Mass.: Harvard University Press, 1974.

Stiglitz, J. and A. Weiss, "Credit Rationing in Markets with Imperfect Information," *American Economic Review* 71 (June 1981), 393-410.

Stiglitz, J. and A. Weiss, "Incentive Effects of Terminations: Applications to the Credit and Labor Markets," *American Economic Review* 73 (Dec. 1983), 912-927.