IMPERFECT INFORMATION, UNCERTAINTY, AND CREDIT RATIONING*

DWIGHT M. JAFFEE AND THOMAS RUSSELL

I. INTRODUCTION

The mechanism and rationale of credit rationing behavior by lending institutions is now the focus of an extensive literature. Credit rationing occurs when lenders quote an interest rate on loans and then proceed to supply a smaller loan size than that demanded by the borrowers. In normal markets such excess demand tends to raise the price (or interest rate), whereas the credit rationing literature isolates the factors that make loan markets different. The discussions of credit rationing have largely stressed institutionally given aspects of loan markets such as usury ceilings, borrower-lender "relationships," risk standards, and various constraints on price setting. In another paper we indicate that this literature begs the question of what basic forces lead to observed loan market institutions.[1] We suggest, moreover, that these institutions, as well as credit rationing itself, can be explained on a fundamental level by the same principles of moral hazard and adverse selection that have been used recently to explain a variety of market failures.[2]

In this paper we develop a more specific model of how imperfect information and uncertainty can lead to rationing in loan markets. As a simple and direct example of the mechanism, we assume, at the extremes, that there are both "honest" and "dishonest" borrowers. Honest borrowers accept only loan contracts that they expect to repay and, under our assumptions, they do in fact repay them. Dishonest individuals, in contrast, default on loans whenever the costs of default

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1. See Jaffee and Russell (undated). The literature on credit rationing has also been surveyed in more detail in Jaffee (1971).

2. See, for example, Akerlof (1970) and Arrow (1963).

are sufficiently low. Lenders, however, are unable to distinguish between the two types of individuals on an *a priori* basis.[3] Alternatively, we indicate how the same model can be applied where the two sets of individuals are "lucky" and "unlucky." The focus of the paper is then to analyze lender and market behavior in a context where the two types of borrowers (or a continuum of such borrowers) are known to exist, but in which individuals can be identified only by actual defaults. We demonstrate, in particular, how credit rationing arises as a means of market response to adverse selection, as well as other interesting features of the resulting equilibrium.

II. THE MODEL OF BORROWING BEHAVIOR

A. Honest Borrowers

The setting is a two-period Fisherian consumption model. We assume a large number of individuals who are identical in all respects and who are honest (in the sense indicated below). Each individual has a utility function, $U[C_1, C_2]$, defined over his consumption in the two periods and for which we assume quasi-concavity. Each individual has an exogenous income stream for the two periods (Y_1, Y_2), which is paid at the beginning of each period. We assume for the moment that individuals can borrow in perfect capital markets, taking as given the one-period interest rate r. Loans are taken out at the beginning of the first period (to augment period-1 consumption) and are repaid with interest at the beginning of the second period (reducing period-2 consumption). The demand curve for loans of an individual can be determined from the solution to the problem:

Maximize $U[C_1, C_2]$ with respect to C_1, C_2,
subject to $C_2 = Y_2 - (C_1 - Y_1)(R)$.
R is the interest rate factor, defined as $R = 1 + r$.

The loan quantity is given in the budget constraint by $(C_1 - Y_1)$, and the use of this constraint implies the assumed condition of honesty.

It is useful to restate the problem with explicit notation for the loan quantity. Thus, let the budget constraint take the form

3. It is more precise to describe our honest individuals as "pathologically" honest, since they refuse to default even when there are incentives to do so, and to describe our dishonest individuals as "potentially" dishonest, since there are many cases where they reveal only honest behavior; for brevity, however, we use only the labels "honest" and "dishonest." For an interesting discussion of the issues of morality and economic maximization that lie behind questions of honest and dishonest behavior, see the interchange between Arrow (1968) and Pauly (1968).

$$C_1 = L + Y_1, \tag{1}$$

$$C_2 = Y_2 - LR. \tag{2}$$

where L is the loan principle. With the substitution of (1) and (2) into the utility function $U[C_1, C_2]$, the problem can now be stated as an unconstrained maximization:

Maximize $U[L + Y_1, Y_2 - LR]$ with respect to L.

The first-order condition for the solution is

$$\frac{dU}{dL} = U_1 - U_2R = 0, \tag{3}$$

where U_i is the partial derivative of U with respect to its ith argument. This will lead to a loan demand function of the form

$$L^* = L^*[R], \tag{4}$$

where, for convenience, we have suppressed the fixed values of Y_1 and Y_2. We assume that dL^*/dR is negative, that L^* is zero at some finite R, and that L^* approaches infinity as R approaches zero.[4]

It is also useful to derive the iso-utility curves of the individual in (L, R) space. These are derived from the condition

$$U[L + Y_1, Y_2 - LR] = K \text{ (a constant)}, \tag{5}$$

by varying the parameter K. A family of such curves is shown in Figure I with the properties that they have zero slope where they intersect the demand function, and that they are monotonically rising and falling below and above the demand curve, respectively. This shape is the result of the properties of the utility function and a proof is given in Appendix A.

B. Dishonest Borrowers

Dishonest borrowers are identical to honest borrowers except that they default on their loans whenever their utility is increased by doing so. We introduce, however, two additional conditions that come into play when default is considered:

(*i*) *The observed loan demand of dishonest individuals must equal the loan demand of honest individuals.* If this condition were

4. These properties hold, for example, with an exponential utility function; see Jaffee and Russell (1976). In general, of course, this type of specification results in the individual being either a borrower ($L > 0$) or a lender ($L < 0$), depending on the interest rate. It is thus clear that there is an interest rate at which loan demand is exactly zero. On the other hand, we are not concerned with the possibility of individual lending, and thus assume that the utility function or income endowments are chosen such as to insure nonnegative borrowing demand at any of the relevant interest rates.

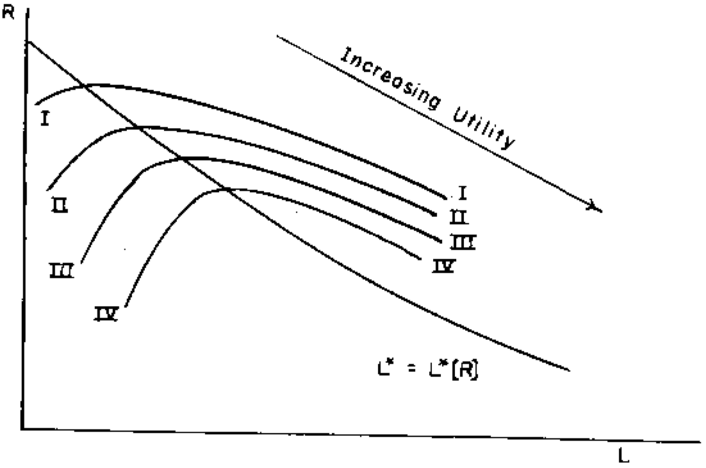

FIGURE I

not met, then lenders could distinguish honest and dishonest individuals. The result, of course, would be that lenders would grant no loans to the evidently dishonest borrowers.

(*ii*) *There is a cost to default that is measured by a constant Z and which is subtracted from the second-period income* Y_2 *when default occurs.* This penalty for default may be interpreted as a reduction in the earning capabilities of dishonest individuals following their revealed default.[5]

The dishonest individual must make a decision, operating under these constraints, between two possible courses of action. He will attempt to maximize the utility function $U[C_1, C_2]$ either by following the honest course that yields

$$C_1 = Y_1 + L^*$$
$$C_2 = Y_2 - L^*R$$

or by following the default course that yields

$$C_1 = Y_1 + L^*$$
$$C_2 = Y_2 - Z,$$

where L^* is still the demand of equation (4). In both courses the C_1

5. There is the problem that repayment of the loan cannot take place and default cannot be revealed until Y_2 has been received. We can assume, however, that Y_2 is received as a continuing flow during period 2, and that this flow ceases as soon as default occurs. Or, alternatively, we can interpret Z as a penalty that is independent of the actual flow of Y_2.

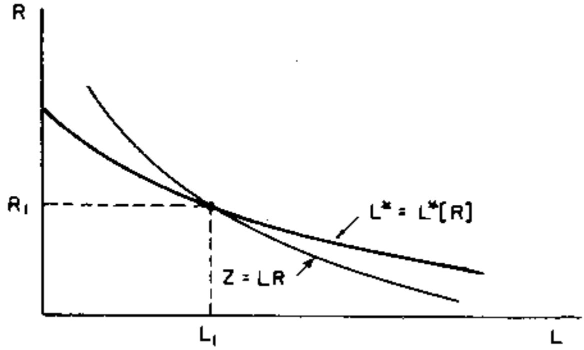

FIGURE II

consumption reflects the L^* demand by direct force of condition (i) above. The two courses thus differ only in their C_2 level, and dishonest individuals choose default whenever $Z < L^*R$; that is, whenever the penalty of default is less than the contracted repayment.[6]

Figure II illustrates some specific properties of the default behavior. The demand curve $L^*[R]$ is the same as in Figure I, based on the maximizing behavior of honest individuals. The default curve $Z = LR$ is the locus of contract sizes above which default will occur. Thus, as pictured in Figure II, along the demand curve default will occur for contracts with an interest rate factor below R_1 or, equivalently, with loan sizes greater than L_1. It is noteworthy that the figure is drawn with one intersection of the demand curve and default locus, and that the default locus cuts the demand curve from above. These properties are motivated by the following considerations:

(*i*) *By assumption, the demand curve intersects the* R *axis, while the default locus is a rectangular hyperbola.* They must intersect, therefore, unless the default locus lies everywhere above the demand curve. The position of the default locus depends, however, on the cost of default Z, and we assume that this value is low enough to create default possibilities. Thus, there must be at least one point of intersection.

(*ii*) *We assume that the utility function* $U[C_1, C_2]$ *has the property of gross substitution between* C_1 *and* C_2. Since the interest rate factor R is the relative price of period-1 consumption, gross

6. This specification may appear restrictive in that it requires dishonest individuals not only to demand the same loan as honest individuals, but also to have the same C_1 as their honest counterparts. In fact, however, the incentives of dishonest individuals are to increase their period-1 consumption, but they are constrained by the budget condition (1). Thus, the "same loan demand" condition implies the "same C_1" condition.

substitution implies that period-2 consumption C_2 falls as R falls. As developed in Jaffee and Russell (1976), the exponential utility function meets this condition. Since $C_2 = Y_2 - LR$, the condition that C_2 falls as R falls is equivalent to the condition that the contract size LR rises as R falls along the demand curve. Along the default locus, on the other hand, LR is constant as R falls. Consequently, the default locus cuts the demand curve from above, and they intersect only once.

The behavior described so far has the features that (a) there is a sharp distinction between honest and dishonest individuals; and (b) it yields the result that all dishonest individuals default over exactly the same range of contracts. Fortunately, we can make the model more realistic in these respects, while at the same time facilitating the analysis of lender response (Section III). We now allow the cost of default Z to vary among individuals, with the result that the default range in terms of contract size LR also varies.[7] In particular, let $Z_{\max}$ be such that individuals with this Z never default. Individuals with $Z_{\max}$ *behave* "honestly," while their *motivation* may be either *moral* if $Z_{\max}$ reflects "moral costs," or *economic* if $Z_{\max}$ reflects simply economic costs.

It is useful to make continuity and limit restrictions on the range of Z values. The smallest existing Z value is of interest, since this value sets the range of contracts over which default behavior is observed. Denote this value as $Z_{\min}$, and associate with it the minimum loan size at which default is observed. In addition, we assume that the distribution of Z values beginning with $Z_{\min}$ is continuous. These assumptions are sufficient to determine a function $\lambda[LR]$, where λ is the proportion of individuals *who do not default* when offered a contract size LR. Such a λ function is drawn in Figure III, and it has the following properties:[8]

(6) $$\lambda[LR] = 1 \text{ for } LR \leq Z_{\min};$$

(7) $$\lambda[LR] \text{ is continuous with } \lambda'[LR] < 0 \text{ for } LR > Z_{\min}.$$

7. A natural implication of this assumption is that lenders would use devices to determine *a priori* the default thresholds of borrowers. Examples of such devices include the various risk screens in use such as income, age, and collateral requirements. In our model, such devices would allow the lender to identify and to influence the default behavior of the distinguishable group. Given the optimal use of these devices, our results would then apply to credit rationing behavior *within* each distinguished group.

8. The condition of equality in condition (6) is intentional. It indicates that individuals will not default when the costs of defaulting exactly equal the benefits. This may be interpreted as the ethical ordering that takes effect when the individual is indifferent on purely economic grounds.

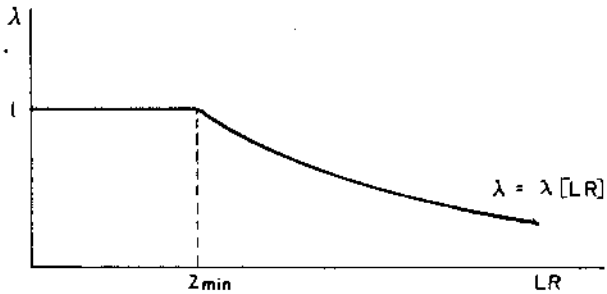

FIGURE III

C. "Lucky" and "Unlucky" Borrowers

The relationship between default proportions and contract sizes embodied in the $\lambda[LR]$ function is the critical input required in the remainder of this paper. Consequently, our results are equally valid for other factors of uncertainty and imperfect information, as long as they imply default patterns that can be characterized by a function such as $\lambda[LR]$. We outline here an example where individuals are lucky and unlucky.

Let all individuals, as above, possess the same utility function $U[C_1, C_2]$ and the same period-1 income Y_1. Assume now, however, that period-2 income is a stochastic variable denoted as $\tilde{Y}_2$. Individuals determine their loan demand by maximizing the utility function taking into account in some way the stochastic feature of $\tilde{Y}_2$. For example, if Y_2 denotes the mean of $\tilde{Y}_2$, and if individuals treat Y_2 as the certainty equivalent of $\tilde{Y}_2$, then the loan demand derivation of subsection II.A above remains valid. That is, the observed loan demand behavior for this "lucky" case is the same as for the "honest" case. Moreover, in an ex ante sense, all individuals in this model are honest, since they do not plan to default. Ex post, however, $\tilde{Y}_2$ may be determined by values below Y_2, and sufficiently unlucky individuals will default on their loans.

Let Z be a stochastic variable equal to $\tilde{Y}_2 - Y_2$. Default occurs whenever second-period income $(Y_2 + Z)$ is less than the loan contract LR; that is, whenever, $Z < LR - Y_2$. This condition is identical to the "honest-dishonest" condition for default except for the constant displacement of Y_2. Furthermore, it is reasonable that Z will be distributed across the population, with "lucky" individuals receiving high Z and "unlucky" individuals receiving low Z. The result, therefore, is that the distribution of Z will determine a default function $\lambda[LR]$ in the same manner as the "honest-dishonest" case.[9]

III. Lender and Market Behavior Under Competitive Conditions

A. The Single-Contract, No-Rationing Equilibrium

We now return to the honest-dishonest interpretation and consider lender behavior and the resulting market equilibrium with competitive conditions in the loan market. Assume that lenders obtain their funds in a perfect capital market at the constant one-period interest rate i, with $I = 1 + i$, and that they have no other costs. This amounts to a case of constant returns to scale such that, at the extensive margin, lenders serve as many borrowers as are forthcoming. Our attention focuses, instead, on the intensive margin determining the loan size granted to each customer.

Lenders are assumed to maximize the *expected value* of their profits (that is, either lenders are risk-neutral, or they serve a very large set of customers with independent risks). Their (expected) profits can then be written as

$$\pi = LR\lambda[LR] - LI, \tag{8}$$

where the first term is the expected revenue (contract revenue times the likelihood of repayment), and the second term is the cost (the amount to be repaid to the capital markets). With a competitive loan market, a zero (expected) profit condition must hold. Therefore, from (8) we have

$$R\lambda[LR] = I. \tag{9}$$

This equation defines the set of loan contracts (L,R combinations) that satisfy the competitive zero profit condition, hereafter called the supply function.

The properties of the supply function are illustrated in Figure IV by the curve $\overline{OTSV}$, and the following should be noted:

(i) For $R = I$, equation (9) implies that $\lambda = 1$. This can be true only when $L \leq Z_{\min}/I$. Thus, for $R = I$, the supply function is given

9. Two differences between the "honesty" and "lucky" interpretations should be noted. First, in the case of luck, individuals themselves will not know their fate ex ante, whereas in the case of honesty they definitely do know. The significance of this difference is noted in footnotes 12 and 13 below. Second, the case of luck leaves open the possibility of *partial* default, since default occurs whenever $Z < LR - Y_2$, but total default must occur only when $Z = -Y_2$ (that is, $\bar{Y}_2 = 0$). Partial repayment of loan contracts would then have to be taken into account in the specific shape of $\lambda[LR]$.

It should be stressed that although individuals all act on the assumption that they will not default, there is a fallacy in that ex post some of them (the unlucky ones) will default. Moreover, the lenders will be aware of the aggregate default probabilities and will take this into account in a manner developed below.

by $L \leq Z_{\min}/I$. This range of the supply function is shown in Figure IV as $\overline{OT}$.

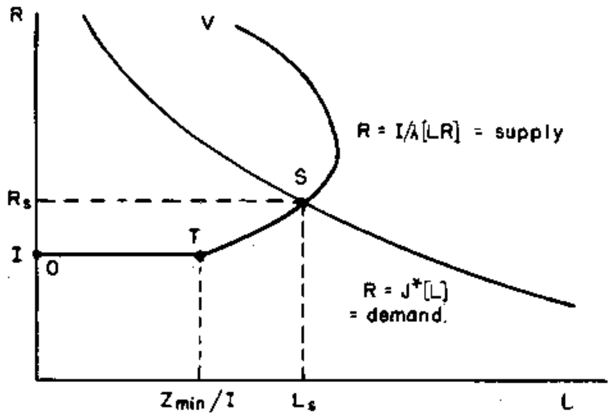

FIGURE IV

(ii) Beyond point T, the supply function is either positively sloped or backward-bending. The slope of the supply schedule depends on the properties of the default distribution λ. For example, as developed more fully in Jaffee and Russell (1976), if λ has the Pareto distribution and the mean of the distribution does not exist, then the supply curve will be positively sloped; if λ has the exponential distribution, then the supply curve is backward-bending. We use the backward-bending case to illustrate the analysis in the discussion that follows. It will be apparent, however, that the particular shape of the supply function does not affect our main results.

The single-contract, no-rationing equilibrium is determined by the intersection of the demand and supply functions, and is illustrated in Figure IV. The equilibrium occurs at point $S(R_s,L_s)$ and has the key property that the equilibrium interest rate factor (R_s) exceeds the marginal cost of funds (I). Since the equilibrium point lies on the supply schedule, R_s exceeds I by exactly the amount necessary to compensate for the default rate λ. The single-contract, no-rationing equilibrium has, therefore, the property that "honest" borrowers—that is, borrowers who do not default—pay a premium above the opportunity cost I to support the other, but indistinguishable, dishonest borrowers. Moreover, this property of the equilibrium will hold regardless of whether the supply curve is positively or negatively sloped at the equilibrium point.[10]

The case illustrated in Figure IV is special in assuming that the intersection of the demand and supply curves occurs on the supply function above the horizontal segment $\overline{OT}$. This ensures an equilibrium with default activity, since from equation (9), when $R > I$, default must occur. The point T, at which the supply curve starts to rise, is at the loan size $Z_{\min}/I$, and therefore by choosing $Z_{\min}$ small enough, the desired case with default is obtained.[11]

B. The Single-Contract, Rationing Equilibrium

The equilibrium described in Section III.A is standard in that demand equals supply at the equilibrium interest rate R_s. There does exist, however, a broader class of potential equilibria that include the possibility of credit rationing. Consider the set of zero profit contracts (L,R) that meet only the condition that the contract does not exceed the demand function. The locus of such zero profit contracts is given again by (9), but now subject to the condition that

$$L \leq L^*[R].$$

The locus is drawn in Figure IV as the curve $\overline{OTS}$ and is the same as the supply function except that it ends at S. Contracts with interest rate factors above R_s are not available because they would have to lie above the demand curve.

Contracts on the curve $\overline{OTS}$ below contract S imply rationing because they lie below the demand curve. The question is whether any of these rationing contracts are preferred to the no-rationing equilibrium S. The answer is yes. Borrowers who would not default at contract S always prefer some rationing contract that lies below S on the curve $\overline{TS}$. This is illustrated in Figure V, which "blows up" the area of Figure IV around the curve $\overline{TS}$ and includes the borrower

10. An equilibrium on the negatively sloped portion of the supply curve is unstable in the sense that the same loan size could be offered at a lower interest rate on the horizontal or positively sloped portion of the supply schedule. This alternative solution, however, would necessarily involve rationing, and this is discussed in subsection III.B below. Indeed, a main point of the discussion in subsection III.B is that even equilibrium points on the positively sloped portion of the supply function are necessarily dominated by rationing solutions further down the schedule.

11. There is only a single intersection of the demand and supply curves. Assume, for example, to the contrary, that there were a second intersection at some interest rate factor higher than R_s in Figure IV. From the discussion in subsection II.B, along the demand function the default rate at this second point must be lower, since the interest rate factor is higher. Along the supply function, however, as R rises, the default rate must rise, as is apparent from equation (9). Therefore, the default rate at the second intersection must be both greater and smaller than the default rate at R_s, and this is inconsistent.

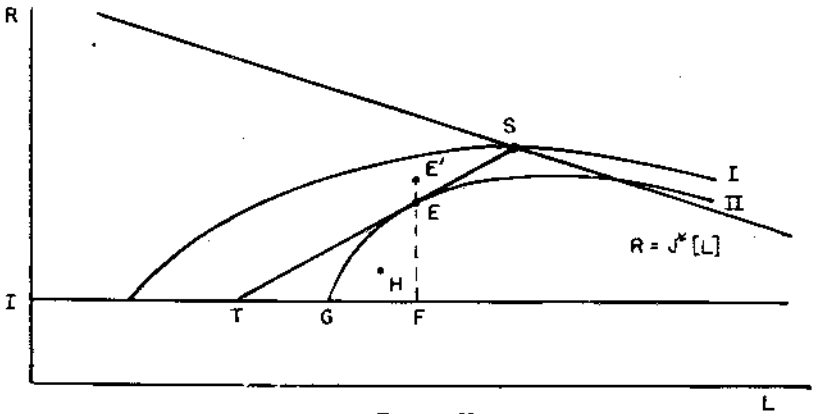

FIGURE V

iso-utility map developed in Figure I. The iso-utility curve I passes through S with zero slope. Thus, there exists a higher level iso-utility curve that intersects the curve $\overline{TS}$, and the intersection with the highest iso-utility curve occurs somewhere along the curve, including point T. In Figure V this equilibrium is illustrated for simplicity by a tangency at point E. Note, however, that if the supply function were negatively sloped starting at point T, then the equilibrium of contract E would, in fact, be a corner solution at point T.

Borrowers who are honest at contract S prefer the equilibrium with rationing at contract E. The advantage of rationing is that fewer individuals default at the smaller loan size, and under competition these gains are passed on to the honest borrowers. Furthermore, lenders will offer the rationing contract E. Consider the case where the market has reached the equilibrium at S. There then exists a rationing contract, with the same loan size as E but a higher interest rate (E' in Figure V) that provides positive profits to the lender and is preferred to S by the borrower. Competition then forces the market to the zero profit equilibrium exactly at E.[12]

12. These points apply to the "lucky-unlucky" case as well. Individual borrowers will prefer contract E to S, since they each assume that they will not default, although there is the fallacy noted in note 9. It is also noteworthy, from the viewpoint of the lender, that there are asymmetries in both the "honesty" and "lucky" cases. In the "honesty" case, the asymmetry is that the lender loses on defaults, but gains only the contracted amount otherwise. In the "lucky" case, the asymmetry is that the lender loses on unlucky customers, but does not share in the gain of lucky customers beyond the contracted amount.

C. Multiple-Contract Equilibria

Assume now that a single-contract equilibrium is attained at E, and consider whether a new entrant into the lending market could find profitable lending opportunities *given that other lenders continue to offer contract E*. Perhaps surprisingly, the answer is possibly yes. A contract such as H in Figure V, with the property that it lies within the triangular area EGF, will have the following three features:

(i) H will be preferred to E by borrowers who do not intend to default at E.

(ii) E will be preferred to H by borrowers who do intend to default at E. That is, dishonest borrowers always prefer a larger loan.

(iii) H will be profitable to lenders if only honest borrowers take the contract and the interest rate factor is above the marginal cost factor I.

This mechanism is an example of *self-selection*, since honest borrowers opt for contract H, while dishonest borrowers remain with contract E. Notice, however, that self-selection requires the dishonest borrowers to reveal themselves, and thus could arise only, if at all, in dynamic situations.[13] Moreover, the existence of a contract H is ruled out when the rationing equilibrium E occurs as a corner solution at point T on the supply function. The rationing solution must occur at point T when the supply schedule bends backward at T, and the rationing solution may occur at T even in the general case. Rationing solutions at T involve no default, and this is why a contract H cannot exist in such cases.

If contract H exists, the shift of honest borrowers from contract E to contract H leaves the lenders at contract E with only dishonest borrowers, and consequently with losses. Contract E should then disappear from the market, and even dishonest borrowers will have to use contract H. This means losses for the lender offering contract H, since he now faces the entire market and the contract lies below the zero profit locus $\overline{TS}$. Contract H should thus also disappear from the market, leaving room for the introduction again of contract E; and so on.

This situation can be characterized as the absence of a multiple-contract equilibrium in the sense that new entrants to the market always find profitable lending opportunities given the existence of

13. Different firms might offer contracts E and H, and it would be only after the fact that the lender offering contract E realizes what has happened to him. More generally, the outcome of this process depends critically on the dynamic interactions that are assumed. Also note that contract H could not be established where individuals are lucky and unlucky unless they had some prior knowledge of their status.

a previous entrant offering a different contract. The long-run solution then depends critically on the dynamic assumptions concerning entry. Either the market could oscillate, in a circular fashion between contracts of the types E and H, or it could simply fail to operate at all.

IV. Market Solutions Under Monopoly

In view of the possible failure of a competitive equilibrium for the loan market, we consider how a monopolist might operate when faced with the same market conditions. One can imagine a situation in which a competitive loan market fails to operate, and thus the government charters lending institutions with some degree of monopoly power. The monopolist solution is easily developed in light of the preceding discussion.

We begin with the same profit function assumed for the competitive industry given by equation (8), which again implies risk-neutral behavior. For the monopolist, and in contrast to the competitive firm, however, rationing behavior is never profitable. This result is basic in standard monopoly theory. There is the additional feature in the loan market that the amount of default depends on the contract size. But, to the extent that the monopolist wishes to decrease the default rate by limiting contract sizes, this is achieved most profitably by raising the interest rate, and not through nonprice mechanisms.[14]

The monopolist is thus to solve the problem of maximizing (8) subject to the demand function. The first-order condition is then

$$\frac{\partial \pi}{\partial L} = (R + LR')(\lambda + LR\lambda') - I = 0, \tag{10}$$

where $R = J^*[L]$ (the inverse of the demand function), $\lambda = \lambda[LR]$, and prime denotes the derivative. This can be interpreted as setting expected marginal revenue equal to marginal cost. The solution is illustrated in Figure IV where the relevant expected average revenue and marginal cost curves have already been drawn. If the expected

14. The following outlines a proof of this point. Assume, to the contrary, that the monopolist finds a profit-maximizing contract (R,L) that features rationing (lies below the demand curve). Through this point construct the rectangular hyperbola $LR = K$. This hyperbola must intersect the demand curve at some higher interest rate factor and lower loan size. The contract revenue at this new point is the same as the original point, namely $LR = K$. Therefore, the default rate λ at the new point must be the same as at the original point. Consequently, expected revenue, $LR\lambda$ is the same at both points. However, costs LI will be lower at the new point, since L is lower at the new point. Thus, the original point (with rationing) is not the profit-maximizing solution: there exists an alternative (no-rationing) contract with higher expected profits.

marginal revenue were now added, then the solution would occur on the demand curve at some loan size smaller than the single contract, no-rationing, equilibrium L_s. In terms of Figure V, on the other hand, there is no necessary relationship between the size of the monopolist's loan offer and the single contract, rationing equilibrium E. Thus, a monopolist may offer a larger loan size than a competitive industry would—although, of course, the monopolist charges a higher price as well, and honest borrowers prefer the competitive contract.

V. Conclusion

This paper has analyzed the behavior of a loan market in which borrowers have more information about the likelihood of default than do lenders. We have seen that, if the market is competitive, there are two possibilities. The market may reach a stable equilibrium in which individuals are all rationed in the amount they can borrow, this ration being so severe that no one defaults. Alternatively, the market may oscillate in an unstable fashion, lenders entering and making short-run profits, but in the long run being forced to leave.

Actual loan markets exhibit neither of these features. Banks typically incur some (small) percentage of defaults and, though bank failures occur, the market does not show the instability predicted by the model. Actual loan markets, however, are quite different from the loan markets analyzed in this paper. In particular, entry to loan markets may be regulated by chartering laws, and actual loan contracts contain many nonprice terms, collateral requirements, down payment requirements, etc., not considered in this paper. A proper interpretation of this paper is that it predicts what would happen *in the absence* of the institutional arrangements found in actual loan markets.

One solution to the market failure problem is government intervention in the direction of chartering monopoly powers. Monopoly is, of course, an innately stable market form; although, as indicated, pure monopoly power implies no credit rationing. It is in this light that the available literature on credit rationing, which assumes monopolistic behavior subject to a variety of institutional constraints, can be best interpreted. If the monopolistic powers that are required for a stable loan market are achieved through nonmarket means—for example, through government intervention or oligopolistic cartel arrangements—then the resulting market structure might well have monopoly power subject to various contraints and limits. And, as developed in Jaffee and Russell (undated), credit rationing is frequently rational behavior in such a context.

This is not the only method of stabilizing the industry. The contract size at which default begins in this model is $Z_{\min}$. $Z_{\min}$ can be affected by changes in the legal system (i.e., there may or may not be a debtor's prison), and it can also be influenced by the use of collateral and equity requirements. It follows that an examination of the nonprice institutions of the loan market is in order, both to discover whether or not they provide a stabilizing force, and to discover if there may be alternative and better arrangements.

VI. Appendix

A. Derivation of Iso-Utility Curve

From Section (II.A) the problem is to derive the shape of the iso-utility curves satisfying (5), which is rewritten here:

$$U[L + Y_1, Y_2 - LR] = K \text{ (a constant)}. \tag{5}$$

Taking the total derivative of (5) with respect to L and solving yields the slope of the iso-utility curve:

$$\frac{dR}{dL} = \frac{U_1/U_2 - R}{L}. \tag{11}$$

Recalling equation (3), which defines the demand curve, we see that it is apparent from (11) that *the slope of the iso-utility curve will be zero if and only if the point satisfies the demand function.*

To obtain information on the shape of the iso-utility curve for points not on the demand curve, we differentiate (11) with respect to L and arrange terms:

$$\frac{d^2R}{dL^2} = \frac{\left[U_{11} - 2\frac{U_1}{U_2}U_{12} + \left(\frac{U_1}{U_2}\right)^2 U_{22}\right] - \left[2U_2\frac{dR}{dL}\right]}{U_2L}. \tag{12}$$

The denominator of (12) is positive, so the sign of (12) is determined by the two terms in the numerator. The first term is negative by virtue of the quasi-concavity of the utility function. The second term is of uncertain sign, but includes the slope of the iso-utility curve as a multiplicative element. Consequently, we know that where the iso-utility curve has zero slope, or equivalently where it intersects the demand function, it must have a negative second derivative. Thus, *in the neighborhood of the demand function the iso-utility curve is concave;* (see Figure I). More generally, concavity need not hold, since (12) can be positive in other regions. We know, however, the slope of the iso-utility curve can change sign only at the point of intersection with the demand curve: if it did otherwise, then there would be a point with a zero first derivative and a positive second derivative, and this is ruled out by (12). The result, therefore, is that *the iso-utility curves are monotonically rising until they reach the demand function and monotonically falling thereafter* (see Figure I).

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REFERENCES

Akerlof, G., "The Market for Lemons: Qualitative Uncertainty and the Market Mechanism, "this *Journal*, LXXXIV (Aug. 1970), 488–500.
Arrow, K., "Uncertainty and the Welfare Economics of Medical Care," *American Economic Review*, LIII (May 1963), 941–73.
—, "The Economics of Moral Hazard: Further Comment," *American Economic Review*, LVIII (June 1968), 537–39.
Jaffee, D., *Credit Rationing and the Commercial Loan Market* (New York: John Wiley & Sons, 1971).
—, and T. Russell, "A Simplification of Credit Rationing Theory in Terms of Insurance Market Failure," mimeo.
——, "Imperfect Information, Uncertainty, and Credit Rationing," Financial Research Center, Memorandum No. 22, Princeton University, May 1976.
Pauly, M., "The Economics of Moral Hazard: Comment," *American Economic Review*, LVIII (June 1968), 531–37.
Rothschild, M., and J. Stiglitz, "Equilibrium in Competitive Insurance Markets: The Economics of Imperfect Information," this *Journal*, XC (Nov. 1976), 629–49.