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IMPERFECT INFORMATION, UNCERTAINTY, AND CREDIT RATIONING: COMMENT AND EXTENSION*

KERRY D. VANDELL

The Jaffee and Russell [1976] model of credit rationing under imperfect information and uncertainty suggests that a single-contract equilibrium will tend to occur at a point of rationing and that a multiple-contract equilibrium will likely be unstable. This paper respecifies and extends the Jaffee-Russell model to incorporate default expectations on the demand side and to consider the price of credit more appropriately to be the net (after expected default) yield rather than the contract rate. Results show rationing is not necessary in the single-contract equilibrium case, nor is an unstable equilibrium possible in the multiple-contract case.

I. INTRODUCTION

One aspect of loan market behavior that has initiated considerable research interest is the topic of credit rationing. Beginning with the availability doctrine discussions of the 1950s (e.g., see Roosa [1951] and Hodgman's [1960] model), the credit rationing literature generally seeks to develop an economic rationale for the allocation of credit by some means other than the price (interest rate).¹ An understanding of the nature of credit rationing and its role in the allocation of credit is important because it can aid in explaining an entire array of problems of market behavior, ranging from (at the macro level) explaining how monetary policy can influence the economy even if demand for money is relatively interest-rate inelastic to (at the micro level) issues of "redlining" and credit allocation.

In a 1976 article in this *Journal*, Dwight Jaffee and Thomas Russell (J-R) developed a model of rationing in loan markets that has become one of the more influential papers in the theoretical literature.² Premised on the existence of imperfect information and uncertainty and borrowers having more information about the likelihood of default than lenders, their model supports two significant findings. First, it suggests that in competitive markets

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1. See Baltensperger [1978] for a critical review of the credit rationing literature.

2. Most of the post-1976 literature on credit rationing has cited the J-R article. Kalay and Rabinovitch [1978] and Stiglitz and Weiss [1981] in particular have directly relied on their model as the basis for their extensions.

a single-contract equilibrium (i.e., an equilibrium with a single set of terms) will tend to occur at a point of rationing. That is, it will occur at a point where the volume of credit demanded by the borrower is greater than that supplied by the lender. At this point, borrowers who do not default pay a premium above the opportunity cost of loan funds to support those (indistinguishable) borrowers who do default.

A second result suggested by the model is that in a multiple-contract world there is a likelihood of an unstable oscillating equilibrium developing as borrowers with different default expectations reveal themselves in a dynamic fashion through their loan term preferences. J-R hypothesize that several factors external to their model may provide rationales for the elimination of rationing behavior and enforce some degree of stability to the loan market. These include possession of monopoly power by lenders, institutional restrictions to market entry, the existence of nonrate credit terms, or collateral and down payment requirements.

This comment and extension shall focus on three points relevant to the J-R paper. First, we take issue with the J-R assumption that certain borrowers have no expectations of default; while other borrowers, although they have positive expectations of default, behave like those who have none in their demand for credit. We shall demonstrate, instead, that virtually all borrowers could be expected to have some *ex ante* expectation of default, and would incorporate such expectations in their revealed preferences for credit. Furthermore, differences in default expectations would not necessarily imply differences in credit demand in the presence of imperfect information and possible "hidden" differences in tastes and preferences or costs of default. The J-R model is then respecified to incorporate default expectations on the demand side.

We then develop the supply side of the revised model and, using the model to examine alternative equilibrium configurations, show that the existence of rationing is not necessary in the single-contract equilibrium case. Rather J-R's perception of rationing is based upon an inappropriate measure of the effective "price" of credit. It will be shown that only under a specific set of conditions does true rationing result, and even then it may be only a subjective perception of rationing not fully shared by all participants in the credit market. Exploration of those conditions

that still may result in rationing will provide further insight into the behavior of credit markets.

Finally, we shall demonstrate that the J-R multiple-contract oscillating equilibrium is not possible, given their assumption of the inability of lenders to distinguish among borrowers with different ex ante default expectations. Instead, we show that the stable single-contract equilibrium along the loan offer curve will still dominate, even in the dynamic multiperiod case.

II. THE JAFFEE-RUSSELL MODEL OF BORROWING BEHAVIOR

The Demand Model

The J-R model on the demand side is a two-period Fisherian consumption model of an individual with a quasi-concave utility function $U[C_1, C_2]$ defined over his consumption. Each individual has an exogenous income stream for the two periods (Y_1, Y_2). 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 (augmenting period-1 consumption) and repaid with interest at the beginning of the second period (reducing period-2 consumption).

Two classifications of borrowers are considered. The first assumes that borrowers are either "honest" (i.e., expect to repay loan contracts that they do in fact repay) or "dishonest" (i.e., default on loans whenever the costs are sufficiently low). Alternatively, borrowers may be identified as "lucky" (i.e., "honest" in an ex ante sense and with a propitious future income level) or "unlucky" (i.e., still "honest," but with an impropitious future income level causing some probability of default). "Honest-dishonest" borrowers are assumed to know their future default states ex ante; "lucky-unlucky" borrowers do not.

The demand curve for loans of an honest individual can be determined from the solution for the problem,

$$\begin{aligned} (1) \quad & \text{maximize } U[C_1, C_2] \\ (2) \quad & \text{subject to } C_1 = L + Y_1 \\ (3) \quad & C_2 = Y_2 - LR, \end{aligned}$$

where $R = 1 + r$ is the interest rate factor.

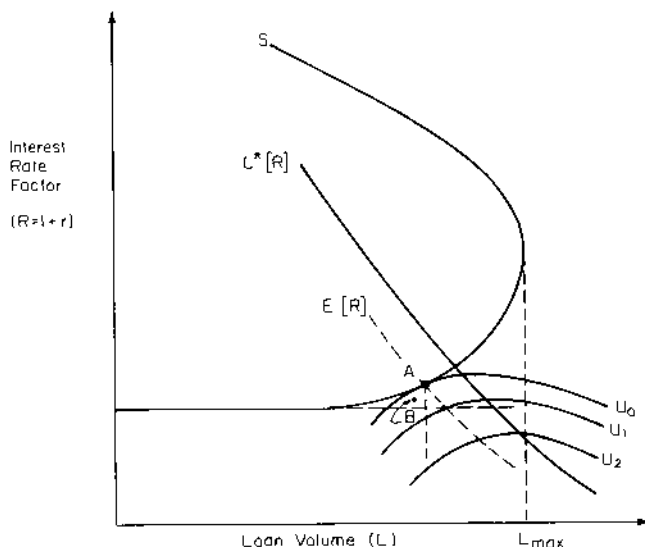


FIGURE I
The Jaffee-Russell Model of Borrowing Behavior

J-R define a demand curve $L^* = L^*[R]$ by the first-order condition,

$$\frac{dU}{dL} = \frac{\partial U}{\partial C_1} - \frac{\partial U}{\partial C_2} R = 0$$

and show that the iso-utility curves of the individual in (L, R) space are concave downward with zero slope at the demand curve as shown in Figure I.

Demand by a dishonest individual is constrained to be the same as that of an otherwise identical honest individual. It is assumed that there is a cost of default which is measured by a constant Z and which is subtracted from the second-period income Y_2 when default occurs. The dishonest individual maximizes his utility either by being "honest" and repaying the loan, which implies that

$$(4) \quad C_1 = Y_1 + L^*$$

$$(5) \quad C_2 = Y_2 - L^*R$$

or, if the cost of default is low enough, by being "dishonest" and defaulting, which implies that

$$(6) \quad C_1 = Y_1 + L^*$$

$$(7) \quad C_2 = Y_2 - Z.$$

Dishonest individuals choose default whenever $Z < L^*R$.

It is assumed that the cost of default differs among dishonest individuals. This results in a probability-of-repayment relationship that indicates the proportion of individuals λ who will not default for each contracted loan repayment level (LR). For required repayments below a certain minimum cost of default (Z_{\min}), of course, no defaults take place, and dishonest individuals display honest behavior. However, for contract sizes above the maximum cost of default possessed by an individual (Z_{\max}), everyone defaults.

Demand by "lucky-unlucky" individuals is assumed to be affected by a stochastic period-2 income \tilde{Y}_2 . If Y_2 is the mean of \tilde{Y}_2 and individuals treat Y_2 as the certainty equivalent of \tilde{Y}_2 , then they will display the same demand behavior as in the "honest-dishonest" case. Ex post, however, such individuals may experience actual incomes sufficiently below Y_2 to cause the necessity of default. Specifically, default occurs whenever the cost of default Z is less than the difference between the required repayment level and period-2 income ($LR - Y_2$). These results parallel those for the dishonest case except for the constant displacement of Y_2 .

Note that J-R's development of the demand relationships does not explicitly include a subjective expectation of default by the borrower. This specification is said to be necessitated by their assumption that those who will default behave identically in their demand patterns to those who will not default; hence they cannot be distinguished a priori.

The Supply Model

On the supply side the J-R model assumes a competitive loan market, with lenders obtaining their funds in a perfect capital market at the constant one-period interest rate (i) with no other costs. Lenders are assumed to be either risk neutral or serving a very large set of customers with independent risks. They attempt to maximize the expected value of their profits, which can be written as

$$(8) \quad \pi = LR\lambda[LR] - LI,$$

where $I = 1 + i$ and $\lambda[LR]$ is the proportion of individuals who can be expected not to default when offered a contract size LR .

The function $\lambda[LR]$ has the properties $\lambda[LR] = 1$ for $LR \leq Z_{\min}$ (where Z_{\min} has been defined previously) and $\lambda[LR]$ is continuous with $\lambda'[LR] < 0$ for $LR > Z_{\min}$. Under the zero (expected) profit condition for a competitive market, expression (8) results in the relationship,

$$(9) \quad R\lambda[LR] = I,$$

for the loan offer curve, with its characteristic backward-bending shape for most λ (Figure I).³

In a competitive loan market J-R demonstrate that the single-contract equilibrium solution which dominates is not at the intersection of supply and demand. Instead, it is at point *A* in Figure I, the tangency of the loan offer curve and iso-utility function, which is a point of rationing, where the volume of credit demanded by the borrower is greater than that supplied by the lender at the equilibrium contract rate. This is because of the upward sloping nature of the loan offer curve in (L, R) space, caused by greater expectations of default at higher loan volumes, and the downward concavity of the iso-utility function of the borrower. Such a rationed equilibrium maximizes borrower utility, yet still permits satisfaction of the lender's profit condition.

A second result which they demonstrate is that in a dynamic multiple-contract world with both honest and dishonest individuals there is a likelihood of development of an unstable oscillating equilibrium. This would occur through self selection as (a) dishonest borrowers reveal themselves by selecting contract *A* at the loan offer curve-iso-utility tangency and subsequently defaulting, while (b) honest individuals would prefer a contract such as *B* at a higher utility level but a lower loan interest rate than they later repay (Figure I). A lender could temporarily make a positive profit by offering contract *B*, to which honest borrower would move. However, this would eventually lead those lender

3. J-R show 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 will be backward bending. Note that both the J-R model and the model to be developed in this paper are only "partial equilibrium" models in that the underlying project is assumed to be held fixed with fixed total investment requirements. For a given required total investment increased equity requirements (reduced loan volume) must increase λ and result in a positively sloped loan offer function in (L, R) space. However, Stiglitz and Weiss [1981] consider the more general case in which project size is variable for different loan volumes. In such a case, as they point out, movement to riskier projects at lowered loan volumes could actually begin to increase the required risk premium on the contract rate and create a downward-sloped loan offer function. This situation is necessary in their model to permit rationing.

continuing to offer contract *A* with only dishonest borrowers, and consequently with losses. As contract *A* disappears from the market, dishonest borrowers move to contract *B* and create losses, ultimately leading to the introduction again of contract *A*, and the cycle is repeated ad infinitum.

III. A CRITIQUE AND EXTENSION

A. Do Borrowers Have Subjective Expectations of Default?

The J-R model results depend directly on the assumed widespread existence of the "honest" borrower, who has no expectation of default from any source.⁴ In fact, as the authors observe, their model results depend on the condition that such a borrower must be "pathologically honest" in that he must refuse to default even when there exist economic rationales for him to do so. It is our contention here that such behavior is economically irrational and would not be expected to exist in loan markets, certainly not in the long run. This is particularly true in commercial loan markets, where repayment decisions are supposedly based on more "businesslike" principles. But even in consumer loan markets, we assert that what is perceived to be "honest" behavior is actually a reflection of a fear of broader economic costs to default beyond the individual loan contract, e.g., loss of one's credit rating.⁵ Seldom is the decision to default purely an ethical proposition.⁶ The "honest" individual in this scenario is seen to be the limiting case of an individual with an infinite cost to default.

What would be a more appropriate characterization of borrowers? Virtually all could be considered to be "semi-honest" in that they enter into the loan agreement in good faith with no intent to default outright (which is not in their economic interests). However, in J-R's words, they are also "dishonest" or at least "potentially dishonest" in that they will default if there exist economic incentives (broadly interpreted) to doing so. Such incentives are not guaranteed to occur, so in many instances borrowers reveal only honest behavior. At the same time, borrowers

4. That is, the specification of the demand model is such that it takes no explicit account of default. The underlying iso-utility relationships are thus entirely independent of any default expectations.

5. See Baltensperger [1978] for a discussion of these broader (usually multiple-contract) economic concerns. The customer relationship concept has always been an important one in the credit rationing literature. See Kane and Malkiel [1965].

6. Even ethical choices can, of course, be valued and interpreted as economic costs of default.

are "lucky-unlucky" to the extent that their second-period incomes (or equivalently their returns from their investment) are stochastic variables, the outcome of which is beyond their control.

These characterizations—"potentially dishonest," yet "lucky-unlucky"—suggest two ways in which borrowers, who are seemingly identical *ex ante*, may be differentiated *ex post* by their default behavior. The first is *ex ante* differences in their costs to default, which are known to the borrowers alone at the time of loan origination.⁷ The second is differences in outcomes for their stochastic income levels, which are exogenous. The borrower would be expected to have some subjective *ex ante* expectation of default from both sources and would be expected rationally to incorporate such expectations into his demand for credit. This fact has been recognized in similar credit demand models developed by Smith [1971] and Barth, Cordes, and Yezar [1979].⁸

Does the J-R demand model specification recognize this behavioral condition for economic rationality? In general, if a rational borrower knows *ex ante* that contracted repayments (LR) above a certain level will be defaulted upon, he would be expected to demand an infinite loan size above that level, though behaving "honestly" otherwise. However, the demand model postulated by J-R for "dishonest" borrowers is constrained in that the level of demand is imposed exogenously to be identical to that for "honest" borrowers at all repayment levels. Thus, it forces irrationality.⁹ In effect, the J-R model says that the utility-maximizing decision

7. Of course, modifications are possible in this strong assumption about information asymmetry that may render the situation more realistic. The borrower could simply have *better* knowledge about the cost of default, but both parties could possess some uncertainty in its distribution.

8. Again, most other models of credit rationing that have extended the J-R analysis (e.g., Stiglitz-Weiss [1981]) are subject to the same criticism.

9. Similarly, the demand model postulated for "lucky-unlucky" borrowers is constrained and requires irrational behavior. The level of loan demand is constrained to be the same as that in the "honest" case, when in fact, if expected second-period income (Y_2) is less than the loan contract (LR), the borrower would be assured of defaulting and would rationally demand an infinite loan size. This is the case in which the borrower regards the mean of Y_2 as its certainty equivalent, without concern about the distribution of Y_2 . In the more general case, in which the distribution of Y_2 is a concern to the borrower, he would demand an infinite loan only if his maximum possible second-period income (Y_{max}) is less than the loan contract (LR). There is some probability otherwise he could increase his utility by demanding less and paying off his loan because of a sufficiently high period-2 income. On the other hand, only if he is assured of making sufficient period-2 income to pay off his loan (i.e., $Y_{min} \geq LR$) would he behave in an entirely "honest" fashion, knowing default to be an irrelevant consideration. The more typical case is that in which $Y_{min} < LR < Y_{max}$ and there is some probability that actual second-period income will fall below LR , initiating default. In each case, it would be expected that a rational borrower would incorporate these expectations, not only in his decision to default but also in his demand for credit.

involves only the decision of whether or not to default for a given cost to default. The revised model correctly considers both the level of loan demand and the likelihood of default to be determined endogenously and simultaneously.

Why would demand behavior that incorporates expectations of default not differentiate borrowers, thus conflicting with J-R's basic premise that borrowers must be indistinguishable in their demand patterns? Very simply because the absence of perfect information renders the relationship between default expectations and loan demand an ambiguous one. This is a critical point that J-R fail to recognize but that has been recognized and developed by others (e.g., see Avery [1979] and Barth, Cordes, and Yezzer [1980]). The lender typically uses observable screening devices available to him to isolate borrower classes *seemingly* identical in both tastes and preferences for credit and costs of default (hence default expectations). If he is totally successful in this regard, of course, different demand patterns must reveal different borrower default expectations, thus contradicting J-R's premise. However, within each class, there also exist nonobservable characteristics that could signal differences in tastes and preferences or costs of default that the lender cannot employ. Thus, within a given class under conditions of imperfect information, actual default expectations may diverge, while demand behavior does not.¹⁰

To summarize, we have contended in this section that virtually all borrowers in credit markets may be characterized as both "potentially dishonest" and "lucky-unlucky." Being "potentially dishonest," they possess varying costs of default that may be better known by them than by the lender. Being "lucky-unlucky," they have a stochastic period-2 income that, if sufficiently unfavorable, could initiate default. Both factors provide the borrower with some subjective *ex ante* expectation of default, and he would be expected rationally to incorporate such expectations into his demand for credit. The J-R demand models for "dishonest" and "lucky-unlucky" borrowers do not recognize this fact. Instead

10. "Honest-dishonest" borrowers, of course, *are* identical *ex ante* and only differ *ex post* in their actual second-period incomes. The lender is seen to be capable of distinguishing borrowers with different expected period-2 income levels and separating them into risk classes. He presumably would not lend to those with insufficient expected incomes. J-R make use of this screening device argument to arrive at a controlled group of "identical" borrowers (see footnote 7 of their article). The present paper also makes use of the screening device argument in a way in which J-R do not—to explain why, through the imperfection of screening devices under conditions of imperfect information, borrower indistinguishability and differences in default expectations do not necessarily imply differences in manifest demand (and vice versa).

they impose irrational constrained demand behavior, arguing that this is necessary to preserve the requirement that borrowers be indistinguishable to lenders. We have shown that incorporating default expectations in borrower demand may be entirely compatible with this requirement under conditions of imperfect information. Thus, the revised model renders compatible the two necessary conditions of borrower indistinguishability and borrower rationality.

B. The Nature of Demand in a Revised Model

What follows is a respecification of the J-R demand model, which incorporates a subjective expectation of default by the borrower. Such a model has been shown not to violate their requirement that borrowers who have varying degrees of creditworthiness not be distinguishable by their demand behavior.

Such a respecification implies a modified consumption model of the form,

$$(10) \quad \text{maximize } U[C_1, C_2]$$

$$(11) \quad \text{subject to } C_1 = L + Y_1$$

$$(12) \quad C_2 = Y_2 - LR'_b,$$

where $R'_b = R\lambda_b[LR]$ and $\lambda_b[LR]$ is the borrower's subjective perception of his probability of repayment. Solution of this model results in a demand relationship of the form $L^* = L^*(R'_b)$. The remainder of this section will examine the characteristics of this demand relationship.

At first glance one might expect that the existence of default expectations would tend to result in infinite demand for credit because such demand maximizes first-period consumption utility with zero expectation of repayment in period 2. However, the appropriate "price" of credit is the net (after default) cost R'_b and not the contract rate R (this is argued further in Section III.C). A zero expectation of repayment in period 2 results in an effective net cost R'_b of zero, which means that demand would be infinite only at a zero price.

This can be shown more formally by substituting (11) and (12) into the utility function, $U[C_1, C_2]$, and estimating the demand curve as an unconstrained maximization:

$$(13) \quad \text{maximize } U[L + Y_1, Y_2 - LR'_b] \text{ with respect to } L.$$

The first-order condition for the solution in (L, R'_b) space¹¹ is

$$(14) \quad \frac{dU}{dL} = U_1 - U_2 R'_b = 0,$$

where U_i is the partial derivative of U with respect to the i th argument.¹² This will lead to a loan demand function of the form,

$$(15) \quad L^* = L^*(R'_b),$$

for a given Y_1 and Y_2 . The nature of L^* depends, of course, on the nature of U . To ascertain the general shape of L^* for various utility specifications, it is necessary to derive the iso-utility curves of the individual in (L, R'_b) space. These result from the condition,

$$(16) \quad U[L + Y_1, Y_2 - LR'_b] = K \text{ (a constant),}$$

by varying the parameter K . The resulting family of iso-utility curves has the property of having zero slope where they intersect the demand function. To derive the shape of the iso-utility curves, we take the total derivative of (16) with respect to L and solve, yielding the slope of the iso-utility curve in (L, R'_b) space:

$$(17) \quad \frac{dR'_b}{dL} = \frac{U_1/U_2 - R'_b}{L}.$$

The slope of the iso-utility curve is seen to be zero if and only if the point satisfies the demand function defined in equation (14).

This corresponds directly to J-R's results, except that in their derivation of demand, it was assumed that $\lambda_b = 1$, which reduces (L, R'_b) space to (L, R) space. Paralleling their analysis (see their Appendix), differentiating (17) with respect to L then yields the relationship,

$$(18) \quad \frac{d^2 R'_b}{dL^2} = \frac{[U_{11} - 2(U_1/U_2)U_{12} + (U_1/U_2)^2 U_{22}] - [2U_2(dR'_b/dL)]}{U_2 L},$$

which implies that in the neighborhood of the demand function the iso-utility curve is concave. Further, the iso-utility curves are monotonically rising until they reach the demand function and monotonically falling thereafter.

11. Remember that (L, R') space rather than (L, R) space was found above to be the appropriate space for representation of the demand relationship.

12. Note that if R'_b is considered an independent variable, then the contract interest rate factor R becomes dependent (i.e., $R = R(R'_b, L)$). $\partial R'_b/\partial L$ then, of course, is zero in general, but $\partial R/\partial L$ does exist and is in general nonzero.

The results of this analysis imply that the demand curve with incorporation of default expectations is well-behaved (i.e., "downward sloping" and not going to infinity), so long as the appropriate price of credit is considered to be the net (after default) yield R'_b and not the contract rate R . At higher loan volumes the expectation of default increases, but for a given required (net) yield R'_b the contract rate R must also increase. This increase in R is sufficient eventually (as L increases) to reduce borrower utility, even though the expectation of default is positive and growing. The level of borrower demand L^* is at that (finite) loan volume along the locus $R'_b = \text{constant}$, where the marginal utility of additional increases in L is zero. It is not possible for demand to be infinite at any $R'_b > 0$, since $R'_b > 0$ implies that $\lambda_b > 0$ and demand can be infinite only when $\lambda_b = 0$ (i.e., there is virtual certainty by the borrower that the loan will not be repaid). Of course, $\lambda_b = 0$ implies that $R'_b = 0$, so demand can be infinite only at zero net cost to the borrower.

To summarize, credit demand in our revised model, in (L, R'_b) space, is still basically well-behaved, even though default expectations have been incorporated on the borrower's side. Demand does not become infinite, unless default is a certainty (in which case $R'_b = 0$). This result is entirely plausible and consistent with our earlier observations, but it has progressed beyond the J-R model in that it incorporates a much more realistic set of assumptions—specifically that demand is externally unconstrained and borrowers rationally incorporate default expectations in their demand for credit.

C. Is Rationing Necessary Under Uncertainty?

In this section we develop the supply side of the revised model and, through simulations of alternative equilibrium configurations, demonstrate that, although J-R's single contract equilibrium at contract A in Figure I is the appropriate equilibrium for their model under the given assumptions, it does not necessarily involve credit rationing. This is because their model is based upon an inappropriate measure of the effective "price" of credit. They assume the contract rate (r) to be the price of credit, hence the appropriate vertical axis for the representation of the demand and loan-offer curves. In reality, however, both the lender and

borrower in a risk-neutral world perceive the expected net (after expected default) yield r' to be the effective price, where

$$(19) \quad r' = R\lambda[LR] - 1.$$

This is an obvious point, but one that has significant implications for interpretation of their results.¹³

The demand relationship developed by J-R implicitly views market conditions from the eyes of a borrower with *no* expectation of default (i.e., an "honest" borrower with $\lambda_b = 1$, which implies that $r' = r$, where the subscript *b* relates to conditions as perceived by the borrower). The lender, however, perceives a different set of market conditions because he has some positive expectation of default (i.e., $\lambda_s < 1$ for $LR > Z_{\min}$, which implies that $r'_s < r$, where subscript *s* refers to conditions as perceived by the lender).¹⁴

Let us examine loan-market behavior from the viewpoint of the lender. Define

$$(20) \quad R'_s = 1 + r'_s = R\lambda_s[LR]$$

to be the effective interest rate factor as subjectively perceived by the lender. The profit condition (8) may then be rewritten as

$$(21) \quad \pi = LR'_s - LI,$$

and the loan offer curve relationship (9) becomes

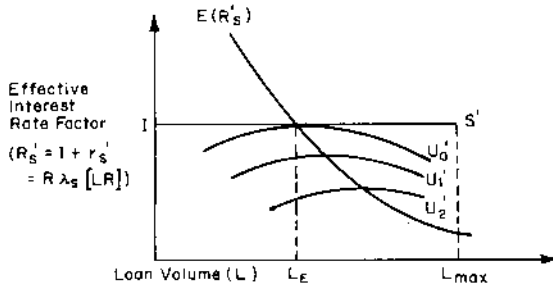
$$(22) \quad R'_s = I,$$

which of course is a horizontal line in (L, R'_s) space (Figure IIa).

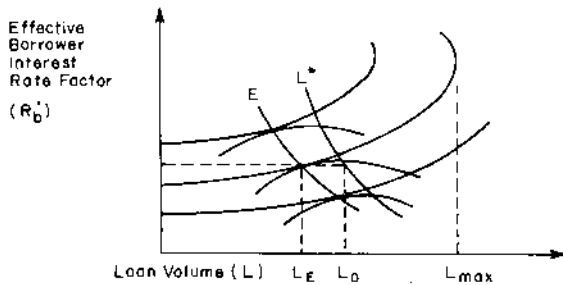
The existence of this horizontal loan offer curve implies that, from the lender's perspective at least, there is no rationing. Borrower demand is perceived to be at that volume which maximizes borrower utility, specifically the tangency between the loan offer curve and the iso-utility relationship represented by the locus $E[R'_s]$. Equilibrium then is at the intersection of supply and demand as perceived by the lender, and there exists no "gap" be-

13. This criticism would be equally true for most other analyses of credit rationing that extend the J-R analysis (see for example Stiglitz-Weiss [1981]).

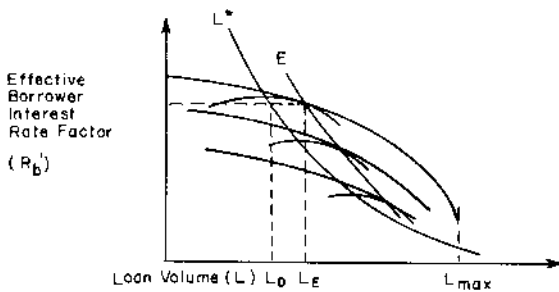
14. Stiglitz-Weiss [1981] also recognize the fact that risk perceptions on the part of the lender may differ from those of the borrower.



a.
From the Lender's Perspective with Net (after Default) Yield as the Effective Price of Credit



b.
From the Borrower's Perspective with Borrower's Expectations of Default Less than Lender's



c.
From the Borrower's Perspective with Borrower's Expectations of Default Greater than Lender's

FIGURE II
An Alternative Model of Borrowing Behavior

tween the loan size demanded and that willing to be supplied caused by the upward sloping nature of the loan offer curve. It is true that the horizontal loan offer curve does not necessarily extend to $L = \infty$, and for any given R'_s there may be a maximum offered loan volume L_{\max} .¹⁵ This could create another type of rationing in the event that borrower demand extends beyond L_{\max} . We shall consider this case later, but for the time being shall assume that the limitations potentially imposed by the existence of L_{\max} are not effective.

Now let us return to observation of the market from the viewpoint of the borrower and make three assumptions. First, suppose, in contrast to J-R's assumption, that the borrower also has some subjective expectation of default (the rationale for this will be discussed later), and that *this expectation is the same as the lender's* (i.e., $\lambda_b[LR] = \lambda_s[LR]$). This means that both the borrower and lender have the same perception of the effective price of credit (i.e., $R'_s = R'_b = R'$) and both view the loan offer curve to be horizontal at $R' = I$. Second, suppose that there is no other factor present which could affect relative net yields between the borrower and lender. These would include differential tax treatments or other institutional arrangements whereby the proceeds from loan repayment or default must be shared asymmetrically, either between the borrower and lender or with third parties.¹⁶ Finally, assume that both parties are risk neutral or are identically risk averse and have identical perceptions of risk (in the sense of uncertainty about expected default levels). *In such a specialized set of conditions it is clear that neither the borrower nor the lender perceives a rationed equilibrium* and the borrower's demand curve $L^*(R'_b)$ is identical to $E(R'_s)$ in Figure IIa.

15. See footnote 3 for those cases in which L_{\max} exists and is finite. L_{\max} can be found by first taking the total derivative of the loan offer curve relationship (22) with respect to R , which yields the slope of the inverse loan offer curve in (R, L) space,

$$\frac{dL}{dR} = \lambda_s + RL \left(\frac{\partial \lambda_s}{\partial RL} \right) R^2 \left(\frac{\partial \lambda_s}{\partial RL} \right).$$

Setting this relationship equal to zero identifies the point at which L does not change for a change in R along the loan offer curve. This is the solution to the equation $\partial \lambda_s / \partial RL + 1/RL \lambda_s = 0$, which determines L_{\max} as a function of R . We can then use the relationship $R'_s = \lambda_s R$ to find the loci of points that define L_{\max} for all R'_s .

16. There are a number of parallels between this analysis and the analysis of optimal financial structure of the firm. See Marshall [1979].

How well are these conditions satisfied in credit markets? Certainly, identical default expectations may not exist, especially in cases of asymmetric information.¹⁷ Figure IIb illustrates, from the borrower's perspective, the case in which the borrower's expectations of default are *less* than those the lender holds for him ($\lambda_b > \lambda_s$). In this case, the locus of equilibrium points E diverges from the borrower's demand curve (L^*) and rationing, in the sense of demand being greater than the contract loan volume at the net "price" to the borrower, is the result. The amount of rationing is represented by $L_D - L_E$. Note that the "rationing" created by this divergence in default expectations may be subjective and not an objective market phenomenon in the event the lender's ex ante expectations of default are upheld ex post.¹⁸ Regardless, the borrower "feels" rationed, and the lender perceives no rationing.

Figure IIc illustrates, again from the borrower's perspective, the case in which the borrower's expectations of default are *greater* than those the lender holds for him ($\lambda_b < \lambda_s$). In this case the borrower perceives a "downward sloping" loan offer curve that offers a higher volume of credit at a given price than he demands ($L_D > L_E$). In this case, of course, there is no rationing as perceived by the borrower. But note that in none of the cases in Figure II have we permitted the existence of L_{max} , a maximum offered loan volume, to be effective in restricting lending. This possibility is considered later.

Tax considerations and distribution of the proceeds from loan repayment or default can also result in a divergence in price expectations similar to that caused by a divergence in default expectations. Tax treatment of borrowers and lenders is highly

17. It is possible to show, given our later assumption that borrowers are both "potentially dishonest" and "lucky-unlucky," that one would expect common expectations of default only in certain special circumstances: (1) either the costs to default must be so large that only "honest" behavior is observed within the range of permitted period-2 income levels; (2) the costs of default must be identical for all borrowers in the class, thus rendering the individual probability-of-repayment relationship for the borrower identical to the aggregate probability-of-repayment relationship perceived by the lender; or (3) there must exist uncertainties in the costs of default that are identically perceived by the borrower and lender.

18. A parallel to this situation may be observed in bond markets. Interest rates on bonds vary according to the perceived risk of default by the entity floating the bonds, and these rates tend to increase with the size of the offering relative to the resources of the entity. These rates adjust as a part of the normal market adjustment process, perhaps influenced by rating agencies' judgments about creditworthiness. The offering entity may quarrel over the market's or rating agency's judgment, but we do not normally conclude that this represents "credit rationing" in bond markets even if the entity does not default on its obligation. Rather it is considered efficient market-clearing behavior.

asymmetric in general. In particular, the deductibility of interest payments from taxable income by the borrower is not reflected identically on the lender side. Nor are marginal tax rates equal in general for borrowers and lenders. Legal restrictions, too, often highly skew the distribution of proceeds from default. For example, any number of third parties, such as lawyers, law enforcement agents, and collection agencies may receive some payment. Restrictions upon the lender against gaining by foreclosure are also common. In each of these cases, the asymmetries present can create subjective perceptions of rationing.

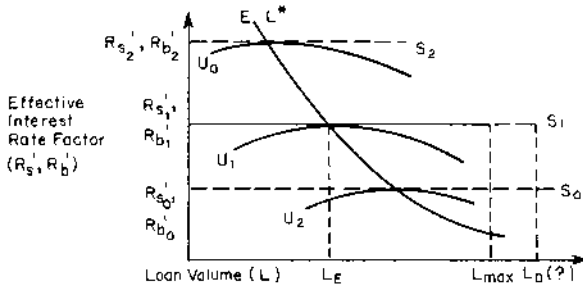
Finally, consider the existence and degree of risk aversion by the borrower and lender and their individual perceptions of risk. The J-R study and most subsequent investigations of credit rationing (including the present one) assume risk neutrality. However, it is virtually certain that some degree of risk aversion exists on both sides of the credit market. Given the existence of risk aversion, there is certainly no reason to expect either the degree of relative risk aversion or perceptions of risk to be the same for the borrower and lender, especially if one considers the appropriate measure of risk to be the marginal contribution of the loan contract to the nonsystematic risk in the lender's portfolio return or the borrower's overall utility.¹⁹ So again, in general, one would expect this asymmetry to be responsible for perception of a "rationed" equilibrium by the borrower.

We now return to the question of whether the existence of a maximum loan volume permitted by the lender (L_{\max}) can create another type of rationing in that borrower demand L^* may extend beyond L_{\max} . Consider first the case of common expectations of default (i.e., $R'_s = R'_b = R'$) and symmetry in treatment of taxes and the proceeds from default (Figure IIIa). In order to keep the required net yield R' constant at I for increased contract loan volumes below L_{\max} , the contract rate on the loan must be raised. This is because $R' = \text{constant}$ implies that

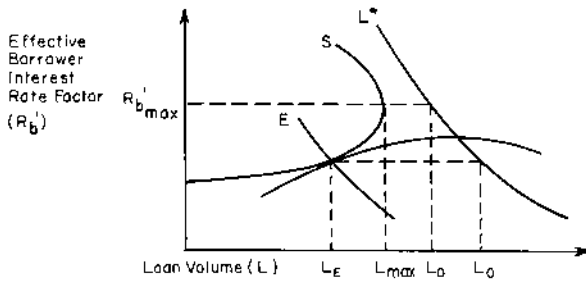
$$\frac{dL}{dR} = -\frac{1}{R} \left(L + \frac{\lambda}{R(\partial\lambda/\partial LR)} \right).$$

At low levels of L the second term in parentheses dominates (since $\partial\lambda/\partial LR$ is a small negative number) and dL/dR is positive. However, L eventually reaches L_{\max} , where $dL/dR = 0$. At this point

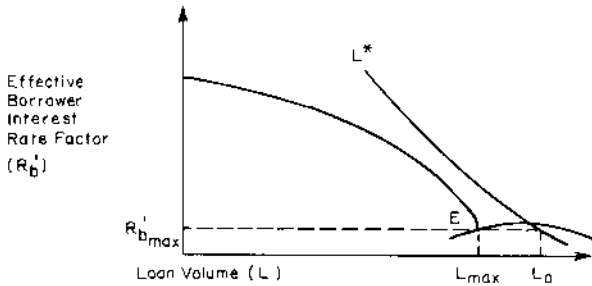
19. See Barth *et al.* [1979] for a discussion of appropriate measures of risk in credit markets.



a. In Net Yield (R') Space: Common Default Expectations



b. From the Borrower's Perspective: Borrower's Expectations of Default Less than Lender's



c. From the Borrower's Perspective: Borrower's Expectations of Default Greater than Lender's

FIGURE III
The Possibility of Rationing Caused by Demand at a Given Required Net Yield Being Greater than the Maximum Loan Volume Permitted by the Lender ($L^* > L_{max}$)

$\partial N/\partial LR + \lambda/LR = 0$. The special characteristic of the inflection point L_{\max} is that beyond this loan volume no amount of increase in R is sufficient to keep the net yield at $R' = I$. Thus, points along the locus $R' = I$ are not achievable beyond L_{\max} (by either the borrower or lender, since they have common expectations of default).²⁰ They therefore cannot be an appropriate range for L^* , which implies that rationing caused by such a situation is an impossible occurrence.²¹

On the other hand, in the case of divergent default expectations or asymmetries affecting relative net yields, it is entirely possible for $L^* > L_{\max}$ at a given required net yield and therefore for rationing to occur, at least as subjectively perceived by the borrower. Figures IIIb and IIIc illustrate the cases in which the default expectations of the borrower are less than and greater than those held for him by the lender, respectively. The question is whether a feasible contract rate R_D may exist at loan volume $L_D > L_{\max}$, which still provides a net yield of $R'_b \max$. It can be shown that in neither case is there anything logically inconsistent about this proposition.²² Whether it is true or not depends upon the nature of $\lambda_b[L_R]$.²³

Thus, two additional sources for rationing have been identified. In the case in which the borrower is more optimistic than the lender, the amount of rationing is perceived to be $L_0 - L_E$ in

20. Another way of proving this is by showing that there does not exist a feasible contract rate R_D at loan volume $L_D > L_{\max}$ which provides a net yield of $R'_b = I$. If this were the case, then $R_D \lambda_b[L_D R_D] = I$. But we know also that $I = R^* \lambda_b[L_{\max} R^*]$, where R^* is the single R that satisfies the relationship at L_{\max} , and by definition $R_D \lambda_b[L_D R_D] < I$ for $L_D > L_{\max}$. Furthermore, $\lambda_b[L_D R_D] = \lambda_b[L_D R_D]$. This implies that both $R_D \lambda_b[L_D R_D] = I$ and $R_D \lambda_b[L_D R_D] < I$, which is impossible.

21. Of course, for certain distributions for λ , L_{\max} would not exist (see footnote 3).

22. In the case in which $\lambda_b > \lambda^*$, $R^* \lambda_b[L_{\max} R^*] = I < R^* \lambda_b[L_{\max} R^*]$. Assume that there exists an R_D such that $R_D \lambda_b[L_D R_D] = R^* \lambda_b[L_{\max} R^*]$. We know by definition $R_D \lambda_b[L_D R_D] < I$ for $L_D > L_{\max}$. Combining terms, this implies that $R^* \lambda_b[L_{\max} R^*] = R_D \lambda_b[L_D R_D] > I > R_D \lambda_b[L_D R_D]$, which is entirely possible, unlike in the common default expectations case. In the case in which $\lambda_b < \lambda^*$, $R^* \lambda_b[L_{\max} R^*] = I > R^* \lambda_b[L_{\max} R^*]$. Assume that there exists an R_D such that $R_D \lambda_b[L_D R_D] = R^* \lambda_b[L_{\max} R^*]$. We know by definition that $R_D \lambda_b[L_D R_D] < I$ for $L_D > L_{\max}$ and by assumption that $R_D \lambda_b[L_D R_D] > R_D \lambda_b[L_D R_D]$. Combining terms, this implies that $I > R_D \lambda_b[L_D R_D] > R_D \lambda_b[L_D R_D] = R^* \lambda_b[L_{\max} R^*]$, which again is entirely possible.

23. In each case, the necessary and sufficient condition for an R_D to exist at $L_D > L_{\max}$ which provides a net yield of $R'_b \max$, can be shown to be $(\lambda_b[L_{\max} R^*] - \lambda_b[L_D R_D])/\lambda_b[L_{\max} R^*] = (R_D - R^*)/R_D$, where R^* is the optimal R corresponding to the relationship,

$$\lambda_b[L_{\max} R^*] = I.$$

Figure IIIb. This is similar to the rationing situation shown in Figure IIb, except that the borrower's demand cannot be satisfied at any set of loan terms. The case in which the borrower is less optimistic than the lender is an interesting and anomalous one in that rationing may occur *in spite of the fact that the lender perceives the borrower to be more creditworthy than the borrower perceives himself to be* ($\lambda_s > \lambda_b$) and loosens his loan terms accordingly. In this case L_{\max} is the maximum loan volume permitted and $L_0 - L_{\max}$ the amount of rationing.²⁴

To summarize, when credit is properly "priced" (i.e., when the price is considered to be the net yield and not the contract rate), the existence of default risk and imperfect information are neither necessary nor sufficient conditions for the existence of credit rationing (in the sense of surplus demand at the market-determined price).²⁵ They are not sufficient because, in addition to default risk and imperfect information being present, the borrower must have expectations of default *divergent* from those held for him by the lender. In most cases he must be more optimistic

24. It is also instructive to observe the nature of rationing at zero price to the borrower ($Rb = 0$). We have shown previously that demand goes to infinity at zero price. What about loan supply? In the case in which borrower and lender default expectations are identical, as is shown in Figure IIIa, zero loan volume is offered at $Rb = 0$ as long as $I > 0$, and rationing must occur. In fact, zero loan volume is offered for any Rb less than I . Only in the case in which $I = 0$ is there no rationing. In the case in which $\lambda_b > \lambda_s$ (Figure IIIb), a similar result holds. No credit is provided at $Rb = 0$, while demand approaches infinity, and rationing takes place. A slightly different result occurs in the case in which $\lambda_b < \lambda_s$. It may be that the downward-bending loan offer curve could actually intersect $Rb = 0$ at some nonzero loan volume. The question is whether it is possible that there could exist a set of loan terms (L_q, R_q) such that both $I = R_q \lambda_s [L_q R_q]$ (i.e., the terms are on the loan offer curve) and $Rb = R_q \lambda_b [L_q R_q] = 0$ (i.e., the terms are on the horizontal axis). If $L_q \leq L_{\max}$, then the first condition is certainly satisfied. This condition implies that $\lambda_s [L_q R_q] > 0$ for $I > 0$ and $R_q > 0$. Satisfaction of the second condition requires $\lambda_b [L_q R_q] = 0$ for nonzero R_q . These two together require that $\lambda_s [L_q R_q] > \lambda_b [L_q R_q]$, which is consistent with the assumption that the lender is more optimistic than the borrower. Thus, the offered loan at $Rb = 0$ could be nonzero, but since demand approaches infinity, rationing still exists.

25. The J-R model, of course, does not contend that the existence of default risk and imperfect information are *necessary* for rationing to be present, it *does* imply that they are *sufficient*. For example, on page 661, they make the point that in the single-contract case, competition forces the market to a zero-profit equilibrium exactly at E , the point of tangency between the loan offer curve and the iso-utility function, a rationed solution. This is shown to be true in both the "honest-dishonest" and "lucky-unlucky" cases. This solution is shown to dominate the previously discussed nonrationed equilibrium at the intersection of their demand and supply curves. As they state in footnote 10: "Indeed, a main point of the discussion in subsection III B [the single-contract rationing equilibrium case] is that even equilibrium points on the positively sloped portion of the supply function are necessarily dominated by rationing solutions further down the schedule." Thus, default risk and imperfect information are considered *sufficient* to create a rationed solution.

with respect to default expectations than the lender ($\lambda_b > \lambda_s$). They are not necessary because, even if default risk and imperfect information were absent, a number of other conditions—such as less risk aversion or less perception of risk on the part of the borrower, more favorable tax treatment, or institutional factors that provide a disproportionate share of the proceeds from default to the borrower—could initiate rationing, as perceived by the borrower. In each case, these conditions result in a divergence in the perceived price of credit and furthermore in the borrower perceiving a *higher* price for a given *offered* volume of credit than the lender. These conditions are quite common and very likely account for much of the “rationing” observed in credit markets in the absence of constraints on term setting. Whether or not the rationing created by these asymmetries is an objective market phenomenon is dependent upon whether or not *ex ante* default expectations are satisfied *ex post*. Regardless, from the lender’s perspective, no rationing is taking place at the time the loan is made.

D. Is an Unstable Oscillating Multiple-Contract Equilibrium Possible in a Competitive Credit Market?

A final issue that can now be disposed of quickly is the J-R conclusion that multiple-contract equilibria could be characterized by an unstable oscillating equilibrium. J-R recognize that contract *B* in Figure I could not be established in the lucky-unlucky case, unless individuals have some prior knowledge of their status. Lucky-unlucky individuals cannot be distinguished by demand differences and are only distinguished *ex post* by differing income outcomes. Thus, the unstable equilibrium must apply to the honest-dishonest case only.

We contend that their requirement that honest-dishonest behavior be revealed through contract choice is inconsistent with their assumption of borrower indistinguishability. Their assumption that borrowers with the intent to default would prefer a higher loan volume, regardless of the contract rate is in effect requiring vertical iso-utility curves in (*L*, *R*) space with utility increasing as loan volume increases. This contrasts with the “honest” borrower who possesses a downwardly concave utility function.

The analysis in Section III.B showed that indistinguishability of the demand behavior of borrowers with different *ex ante* expectations of default was perfectly possible under conditions of

imperfect information. If such is the case, this would result in the stabilization of the equilibrium at contract *A* and does not necessitate appeals to monopoly restrictions on entry, nonprice terms, collateral and downpayment requirements, or increased penalties of default, which are suggested by J-R as stabilizing forces.²⁶

IV. CONCLUSION

This paper has critiqued and extended the Jaffee-Russell model of loan market behavior. It has extracted three primary results:

First, it has rendered the J-R model internally consistent, permitting rationality on the part of all borrowers. Virtually all borrowers would be expected to have some expectation of default on a loan and, as economically rational individuals, to incorporate their default expectations in their demand behavior. When information is incomplete, this would not necessarily enable borrowers with different default expectations to be identified through their demand behavior. Such demand behavior would be "well-behaved" (i.e., "downward sloping" and not infinite) so long as net (after default) yields, and not contract rates, are interpreted as the effective price of credit.

Second, it has narrowed the conditions under which rationing may occur. Credit rationing is not a necessary outcome in loan markets under imperfect information and uncertainty when default risk is present, as long as credit is properly "priced." In fact, rationing, in the sense of surplus demand at the market-determined price, will occur only under certain circumstances representing disparities between the borrower and lender, namely divergent expectations of default, different degrees of risk aversion or perceptions of risk, differential tax treatments, or institutional restrictions that result in asymmetric distribution of the proceeds from default. Even in these cases, such rationing may not be an objective market phenomenon if lenders' a priori default expectations are upheld *ex post*.

Third, it has reinforced expectations of stability in multiple-contract loan equilibrium without appealing (as did J-R) to monopoly power, institutional restrictions to market entry, the ex-

26. Moreover, contract *A* does not ration credit so severely that no one defaults, as J-R suggest in their conclusions. A certain proportion $(1 - \lambda)$ of borrowers will experience undesirable income-default penalty outcomes and will find it necessary-desirable to default. This will remain true over multiple-contract time. We have previously shown that such an equilibrium does not necessarily involve rationing behavior.

istence of nonrate credit terms, or collateral and down payment requirements. Under conditions of imperfect information, borrowers with different costs of default are not distinguishable by their demand behavior. They therefore will all seek a common (stable) contract.

In sum, we conclude that, even when default risk is present, and under conditions of imperfect information and uncertainty, credit markets may function perfectly well, without rationing or unstable equilibrium behavior. Consequently, for explanations of rationing behavior, further attention should be given to the causes of divergent default expectations (of which imperfect information is only one) and asymmetries in institutional restrictions imposed upon borrowers and lenders affecting their relative net yields or costs of credit.

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