ENFORCEMENT FRICTIONS, ENDURING RELATIONS, AND CREDIT MARKET EQUILIBRIUM
by Eric Schulz
June, 1996
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Enforcement Frictions, Enduring Relations, and Credit Market Equilibrium

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ABSTRACT

This paper introduces a matching model of credit and exchange in which potential difficulties in the enforcement of contracts play a central role. The repeated games framework that is developed is used to analyze the pricing and availability of credit, the consequences of information monopoly in credit markets, and the effect of the introduction of a credit intermediary on economic activity. The model generates an endogenous credit limit and highlights the importance of enduring relations. Also studied are the effects on the pricing and availability of credit of improvements in production technology, of sanctions, and of the value of collateral.
1. INTRODUCTION

A great deal of credit originates in settings where the borrower and lender deal directly with one another rather than in auction markets. Such pairwise or customer market credit accounts for about three-quarters of U.S. private sector credit (Blinder 1989). Research on credit markets in less developed nations indicates that this form of credit may be even more important in these countries. These markets may work less than ideally. Credit may be available only among persons who interact with each other frequently over a small geographic area and it may not be available to segments of a community.

A very important, though rarely studied, feature is that enforcement of debt contracts tends to be less than perfect. Should a borrower default, the lender is certainly able to alter trade with that borrower in the future. However, recourse to the legal system for repayment should the borrower default seems not to be a realistic option in many cases. Numerous developing nations are ill-equipped legally to deal with defaults. For example, property rights may not be adequately assigned so that the use of collateral is problematic. In highly developed nations, legal costs may be high enough to discourage the use of legal redress.¹

Yet there are circumstances where it may be possible to impose sanctions beyond the alteration of future trade in the case of default. When the use of collateral is possible and a good can be seized, the lender’s loss and the borrower’s gain from defaulting is reduced to a degree (depending on factors such as how rapidly the good depreciates). In some circumstances, it may be possible to impose other sanctions.²

Given these difficulties, it is not surprising to note the importance of enduring relations in credit markets. Over two centuries ago, Adam Smith ([1763] 1896) noted that "When people seldom deal with one another, we find that they are

¹ Macauley (1963), in a study of relations among U.S. businesses, finds that "businesses seldom use legal sanctions to adjust exchange relationships or to settle disputes." (p.55)
² For example, Udry (1994) and Feder, et al. (1994), in their studies of rural credit markets in northern Nigeria and China, respectively, note the use of kinship and village sanctions.
somewhat disposed to cheat, because they gain more by a smart trick than they lose by the injury which it does their character." (p. 254) Recent evidence confirms the importance of this feature.

The model presented is basic but captures central features of credit relations. The frictions of a lack of trust and difficulties in the enforcement of contracts are used to develop a micro-based model of credit. The model is used to study interest rate determination, the availability of varieties of credit, the role of collateral and sanctions, and the effect of credit intermediation, and their interaction with output and welfare. An environment is presented in which buyers in need of credit visit sellers who must decide whether they will grant credit and trade.

Explicitly studying the repayment decisions of borrowers yields conditions under which lenders will grant direct credit. The model generates intuitive and commonly-observed results regarding, for example, credit availability depending on factors such as production ability (or income), collateral, and the degree of ongoing relations. In addition, this approach yields some novel results. A new channel through which improvements in goods production technology lead to greater credit availability and welfare is delineated. The effect of information monopoly and the role of collateral and sanctions in pricing are studied. In this environment, an increase in the ability to use collateral\(^3\) has the surprising effect of raising the price for some borrowers while lowering it for others. The model is then used to consider the effects of intermediation on economic development. Interestingly, the introduction of intermediation is not unambiguously positive because it reduces the availability of direct credit. Conditions under which intermediation increases economic activity are considered.

Of course, there has been considerable research in recent years on the effects of asymmetric information in credit markets. The prominent early examples are Jaffee and Russell (1976) and Stiglitz and Weiss (1981). Stiglitz and Weiss (1983) consider the intertemporal linkage of contracts in the presence of

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\(^3\) The amount of collateral used or sanctions imposed are taken as exogenous in this paper in order to consider the effects, for example, of changes in the legal environment with respect to their usage.
of asymmetric information. Diamond (1989) examines the strength of reputation effects over time in debt markets, when there is asymmetric information regarding the quality of investment projects, as a function of the proportion of undesirable borrowers and the age of the firm.

Another relevant strand of the literature investigates the operation of rural credit markets. In an excellent survey, Besley (1994) notes that prominent features of such markets are scarce collateral, problems with enforcement, and localized credit. Walker and Ryan (1990) richly detail the importance of enduring relations, the intimate knowledge that lenders have of borrowers, the primacy of the threat of the cutting-off of future credit as a means of encouraging repayment, and some problems with the use of collateral in informal credit markets in India. The volume edited by Hoff and Stiglitz (1994) contains numerous case studies.

This model differs from those cited in a number of ways. There is no asymmetric information regarding borrowers' investment projects or their basic characteristics in the central analysis. The effect of introducing asymmetric information is considered only briefly. As opposed to the models above, studied here in an essential way is the enforcement problem. The focus is on borrowers who are not trustworthy—they will fail to repay, even though they are able to, if lifetime utility is increased. These features make the granting of credit problematic. This appears to be a very important consideration in practice and is so in the model. The study of the repayment decisions of borrowers and consequent behavior of lenders yields essential results on the functioning of credit markets and institutions.

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5 Benjamin (1978) focuses on the role that collateral plays in the presence of enforcement problems in a very different two period framework. In a very recent paper, Hoff and Stiglitz (1995) study the effect of subsidies under monopolistic competition in the presence of enforcement costs. Besley and Coate (1995) study the use of social sanctions in lending to groups in a one-period game.
6 Clearly, a borrower may default due to a bad realization on an investment project. This possibility is abstracted from here to focus on the enforcement problem.
The pairwise nature of these credit relationships naturally draws one to models of matching for analysis. Models of matching have been fruitfully applied to analyze a broad range of economic issues. In an interesting recent paper, Peter Diamond (1990) studies the characteristics of credit market equilibrium in an adaptation of his barter-search economy. His model uses Nash bargaining to determine the price of credit, agents effectively meet only once, they completely drop out of the economy if they ever fail to repay a debt, and there is no intermediation. He shows that in the presence of "lumpiness" there is a feedback mechanism that leads to multiple equilibria where credit limits depend on the value of trade and studies their properties.

While similar in the spirit of taking an early step in the development of a micro-based model of endogenous credit, the means of payment, and production which seriously considers real-world frictions, this paper differs significantly. Its contributions stem from several features. A matching--not search--framework is introduced that does not include the feedback mechanism of the Diamond model but adds the realistic feature that agents meet with varying frequencies over time and so there are potential channels of trade that may be regularly exploited. In addition, a mechanism involving potential entry is introduced to study the terms of credit. The basic idea is that, while enduring relations are important in this context, borrowers may be able to switch to form new relationships should their current lender attempt to "gouge" them. This allows for endogenous price setting by sellers facing varying degrees of competition without needing to resort to some form of bargaining mechanism as is typically done in models of matching. The combination of these features in an environment with untrustworthy borrowers leads to a model which is able to address a range of issues and generate novel results on, for instance, the role of collateral, the interplay between credit and economic development, and the crowding out effects of intermediation.

The rest of the paper is organized as follows. Section 2 presents the basic structure of the model. Considered first is the basic model of non-intermediated
credit. Such credit between businesses is known as trade credit; such credit between a business and a consumer is known as customer credit. For simplicity, non-intermediated credit will generally be referred to as direct credit in this paper. Next, a borrower's repayment decision is considered. Section 4 presents the details of the model. The mechanism of potential entry is used for price determination. A Nash equilibrium which is stationary in prices and in which not all of the possible credit transactions in the economy are consummated is derived. Section 5 provides results and discussion. In Section 6, information monopoly and its effect on the role of collateral and pricing is discussed. A credit intermediary is introduced and its effects are considered in Section 7. Concluding remarks are contained in Section 8.

2. Basic Structure of the Model

To study the credit decision, a basic framework is adopted. Buyers and sellers with the possibility of trade meet with varying frequencies over time. Those that meet with a relatively high frequency can be thought of as representing a customer and a neighborhood bakery or grocery, traders on a commodity exchange, or residents of a rural village; those that meet with lower frequencies may represent a customer and an appliance or automobile dealer or residents in neighboring rural villages; those that meet extremely rarely may represent a tourist visiting a shop or residents of distant villages. To study the credit decision in the presence of enforcement problems, it is assumed that when a buyer and seller meet at time t, the buyer is unable to pay; he is able to only offer a promise to pay in the following period, t+1. At t+1, buyers are able to produce to repay if they choose.

The details of the model will now be given. Buyers visit sellers who may decide to grant credit. If so, in the following period the borrower either bears the cost of repayment or not, in which case that seller/lender terminates future

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7 In the U.S., the volume of trade credit between businesses is significant. Trade credit constitutes about one-sixth of assets of U.S. industrial firms (Ross, Westerfield, and Jaffe 1993) and about 40% of current liabilities of U.S. nonfinancial firms (Brigham 1995).
trade. Thus, the value of trade with a particular seller is important in determining a buyer's credit limit with that seller. The seller's pricing is constrained by the possibility that the buyer may be able to obtain credit from another seller in that market. To capture this, sellers face potential entry in each period. The basics of the environment to be described are given in Table 1.

### TABLE 1

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>Buyer ( j ) (( B_j )) is matched to market ( i ) with probability ( \pi(i, B_j) ).</td>
</tr>
<tr>
<td>Sellers produce in PM; buyers produce in AM.</td>
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<tr>
<td>( c/\beta ) is the zero profit price or gross interest rate charged by sellers.</td>
</tr>
<tr>
<td>Buyers' characteristics differ only in that they may have different matching probabilities across markets.</td>
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<tr>
<td>Sellers know all characteristics of buyers.</td>
</tr>
<tr>
<td>((t, PM)) Incumbent first posts credit schedule ( R^I_t(\pi, h_t) ).</td>
</tr>
<tr>
<td>The potential entrant observes this and then posts credit schedule ( R^E_t(\pi) ).</td>
</tr>
<tr>
<td>Each buyer is next matched to one market to shop for the PM good.</td>
</tr>
<tr>
<td>A seller produces a unit at a utility cost of ( c ) for any buyer who meets the terms of the credit schedule.</td>
</tr>
<tr>
<td>((t+1, AM)) No matching occurs. Any buyer who was granted credit at ((t, PM)) is able to produce to repay.</td>
</tr>
<tr>
<td>Incumbent exits the market if it was optimal to repay the entrant.</td>
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As noted, this is a matching model with two basic types of agents, buyers (borrowers) and sellers (lenders). Every buyer lives an infinite number of periods. Sellers' periods of activity within their market are determined in the model and may be infinite. Equilibrium credit terms are determined for each possible matching probability and do not depend on the number of buyers and sellers. For concreteness, it may be helpful to think of there being large, finite numbers of buyers and goods markets to which they can be matched.

Each period is subdivided into two subperiods denoted by AM and PM. Let \((t, AM)\) [(\(t, PM)\)] denote the AM [PM] subperiod of period \( t \). Time begins at
In the PM of each period, each buyer is matched according to a stationary probability distribution to a market for a particular good. That is, buyers go shopping in the PM. The probability that Buyer j (B_j) will visit the market for some good i is denoted by π(i,B_j) or, where the market and the buyer under consideration are clear or arbitrary, by π. In equilibrium, there is one seller per market so that π(i,B_j) is also the probability that buyer B_j meets the seller in market i. Each buyer is matched into one market in each period though a market may be visited by more than one buyer.

Sellers can instantaneously produce a unit of an indivisible good in the PM, if they choose, upon meeting a buyer. Production of a unit of this good entails a utility cost in the amount of c for the seller.

Buyers, in contrast, are able to produce only in the AM. A buyer’s good is perishable within a subperiod and is perfectly divisible. Producing x units of the good has disutility D(x) associated with it.

The difference in divisibility is assumed for a couple of reasons. Credit markets are used frequently to borrow to purchase indivisible goods. In addition, allowing the seller’s good to be indivisible simplifies the model in that a seller’s decision to grant credit for the purchase of a good is a 0-1 decision. Any buyer’s good is assumed to be divisible in order to allow for flexibility of payment for the seller’s good.

Sellers obtain utility only from the AM good (produced by buyers) while buyers obtain utility only from the PM good (produced by sellers). Buyers visit (are matched to) sellers in the PM seeking the PM good. The structure of production and trade is chosen so that when a buyer visits a seller at (t,PM), all that he can offer in exchange for a unit of the (t,PM) good is a promise to pay some amount of the (t+1,AM) good.

Let S_i be a seller in market i. Assuming that S_i and B_j meet at (t,PM) and agree to trade, S_i’s utility from the trade is given by

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8 The timing convention is adopted to study credit. The AM, PM subperiod convention is adopted simply because it yields somewhat cleaner expressions and notation than using alternating periods for shopping and repaying.
\[ u^i_t = -c + \beta R_t \quad \text{if } B_j \text{ repays } S_i \text{ the amount } R_t \text{ at } (t+1, AM) \] and
\[ u^i_t = -c + \beta k c \quad \text{if } B_j \text{ does not repay.} \]

\( R_t \) is the gross interest rate or price between \( t \) and \( t+1 \). It is measured in terms of the quantity of the buyer's AM good that is paid per unit of the seller's PM good. \( \beta \) is the discount factor which measures the degree of impatience across periods; \( 0 < \beta < 1 \) is assumed. Should the buyer fail to repay, the seller is able to seize the good at \( (t+1, AM) \) and recoup \( k c \) of the cost of production, where \( 0 \leq k \leq 1 \).\(^9\) To distinguish this function from that of the buyer, the seller's per trade utility function given above will also be referred to as profit. (Sellers will also be identified as "firms" below.)

\( B_j \)'s utility function per trade is given by
\[ u^j_t = u(1) - \beta D(R_t) \quad \text{if } B_j \text{ repays } S_i \text{ at } (t+1, AM) \] and
\[ u^j_t = u(1) - \beta L \quad \text{if } B_j \text{ does not repay.} \]

The utility from obtaining a unit of the PM good is given by \( u(1) \). Consuming two units of a given good in a subperiod yields \( u(2) \), where \( u(2) > u(1) \) and \( u(2) - u(1) < u(1) \). For simplicity, any additional units consumed in a period yield no utility.

The function \( D \) gives the instantaneous disutility of producing the buyer's AM good. \( D \) is differentiable and \( D' > 0 \) and \( D'' > 0 \). It is further assumed that \( u(1) > D(c/\beta) \) and that \( [D(2c/\beta) - D(c/\beta)] > u(2) - u(1) \) so that a buyer would be willing to trade \( c/\beta \) units of the AM good to obtain a unit of the PM good but would not be willing to produce another \( c/\beta \) units of the AM good to obtain a second unit of the PM good. (In equilibrium, because of competitive potential entry, the price of a unit of the PM good will be \( c/\beta \) units of an AM good.) A greater \( D \) function means greater disutility is associated with each level of

\(^9\) One can think here of the seller being able to replenish some of the resources put into production by seizing the good.
production so that it can be interpreted as a measure of income-earning ability.

$L$ is the utility loss at $(t+1,AM)$ the buyer suffers as a result of not repaying. $L$ may represent the loss of part of the utility provided by the good if it is seized as collateral or the disutility imposed on the buyer via sanctions used by the firm.\(^{10}\) That less than perfect enforcement is possible is captured by the assumption that $D(c/\beta) > L$.

In all but Section 6, it is assumed that sellers know all of the characteristics of the buyers. It is also assumed that a particular buyer's repayment history with a given firm is private information to that firm and buyer. (Actually, all that is needed for the results is that firms in one market cannot condition their decisions to grant credit or not on a buyer's credit record in other markets. Since there is no difference in the payoff functions of the buyers, a potential entrant in a given market is not handicapped by not knowing the credit history of the buyers in the market. Buyers will repay with probability one or with probability zero based on their basic characteristics.)

To summarize, at each $(t,PM)$, buyers are matched with sellers. Each seller must decide whether or not to grant credit to any buyer who visits at $(t,PM)$. Here, to "grant credit" means to give the buyer a unit of the indivisible PM good in exchange for a promise of some amount of that buyer's $(t+1,AM)$ good.

While I will refer to the AM good and the PM good, it is easiest in the context of the matching model to think of buyers and sellers as producing different goods and that the problem of double coincidence of wants has been solved. As noted above, different $\pi$'s can be thought of as representing different frequencies of possible transacting among various groups. However, it is not desirable to identify a particular $\pi$ with a particular type of good or service. One can certainly think of wholesalers and retailers as having high $\pi$'s for items for which most persons would have relatively low $\pi$'s.

\(^{10}\) For simplicity, it is assumed that the seller can directly impose a penalty without involving other members of the community.
3. The Repayment Decision of Buyers

Before expanding the model to consider potential entry which will allow the derivation of the equilibrium with competitive pricing, it is useful to briefly consider a buyer's choices with respect to repayment in a market to which the buyer has been matched for which the buyer has a matching probability of \( \pi \) when i) the price is constant over time (\( R_t = R \) for all \( t \)) and ii) there is only one active seller per market who cuts off credit to the buyer should the buyer fail to repay \( R \) per trade. (Both of these conditions will be shown to hold in the equilibrium analysis that follows.) Condition ii) means that if the seller cuts off credit to the buyer, the buyer has no possibility of obtaining the good produced by the seller. Each time a trade from a meeting at \((t, PM)\) is fully completed (the seller grants credit in the PM, the buyer repays in the following AM), a buyer obtains \( u(1) - \xi D(R_t) \) in utility.

When the buyer is matched to the seller for the first time (call it time period zero), the buyer's expected lifetime utility from choosing to always repay is

\[
(1) \quad u(1) - \beta D(R_0) + \sum_{t=1}^{\infty} \pi \beta^t [u(1) - \beta D(R_t)] = \frac{1-\beta+\pi \beta}{1-\beta} [u(1) - \beta D(R)]
\]

when \( R_t = R \) for all \( t \).

On the other hand, a buyer obtains \( u(1) - \xi L \) if he fails to repay and the seller cuts off future trade and takes action so that the buyer loses \( L \) at \((t+1, AM)\). Given the constancy of the interest rate, if a buyer decides to not repay, he will do so immediately. A buyer will choose to not repay if

\[
(2) \quad D(R) > \frac{\pi u(1) + (1-\beta)L}{1-\beta+\pi \beta}.
\]

This expression indicates that once the buyer has received credit (the PM good) from the seller, it is best to not repay if the cost of repayment, \( D(R) \), exceeds the expected present value of benefits from repaying and being granted credit in the future.
This condition can be restated as follows: Do not repay if

\[ (3) \quad \pi < \frac{(1-\beta)[D(R)-L]}{u(1)-\beta D(R)}. \]

Expressions (2) and (3) make clear that a seller’s decision to grant credit depends on all of the buyer’s characteristics and the loss faced by the buyer if he fails to repay. For example, sellers will not grant credit to buyers whose disutility of production is too high (which can be interpreted as production or income-earning ability which is too low) and whose matching probability (frequency of interaction or need) is too low. It’s clear that the analysis could be done allowing any of the borrowers’ characteristics to vary. For example, if matching probabilities and discount factors varied across buyers, Figure 1 gives the region of the two variables such that buyers would optimally repay for given values of the other variables when \( c=1, D(R)=(1/\beta)^2, L=.15, u(1)=1.5. \) For simplicity it will be assumed for the equilibrium analysis of Section 4 that buyers differ only in that they may have different matching probabilities for different sellers. In the rest of the paper, reference will, however, be made to results that would hold were other characteristics to vary.

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4. Structure of the Model

4.1 Structure of Competition

To consider competitive equilibrium\(^{11}\), the structure of the model is enriched as follows. For each time period, at \((t,PM)\), in each market there will be a seller designated as the incumbent and a potential entrant. The potential entrant will, for brevity, often be referred to as the "entrant", even though he

\(^{11}\) The structure in this section yields a competitive (zero profit, here) outcome even though there is only one active firm per market in equilibrium. The structure can be adapted to analyze varying degrees of competition.
may choose not to enter.

The incumbent moves first and posts a price schedule, $R_t^I(\pi, h_t)$, which gives the amount of the $(t+1, \text{AM})$ good which a buyer who is matched into the market with probability $\pi$ (is of type $\pi$) and whose repayment history with the incumbent is given by $h_t$ should repay in exchange for a unit of the $(t, \text{PM})$ good. The equilibrium analysis is restricted to focus on the role of buyers' matching probabilities and repayment histories in that sellers must, in any period, charge the same price to buyers who are the same across these dimensions. The crucial importance of a person's repayment history in firms' credit decisions is well-known.

By using this price schedule, the incumbent also adopts a credit policy--i.e., conditions that must be met by a buyer in order to be granted credit. For example, the incumbent may post that buyers who visit with probability .1 and who have a history of never having failed to repay him should pay a price of 1.08, while credit may not be offered to buyers who have ever failed to repay. Only the case in which sellers can potentially discriminate based on $\pi$ is considered here. $R_t^I(\pi, h_t) = \infty$ means that the incumbent does not offer credit to a buyer of type $\pi$ with repayment history $h_t$. $R_t^I(\pi, h_t) = \infty$ for all $h_t$ thus means that the incumbent does not offer credit to buyers of type $\pi$. All buyers and the potential entrant observe these publicly-posted or advertised prices.

The potential entrant next posts a price schedule, $R_t^E$, which indicates the price for a given matching probability. $R_t^E = \infty$ for a given matching probability means that the potential entrant decides not to enter the market for buyers of that type.

Finally, buyers are matched into the market. They observe the posted prices for their type and repayment history and make choices regarding shopping and repayment.

The characteristics of a buyer that an incumbent firm observes are the buyer's type, $\pi$, and the buyer's repayment history with it. An entrant observes only the buyer's type, $\pi$. All agents have access to the history of which firms were in the market in the past and the prices charged.
Let $I_t$ ($E_t$) denote the incumbent (potential entrant) under consideration at $(t,PM)$. $B_j$ visits (is matched into) the market at $(t,PM)$ and observes whether he is offered credit by either $I_t$ or $E_t$ and, if so, the prices of the sellers. $B_j$ then chooses with which seller to shop and to either repay or not repay any seller who has offered him credit.

In the equilibrium developed below, entry does not occur and thus the original incumbent, $I_0$, retains incumbency throughout the game. For completeness, the transition rules governing incumbency from period to period will now be given.

The rules given are for a given matching probability $\pi$. Since price discrimination is possible, it is helpful to think of each matching probability $\pi$ as defining a separate submarket for any PM good. At $(0,PM)$, $I_0$ is the initial incumbent and $E_0$ is the potential entrant. $I_t$ becomes $I_{t+1}$ if 1) $I_t$ offers credit and is repaid by a rational buyer of type $\Pi$ or 2) $I_t$ does not offer credit and $E_t$ either does not offer credit or $E_t$ does offer credit but is either not repaid or not shopped with. Otherwise $I_t$ loses incumbency and exits the market.

$E_t$ becomes $I_{t+1}$ if $E_t$ offers credit and is repaid and $I_t$ either does not offer credit or $I_t$ offers credit but is either not repaid or not shopped with. Otherwise $E_t$ exits the market.

In all other cases, there is no incumbent at $t+1$, only two new firms (one of whom is arbitrarily designated the incumbent, the other the potential entrant), each of whom knows that neither was in the market in the past.

Let $H_t$ be all possible histories. Let $H_t^k$ be the portion of all possible histories available to agent $k$, where $k=I$ for the incumbent, $k=E$ for the entrant at time $t$, and $k=B_j$ for buyer $j$.

By assumption, no seller is in more than one market and buyers' strategies in one market are independent of their strategies in any other market. The strategies of the incumbent, entrant, and arbitrary buyer $B_j$ of type $\Pi$ at the component game beginning at $(t,PM)$ and going through $(t+1,AM)$ are as follows. First, consider the incumbent's strategy, $S^I_t$. $S^I_t$ is a function which maps buyers' types and $H_t^I$ into the extended reals, $R'$. The price schedule, $R^I_t$, of
the incumbent is the strategy posted for the possible matching probabilities and repayment histories.

Next, $E_t$'s strategy is $S^E_t$ which sends $H^E_t$, buyers' matching probabilities and the incumbent's price schedule into $R'$. $S^E_t \equiv \infty$ for all $t < t'$, and for $t > t'$ if $E_t$ does not attain incumbency from $(t, PM)$ to $(t+1, AM)$ trade. $S^E_{t+1} \equiv S^E_{t+1} \cup \mathcal{X} \not\rightarrow R'$ if $E_t$ gains incumbency, where $H^E_{t+1} = H^E_t$. A potential entrant's decision to actually enter by naming a finite price means automatically that the entrant offers credit. $E_t$ observes $I_t$'s price schedule and takes it into account when choosing his strategy.

Buyer $j$'s strategy $b^j$ sends $H^I_j$ and the prices offered by $E_t$ and $I_t$ into the set $\{E_0, E_1, E_2\} \times \{I_0, I_1, I_2\}$. A buyer observes prices of sellers and thus whether credit is offered. $E_0$ ($I_0$) means the buyer chooses to not repay $E_t$ ($I_t$), $E_1$ ($I_1$) means the buyer chooses to repay $E_t$ ($I_t$), and $E_2$ ($I_2$) means that the buyer chooses to not visit $E_t$ ($I_t$).

Let $S^E = (S^E_0, S^E_1, S^E_2, \ldots)$. Then let $S^{E-j}$ be the same vector but without $E_t$'s strategy; e.g., $S^{E-1} = (S^E_0, S^E_2, S^E_3, \ldots)$. Similarly, let $b = (b^1, b^2, \ldots, b^n)$ be the vector of strategies for the $N$ buyers of type $\pi$ who may be matched into this submarket. Then $b^1 = (b^1, b^{1-1}, b^{1-2}, \ldots, b^n)$. Let $S^I_t, S^E_t, B^j$ denote the strategy sets for $I_t$, $E_t$ and $B_j$. Further, let $U^k$ represent the payoff, the present value of utility, to agent $k$.

### 4.2 Nash Equilibrium

It is now possible to define a Nash equilibrium (NE) for the game.

$(S^I_0, S^E, b)$ is a Nash equilibrium iff

\[
U^I(S^I_0, S^E, b) \geq U^I(s^I_0, S^E, b) \quad \text{for all} \quad s^I_0 \in S^I_0
\]

\[
U^E_t(S^I_0, S^E_t, S^{E-t}, b) \geq U^E_t(S^I_0, S^{E'_t}, S^{E-t}, b) \quad \text{for all} \quad t, \quad \text{for all} \quad s^{E'_t} \in S^{E_t}
\]

\[
U^B_j(s^I_0, S^E, b^j, b^{-j}) \geq U^B_j(s^I_0, S^E, b^{j'}, b^{-j'}) \quad \text{for all} \quad j, \quad \text{for all} \quad b^{j'} \in B^j.
\]

Consider, for a moment, play if the game is repeated only once. That is, consider the component game that begins at $(0, PM)$ and ends at $(1, AM)$.

**Result:** The unique subgame perfect Nash equilibrium of this one-period component game involves no trade.
Proof: The unique subgame perfect Nash equilibrium for the game is derived by backward induction. In the one-period game, $I_0$ either grants credit to all or none of the buyers of type $\pi$ since there is no repayment history upon which to condition the granting of credit. It is always best for a buyer in a one-period game to not repay any seller who grants him credit. Thus, it is always best for any seller to not offer credit.

If the game is repeated infinitely often, it is thus necessarily the case that one NE is that the buyers choose to fail to repay any credit offered, no potential entrant enters, and the initial incumbent never offers credit.

That a NE exists in which credit is offered to at least some buyers is shown by the following proposition. The proposition is discussed below and proved in the appendix.

**Proposition 1:** For any given market, there exists a Nash equilibrium in which 1) the initial incumbent offers credit, at the constant price of $c/\beta$ over time, to buyers with matching probabilities no less than $\bar{\pi}$, but not to buyers with lower matching probabilities, 2) no potential entrant enters, 3) all buyers who are granted credit repay.

$\bar{\pi}$ is defined to be the matching probability $\pi$ that leaves a buyer indifferent between repaying and not at the zero profit price:

$$ u(1) - \beta L = u(1) - \beta D(\frac{C}{\beta}) + \bar{\pi} \sum_{t=1}^{\infty} \beta^t [u(1) - \beta D(\frac{C}{\beta})]. $$

Now let $R(\pi)$ be the number $x$ that solves

$$ u(1) - \beta L = u(1) - \beta D(x) + \sum_{t=1}^{\infty} \beta^t [u(1) - \beta D(\frac{C}{\beta})]. $$

Further, let $\tilde{h}_t$ denote the generic repayment history where the buyer has never defaulted. Let $Q^I_t$ be the set of all buyers who have failed to repay $I_t$. Let $\tilde{h}_t$ be the history such that for some period $t<\tau$, neither $I_\tau$ nor $E_\tau$ became $I_{\tau-1}$. 
A. The Outcome for Buyers with \( \pi \geq \overline{\pi} \)

The strategies of \( I_t \) and \( E_t \) for buyers with \( \pi \geq \overline{\pi} \) are as follows:

\[
R_t^I = \frac{C}{\beta} \quad \text{if } B_j \in Q_t^I, \\
\quad = \infty \quad \text{otherwise}
\]

\[
R_t^E = R_t^I - \epsilon \quad \text{if } R(\pi) \geq R_t^I(\pi, \overline{h}_t) > \frac{C}{\beta}, \quad \text{and } h_t \neq \overline{h}_t, \quad \text{where} \quad \epsilon = \frac{1}{2} (R_t^I - \frac{C}{\beta})
\]

\[
= R(\pi) \quad \text{if } R_t^I(\pi, \overline{h}_t) > R(\pi) \quad \text{and} \quad h_t \neq \overline{h}_t
\]

\[
= \infty \quad \text{otherwise}
\]

That is, should \( I_t \) list a price for buyers who have never defaulted such that it would be rational to repay \( I_t \) were \( I_t \) the only firm in the market but which is greater than the zero profit price, \( c/\beta \), \( E_t \) undercuts \( I_t \)'s price by charging \( R_t^E = \frac{1}{2} \left( \frac{C}{\beta} + R_t^I \right) \).\(^{12}\) Should \( I_t \) charge a price to buyers who have never defaulted so high that it would not be rational for a buyer to repay, even when forecasting a return to zero profit prices in the future, \( E_t \) undercuts that price with the highest price it is rational for buyers to repay, \( \overline{R}(\pi) \).

Let \( Z_t^I \) and \( Z_t^E \) be functions which indicate whether or not the buyer repays the seller indicated. \( Z_t^I = 0 \) if \( B_j \) chooses not to repay \( I_t \), \( Z_t^I = 1 \) if \( B_j \) chooses to repay \( I_t \), and \( Z_t^E = 2 \), if \( B_j \) chooses to not shop with \( I_t \). Then \( Z_t^I = 1 \) and \( Z_t^E = 0 \) corresponds to \( B_j \) choosing the strategy \((I1,E0)\).

The strategy of \( B_j \) is

\[
b^j_t = (Z_t^I, Z_t^E) \quad \text{where}
\]

\[
Z_t^I = 0 \quad \text{if } R_t^I > R_t^E \quad \text{or} \quad B_j \in Q_t^I \quad \text{or} \quad R_t^I > \overline{R}(\pi)
\]

\[
= 1 \quad \text{otherwise}
\]

\(^{12}\) As is the case in the usual Stackelberg price-setting game, it is not possible for \( E_t \) to optimally undercut \( I_t \) because the set of prices strictly less than \( R_t^I \) is open.
\[ Z_t^E = 0 \text{ if } R_t^I \leq R_t^E \text{ or } R_t^E > R(n) \]
\[ = 1 \text{ otherwise} \]

That is, buyers repay the incumbent as long as the incumbent is not undercut by the entrant and the incumbent offers credit at a price such that it is individually rational to repay. If these conditions are not met, the buyer repays the entrant if he offers credit and doing so is individually rational, forecasting that the buyer will be able to obtain the good at the zero profit price in the future.

Given these strategies, in the equilibrium, \( I_t \) offers the zero profit price of \( c/\beta \) for all \( t \) to any buyer with \( n \geq n \) who has never failed to repay him, no potential entrant enters (i.e., \( E_t \) chooses \( \infty \) for all \( t \)), and any buyer with \( n \) no less than \( n \) chooses to repay the incumbent each time that they are matched. (A buyer who is indifferent between repaying and not is assumed to repay.)

The strategy of the potential entrants is to profitably undercut the incumbent in period \( t \), if possible, recognizing that should one be able to enter at a profit, he will become the incumbent and will have to charge \( c/\beta \) in the future. It will not be profitable to undercut an incumbent who charges \( c/\beta \). Doing so would gain incumbency for the entrant in the next period but he would then face potential entrants.

The strategy of the buyer is to repay the incumbent as long as the incumbent's price is not undercut. Buyers exhibit loyalty (and thereby support the equilibrium) in that, if the entrant offers the same price as the incumbent, the buyers repay the incumbent and not the entrant. Should the incumbent ever be undercut, buyers repay the entrant if doing so, assuming future prices will equal \( c/\beta \), will yield expected lifetime utility at least as great as that obtained by not repaying, \( u(1) - \beta L \).

The proof of Proposition 1 is contained in the Appendix.
B. The Outcome for Buyers with \( \pi < \bar{\pi} \)

**Proposition 2:** When a buyer's repayment history with a given firm is private information to the buyer and firm, there cannot be a Nash equilibrium in which any seller offers credit to buyers with \( \pi < \bar{\pi} \).

This proposition holds because it is optimal for a buyer with \( \pi < \bar{\pi} \) to fail to repay a seller who offers any price path that gives the seller zero present value of profit. The proof appears in the Appendix.

**Proposition 3:** For buyers of type \( \pi < \bar{\pi} \), the following strategies form a Nash equilibrium.

- \( S_t^i = \infty \) for any buyer, for all \( t \)
- \( S_t^e = \infty \) for all \( t \)
- \( b_t^j = (I0, E0) \) for all \( t \)

**Proof:** This follows immediately from consideration of the one-period game.

In summary, this section has given equilibrium strategies which yield the outcome that there is only one active seller per good and a stationary price path obtains at the competitive (zero profit) level (\( R_e = c/\beta \)), as was assumed in order to derive the results in Section 3. In this economy, credit is granted only when a seller is visited by a buyer whose \( \pi \) is at least \( \bar{\pi} \).

5. The Extent of Trade and Comparative Statics

Buyers with \( \pi < \bar{\pi} \) are not granted credit. The next proposition shows that \( \bar{\pi} > 0 \) so that not all possible credit transactions are consummated.

**Proposition 4:** Under the assumptions made on \( \beta, D, L, \) and \( u, \bar{\pi} > 0 \).

**Proof:**

Given that \( \bar{\pi} = \frac{(1-\beta)[D(\frac{C}{\beta}) - L]}{u(1) - \beta D(\frac{C}{\beta})} \), and that \( u(1) - \beta D(\frac{C}{\beta}) > 0 \)

\( \bar{\pi} > 0 \) iff \( (1-\beta)[D(\frac{C}{\beta}) - L] > 0 \). Thus, \( \bar{\pi} > 0 \) since \( 0 < \beta < 1 \) and \( D(\frac{C}{\beta}) > L \) was
This intuitively sensible result indicates that the problems with the lack of trustworthiness and enforcement in the economy lead to less credit and trade than would be the case otherwise. That non-intermediated credit is not available to buyers with low matching probabilities accords well with actual practice; such credit is often available, for example, from bakeries and video stores to frequent customers. It is not generally available between residents of different rural villages or to tourists.

**Proposition 5:** $\bar{\pi}$ moves inversely with $L$, $\beta$, and $u(1)$, and directly with the costs of production, $c$ and $D(R)$.

The proof follows straightforwardly from the partial derivatives of $\bar{\pi}$ and is contained in the appendix.

This says that more credit is available the greater are $u(1)$, $\beta$, and $L$, and the smaller is $c$. That $\bar{\pi}$ moves inversely with $L$ has implications for the types of goods available on trade credit. With $L$ interpreted as the loss of utility to a defaulting borrower when a good is seized as collateral, this says that goods that depreciate more rapidly, so that $L$ is lower, will be less likely to be sold on trade credit.\(^{13}\) Of course, $L$ can be interpreted as the utility loss suffered by a defaulter due to social sanctions as well as due to the seizure of the good as collateral. This suggests that a government policy which makes it easier to impose sanctions or to use collateral will increase the amount of direct credit in the economy. Since more credit is available at the price $c/\beta$, such a policy is Pareto-improving. (But note the effect of collateral or sanctions in the presence of information monopoly in Section 6.)

A greater $u(1)$ means that the good is more valuable to the buyer so that the buyer is less apt to fail to repay and cut off his continued access to the good. When $\beta$ increases, since $R=c/\beta$, the disutility of producing to repay in each period declines. Also, an increase in $\beta$ makes each expected future repayment

\(^{13}\) Ross, et al. (1993) note that low collateral value and perishability of goods are factors which lead to less trade credit being granted.
and consumption of the good more valuable.

Direct credit is less likely to be extended, ceteris paribus, the greater is the cost of production, \( c \), for the seller, which accords well with actual practice. An increase in \( c \) increases the disutility of production for the buyers, \( D(c/\beta) \), which lessens the value of the ongoing relation. Video stores may rent tapes but not VCR's without a security deposit. Physicians may grant office visits on a credit basis but not perform expensive procedures without evidence of insurance.

An endogenous credit limit is specified for a given buyer by the model as the highest \( c \) consistent with the borrower repaying. This credit limit is obtained by solving Equation (6) for \( c \), given the buyer's characteristics.

\[
D\left(\frac{c}{\beta}\right) = \frac{\pi u(1)+(1-\beta)L}{1-\beta+\pi \beta}
\]

Simply put, better customers (higher \( \pi \)) are able, ceteris paribus, to obtain more credit. That is, such buyers would be able to obtain credit for goods with higher prices than would buyers with lower matching probabilities. The credit limit also rises with the value, as well as collateral value, of the good to the buyer.

Interestingly, note that as \( c \) falls (production technology improves), welfare and the volume of trade increases in this economy for nonstandard reasons. That is, as \( c \) falls, \( \Pi \) falls so that credit is more likely to be extended. This means that more credit transactions and thus production will take place. Thus, this model brings out a new channel--a credit channel--through which improvements in the technology of production can yield greater welfare. The same result clearly holds for an improvement in the buyers' production technology which lowers disutility of production. The model predicts that direct credit becomes more readily available as nations adopt newer, more efficient technology.

Further, the model highlights the problems faced by the poor in credit markets. Credit is not available to persons with relatively high disutility of
production (low income-earning ability) even though they can afford to repay here. Lenders correctly perceive, considering the enforcement problems, the reduced incentive to repay when the disutility of production is greater.

6. Information Monopoly and the Role of Collateral

The availability of collateral affected the availability of credit because it affected buyers' repayment decisions. The possibility of reclaiming the good did not otherwise alter sellers' behavior since, with buyers' characteristics known, buyers who are granted credit repay with probability one; those who aren't would, if given credit, repay with probability zero. To note the effect of collateral on sellers' decisions when buyers default in equilibrium and to consider the effects of information monopoly, the model will be slightly altered.

Suppose, in this section, that there are two types of buyers who are distinguished by different disutilities of production. Suppose that a proportion \( g \) of buyers has a disutility of production function, \( D_1 \), which is identical to the \( D \) function above, and a proportion \( 1-g \) has a disutility of production function \( D_2 \) where \( \beta D_2(c/\beta) > u(1), D_2' > 0, D_2'' > 0 \). It will never be optimal for a buyer with a \( D_2 \) function to repay at a price no less than the zero profit price.

Incumbents, it is assumed, know the market well enough that they know a buyer's production ability, as well as the other characteristics of buyers. Potential entrants do not know the market as well and are unable to distinguish a buyer with a \( D_1 \) disutility function from one with a \( D_2 \) function. For simplicity, suppose potential entrants know all other characteristics.

Recall that sellers obtain \( kc \) in utility, where \( 0 \leq k \leq 1 \), in the AM should a buyer default. This can be thought of as the benefit to the seller from seizing the collateral, net of the costs of doing so.

To be considered here are credit availability and pricing in this environment, when sellers charge a constant price over time. Given no means of separating buyers ex-ante, entrants cannot be certain that any given buyer has production ability high enough that he will repay. Since it is optimal for a
buyer to fail to repay immediately, if he fails to repay at all, entrants can learn a buyer's type by offering credit and observing whether repayment is made.

Now the incumbent can forestall entry by charging a price that yields an entrant expected profit of zero. This price satisfies

\[
(1-g)(-c+\beta kc) + g(-c+\beta R)(1+\frac{\pi_1}{1-\beta}) = 0.
\]

The first term indicates the loss due to the proportion \((1-g)\) who renge while the second term is the profit from ongoing relations from those who find it best to repay. Call the \(R\) that solves this equation \(R_0\).

\[
R_0 = \frac{c}{\beta} \left[ 1 + \frac{(1-\beta k)(1-g)(1-\beta)}{g(1-\beta + \pi_1)} \right]. \quad \text{Under the assumptions, } R_0 > \frac{c}{\beta}.
\]

In addition, the incumbent must insure that it is not best for a buyer to fail to repay, even without entry. That is, the price he charges must satisfy

\[
(9) \quad u(1) - \beta D(R) + \frac{\pi_1}{1-\beta} \geq u(1) - \beta L.
\]

Call the \(R\) that yields equality, \(R_1\).

\[
R_1 = D^{-1}[\frac{\pi u(1) + (1-\beta) L}{1-\beta + \pi_1}]
\]

The incumbent can now prevent entry and insure repayment by charging buyers of type \(\pi\) a price \(R^I = \min(R_0^I, R_1^I)\). \(R^I > c/\beta\) for all \(\pi > \bar{\pi}\).

Since \(R_0^I\) is decreasing and \(R_1^I\) is increasing in \(\pi\), if \(R_0^I = R_1^I\) at some \(\pi < 1\), call it \(\pi^*\), \(R_1^I\) will be the price charged to all buyers with greater \(\pi\). See Figure 2 for an example of \(R^I\) when \(0 < \pi^* < 1\) and \(\beta = .95\), \(g = .8\), \(k = L = .15\), \(u(1) = 1.5\), \(D(x) = x^2\), \(c = 1\).

If the collateral value of the good increases to both the lender and borrower \((k \text{ and } L \text{ increase})\), say, due to legal change, \(R_0^I\) decreases while \(R_1^I\) increases so that \(\pi^*\) decreases. Borrowers with \(\pi > \pi^*\) will now pay a lower price
than before since the greater is $k$, the lower is the cost of default for the seller and so the cost of entry (learning the borrowers' characteristics) is lower. For these borrowers, potential entrants thus pose a greater threat to the incumbent who must charge a lower price to ward off competition.

For buyers with $\pi < \pi$, the incumbent's price is constrained by repayment rather than competitive considerations. The price he is able to charge increases with $L$. Or, put the other way around, the lower is $L$, the less is the loss to the buyer from defaulting, so that the incumbent must charge a lower price to encourage repayment.

Finally, note that $R_0$ moves inversely with the proportion of good credit risks, $g$. If $g$ is small enough, $R_0 = R_1$ for all buyers. The incumbent then, in effect, faces no competition at all. Then an increase in $L$ due to the increased ability to use collateral or impose sanctions leads to the interesting result that price rises for all borrowers.

That interest rates may rise with the use of collateral is perhaps counterintuitive as it runs against the grain of conventional thinking on the role of collateral. It is, however, consistent with the finding of Walker and Ryan (1990) that, ceteris paribus, interest rates were higher in the rural Indian markets they studied when collateral was used. They note that moneylenders used collateral "primarily as a means to improve repayment incentives." (p.205)

In summary, this section indicates that the effects of the possibility of the use of collateral or sanctions vary. For relatively infrequent buyers, $\pi < \pi$, it means price is higher since it decreases the gain to borrowers from reneging. For buyers with higher matching probabilities, the existence of collateral makes entry (competition in the credit market) safer and so forces the incumbent to charge a lower price.
\[ R^{f} - \min\{R_{0}^{f}, R_{1}^{f}\} \]

**FIGURE 2**
7. Credit Intermediary

To this point, the only credit in the model consists of credit that is granted directly by a lender to a borrower. To be considered now is the effect of introducing a credit institution. To do so, it is possible to return to the case where all buyers have the same disutility of production. For this purpose, a simple credit company is introduced. In order to focus on its role of pooling of information on repayment histories, it is not necessary to explicitly consider its objective function.

The credit company operates as follows. Should a buyer deemed creditworthy by the company desire to use credit through the company, the buyer visits the company prior to shopping in the PM to obtain a certificate. The credit company charges the buyer a fee of T units of the AM good per transaction (which can be thought of as interest payments to intermediaries). In addition, use of a credit certificate in a transaction costs buyers F in utility terms (which can be thought of as any additional transaction or record-keeping costs associated with using a credit intermediary). The company records the buyer's name and the amount the certificate is worth both on the certificate and in its records. The buyer presents this certificate to the seller he visits in return for a unit of the seller's good. In the following AM, the buyer is to deliver to the credit company the amount noted on the certificate to be passed on to the seller. Should the buyer fail to deliver, the credit company is able to use the fees it collects (or produce the goods at a cost to itself) in order to pay the seller. Thus, the credit company is able to pool information regarding the repayment history of a buyer across the firms with which the buyer uses certificates. The company will no longer issue certificates to the buyer should the buyer fail to repay. The system described captures features not only of standard credit intermediaries but also of the use of checks with a check guarantee card.

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14 If, instead, buyers differed as in Section 6, the credit company would need to charge a higher fee to cover losses but otherwise the basic results would go through.
The presence of a credit company which guarantees payment may alter behavior by buyers and firms. That is, buyers may be able to fail to repay non-intermediated credit but still be able to get credit from another seller by using a credit certificate. Without a credit company in the model above, buyers who failed to repay credit given by the incumbent in a market could not obtain credit from any other firm (entrant) (except in the case where the incumbent charged a greater than zero profit price) for fear of not being repaid. With repayment guaranteed by the credit company, however, a firm (entrant) may safely accept a credit certificate, even if it knows the buyer has failed to repay direct credit. The verb "may" is used since it's possible that failure to repay direct credit may lead to revocation of intermediation services. Yet with limited sharing of credit information, even in the U.S., and with severe limits on information sharing in some other countries, it seems most realistic to consider the case in which buyers can fail to repay direct credit without having intermediated credit revoked. Unless failure to repay direct credit is a signal of other problems, it seems, for example, a credit card would not be revoked unless the credit card company itself were not repaid.

Thus, in deciding whether or not to grant direct credit, the incumbent firm must consider a buyer's altered incentives. If the buyer chooses to repay \( I_t \) now, and therefore in the future, he obtains

\[
(11) \ u(1) - \beta D \left( \frac{c}{\beta} \right) + \frac{\pi \beta}{1-\beta} [u(1) - \beta D(\frac{c}{\beta})].
\]

If not, he can use a credit certificate with another firm (since the firm knows payment is guaranteed) in the future and so obtains

\[
(12) \ u(1) - \beta L + \frac{\pi \beta}{1-\beta} [u(1) - F - \beta D(\frac{c}{\beta} + T)].
\]

Now it is best to fail to repay the direct credit if

\[
(13) \ D(\frac{c}{\beta}) - L > \frac{\pi}{1-\beta} [F + \beta D(\frac{c}{\beta} + T) - \beta D(\frac{c}{\beta})],
\]
i.e., if the cost of repayment today outweighs the expected present value of the additional costs of using the credit intermediary in the future.

(13) can be rewritten as

\[
(1 - \beta) [D(\frac{C}{\beta}) - L] \leq 0.
\]

Clearly, \( \pi > 0 \). Further, \( \pi > \bar{\pi} \) as long as \( u(1) > F + \beta D(c/\beta + T) \), which must be true for credit certificates to be viable. Thus, the possibility that buyers can fail to repay direct credit but still use credit certificates means that less direct (non-intermediated) credit will be available.

The credit company must determine which, if any, buyers will repay it, recognizing that sellers will not grant direct credit to buyers who have matching probabilities less than \( \bar{\pi} \). Let, for Buyer \( j \),

\[
\pi_j = \sum_{i \mid \pi(i, B_j) < \bar{\pi}} \pi(i, B_j).
\]

\( \pi_j \) is the probability that \( B_j \) will be matched in a period to a seller who will not offer direct credit to \( B_j \).

Now, when will a buyer find it advantageous to actually repay the credit company? If the buyer does repay, he has continued access to goods from all the sellers with whom he is matched with probability less than \( \bar{\pi} \) so that his expected present value of utility from repayment is

\[
(15) u(1) - F - \beta D(\frac{C}{\beta} + T) + \pi_j \beta (u(1) - F - \beta D(\frac{C}{\beta} + T)) \]

If he fails to repay, he obtains

\[
(16) u(1) - F - \beta L.
\]

Thus, the buyer will optimally repay the credit company as long as

\[
(17) \pi_j \geq \frac{(1 - \beta) [D(\frac{C}{\beta} + T) - L]}{u(1) - F - \beta D(\frac{C}{\beta} + T)} \equiv \bar{\pi}^{\pi}.
\]
Expression (17) indicates that a buyer's repayment decision depends on the buyer's primitives, the loss imposed due to default, and any costs associated with using the intermediary. If buyers differed in all dimensions, buyers who are perceived by the intermediary to have lower disutility of production (greater earning potential) and have relatively many transactions in which intermediated credit would be useful are more likely to be awarded credit by the company. In addition, \( \pi_i^j \) moves directly with \( F \) and \( T \) so that, if the costs of using the credit intermediary are lower, more credit is made available by the intermediary.

In summary, the introduction of the credit company results in the raising of the standards needed to obtain direct credit as \( \pi' > \pi \). Transactions with buyers with \( \pi \geq \pi' \) are still conducted with direct credit. Buyers matched to sellers with \( \pi \leq \pi' \) are not granted direct credit. Buyers who meet the condition given in (17) are able to use credit certificates for all transactions for which \( \pi < \pi' \).

Thus, consideration of borrowers' incentives when it is possible to use an intermediary for future transactions leads to the rather surprising result that less non-intermediated credit will be made available by sellers—some direct credit is crowded-out. The expansion of credit and trade is due to the pooling of information on repayment histories of the buyers by the intermediary across markets. This pooling can induce borrowers to repay the credit company for transactions with firms they would not repay if credit were granted individually for the reason that failing to repay the credit company affects trade possibilities in many, rather than just one, market. Introduction of the credit company does not unambiguously increase welfare. While the credit company may intermediate transactions that would not take place in its absence, less (cheaper) direct credit is available.

The model thus addresses the question of the role of financial intermediation in economic development.\(^{15}\) For the reasons given above, the introduction of intermediation on the volume of transactions is not unambiguous here. It is clear, however, that intermediation can lead to the consummation of potential credit transactions that would not take place in its absence. In an

\(^{15}\) See King and Levine (1995) for a detailed discussion.
economy with many potential trades blocked by lack of trust, intermediation may lead to a large increase in economic activity.\footnote{In an economy without such rich opportunities, the analysis suggests that intermediation may not spur much economic activity since some direct credit is eliminated.}

A decrease in production cost, \( c \), decreases \( \pi^{cc} \) so that there is an expansion in the possibility of credit and economic activity. Examination of the data from a country where such a change occurred may lead one to conclude that the increase in economic activity was due to increased intermediation. However, as was shown in Section 5, the decrease in production cost brings about more credit transactions even in the absence of intermediation.

8. CONCLUSION

This paper presented a model of credit in which difficulties in the enforcement of credit contracts play a central role. The importance of enduring relations for customer market credit was highlighted. A competitive equilibrium, generated using a mechanism involving potential entry, was derived and its properties studied. Considered briefly was the effect of information monopoly in credit markets. An interesting relationship between collateral value (or sanctions) and pricing was discovered as was a channel through which improvements in production technology lead to greater credit availability and economic activity. Finally, it was shown that the introduction of a credit intermediary helps to overcome the frictions of a lack of trustworthiness and enforcement difficulties but may crowd out some non-intermediated credit in the economy.

The paper presented a basic framework which seems to capture frictions, and their consequences, that appear to be present in the market for credit across societies. Recent work suggests that continued efforts to incorporate realistic frictions in micro-based models of credit is a worthwhile endeavor. There are some immediate extensions. Though this paper dealt briefly with information monopoly, it is of interest to adjust the model to address the general issue of monopoly power in credit markets.

Moreover, the credit intermediary was able to ease the frictions to credit
trade through the information pooling it does. An interesting question is whether money could help overcome some of the trade frictions in the environment presented. An objective is to develop an endogenous model of the medium of exchange and its role in macroeconomic issues. This paper represents the first step in that endeavor.

While it appears that the model does capture important elements of the functioning of credit markets in general, it is true that credit markets and institutions differ somewhat across the world. It is hoped that specializations and extensions of the model will provide further insight into the functioning of credit markets.
Appendix

Proof of Proposition 1:

It will now be shown that, for buyers with \( \pi \geq \bar{\pi} \), \( I_0 \) choosing \( c/\beta \), \( E_t \) choosing not to enter, and buyers choosing to repay the incumbent is a NE. Throughout, let \( B_j \) be an arbitrary buyer of type \( \pi \geq \bar{\pi} \) and \( I \) will be used to denote \( I_0 \).

1) It will first be confirmed that \( I \) cannot benefit by deviating given the others' strategies. If \( I \) follows the equilibrium strategy, his payoff is zero. (The proof will make use of the "unimprovability in a single step" principle from dynamic programming. That is, as long as the payoff function is bounded below, any unimprovable strategy is optimal. See Kreps (1990) for a discussion of the principle.)

To start, if \( I \) does not grant credit to any of the type \( \pi \) buyers at \((t, PM)\) (\( R^I_t = 0 \) for all type \( \pi \) buyers), the entrant enters and charges a price which yields him a positive profit and that still insures repayment at \((t+1, AM)\). Buyers do repay \( E_t \) and \( I \) loses incumbency with type \( \pi \) buyers. \( I \) makes zero profit from this so \( I \) may as well choose \( c/\beta \).

If instead \( I \) deviates to \( R^I_t \), where \( 0 < R^I_t < c/\beta \), \( E_t \) enters and buyers repay \( E_t \) and not \( I \). \( I \) loses incumbency with type \( \pi \) buyers. This strategy yields \( I \) \((-c)(1-\beta k)\) [number or measure of \( \pi \) buyers who visit the market at \((t, PM)\)] = \(-c(1-\beta k)\mu_t(\pi)\) at \( t \) and zero from \( t+1 \) on as incumbency is lost. Given \( \mu_t(\pi) > 0 \), raising price in any period and offering credit leads to negative profit in that period and the loss of incumbency.

If \( I \) deviates to \( R^I_t < c/\beta \), say \( R^I_t = c/\beta - a \), where \( a > 0 \), and then reverts to \( R^I_t = c/\beta \) for all \( t > t \), \( E_t \) does not enter, buyers buy from and repay \( I \), and \( I \) retains incumbency. Thus, \( I \) obtains \( \mu_t(\pi) [\beta(c/\beta - a) - c] + 0 \), where the zero is the payoff \( I \) receives in the future from charging \( c/\beta \). Thus, this strategy yields \(-\mu_t(\pi)a < 0 \) so it is better to choose \( R^I_t = c/\beta \).

2) To be considered next is: Can \( E_t \) benefit by deviating from the prescribed strategy given the strategies of the others? If \( E_t \) follows the putative equilibrium strategy, \( E_t \) obtains a payoff of zero. If, instead, \( E_t \) deviates and
enters with \( R^E_t \geq R^I_t = c/\beta \) buyers do not repay \( E_t \) and do repay \( I \). This means that \( E_t \) does not attain incumbency and thus exits the market for type \( \pi \) buyers with what he earns in this trading period, \(-c(1-\beta k)\mu_\pi(\pi) < 0\).

If \( E_t \) enters with \( R^E_t = c/\beta - a < R^I_t = c/\beta \), buyers repay \( E_t \), not \( I \), and \( E_t \) becomes the incumbent at \((t+1, \text{PM})\). \( E_t \) obtains \( S(c/\beta - a) - c = -\beta a < 0 \) from each trade initiated at \((t, \text{PM})\). Though \( E_t \) becomes \( I_{t+1} \), the best any incumbent can do is zero. Thus, it is best to not enter.

3) Finally, can a buyer, \( B_i \), benefit by deviating, given the others' strategies? Given that no entry occurs and \( R^I_t = c/\beta \) for all \( t \), it is clearly best for any buyer with \( \pi \) no less than \( \bar{\pi} \) to repay. This is true because

\[
(A.1) \quad [u(1) - \beta D\left(\frac{c}{\beta}\right)] + \pi \sum_{t=1}^{\infty} \beta^t [u(1) - \beta D\left(\frac{c}{\beta}\right)] \geq u(1) - \beta L \quad \text{if} \quad \pi \geq \bar{\pi}
\]

(with strict inequality for \( \pi > \bar{\pi} \)).

That is, with no entry, should the buyer ever fail to repay, he will be cut off from credit in this market forever. It is best to continually repay as long as the expected lifetime utility of doing so outweighs the gain from not repaying and being cut off from credit forevermore. Given that no agent can benefit by deviating from the prescribed strategies, the strategies do constitute a Nash equilibrium.

Proof of Proposition 2:

This proposition is true because a buyer with \( \pi < \bar{\pi} \) will optimally fail at some point to repay and will leave the seller who offers credit with a loss. Recall that a buyer will repay if, and only if,

\[
(A.2) \quad u(1) - \beta D(R_0) + \pi \sum_{t=1}^{\infty} \beta^t [u(1) - \beta D(R_t)] \geq u(1) - \beta L.
\]

\( \bar{\pi} \) was defined to be the parameter such that
That there is not a path of finite prices that can be part of a NE for these buyers can be seen by considering the problem of maximizing a buyer’s utility (assuming repayment) subject to the seller obtaining non-negative profit. That is,

\[
\begin{align*}
\text{(A.4)} \quad & \max_{\{R_t\}} U(\{R_t\}) = \max_{\{R_t\}} \left( u(1) - \beta D(R_0) + \pi \sum_{t=1}^{N} \beta^t [u(1) - \beta D(R_t)] \right) \\
\text{subject to} \quad & \beta R_0 - c + \pi \sum_{t=1}^{N} \beta^t [\beta R_t - c] \geq 0.
\end{align*}
\]

This problem has the solution \( R_t = c/\beta \) for any \( N \) and, moreover, the objective function attains its greatest value, \( U' \), when \( N=\infty \). \( U' < u(1) - \delta L \) since \( \pi < \bar{\pi} \).

The buyer will repay if and only if he can obtain total utility no less than \( u(1) - \delta L \) by doing so. But then the seller’s profit must be less than zero. This means that for any path of prices for which the seller offers credit and which yields the seller non-negative profit, the buyer is better-off not repaying. If the buyer chooses to either immediately not repay or to not repay when his cumulative utility is no less than \( u(1) - \delta L \), the seller makes a loss and so is better-off by not offering credit.

**Proof of Proposition 5:**

That \( \bar{\pi} \) moves inversely to \( L \) and to \( u(1) \) is obvious. The relation between \( \bar{\pi} \) and \( \beta \) follows from observing the partial derivative, \( \bar{\pi}_\beta \).

\[
(A.5) \quad \bar{\pi}_\beta = -\frac{[u(1) - D\left(\frac{C}{\beta}\right)] [D\left(\frac{C}{\beta}\right) - L] + \frac{(1-\beta)}{\beta} c D' \left(\frac{C}{\beta}\right) \left[\frac{u(1)}{\beta} - L\right]}{[u(1) - \beta D\left(\frac{C}{\beta}\right)]^2} < 0
\]

\( \bar{\pi}_\beta \) is less than zero since each of the terms in the numerator is positive under
the assumptions of the model.

That $\bar{\pi}$ moves directly with $c$ is seen by considering $\bar{\pi}_c$.

\[
(A.6) \quad \bar{\pi}_c = \frac{(1-\beta)D'(\frac{c}{\beta})\left[\frac{u(1)}{\beta}-L\right]}{[u(1)-\beta D(\frac{c}{\beta})]^2} > 0 \text{ under the model's assumptions.} \]
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