ADVERSE SELECTION, COMPETITIVE RATIONING AND GOVERNMENT POLICY IN CREDIT MARKETS

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Arvind Virmani
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Development Research Department
Economics and Research Staff
World Bank

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It is now widely accepted that if markets for specific goods and services fail or are inefficient, some form of imperfect information or asymmetry is often the primary cause of such failure. The present paper identifies a deficiency in the concept of rationing by random selection contained in the widely quoted paper of Stiglitz and Weiss. It then presents an alternative analysis in which information can produce market failure, and shows how government policy can be used to eliminate such a problem. This solution is shown to be quite different from the one proposed and analysed in a paper by Smith.
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1. INTRODUCTION

Stiglitz-Weiss (1981) in their paper on adverse selection in credit markets say that,

"This paper provides the first theoretical justification for true credit rationing."

My initial appreciation of this justification was tempered by an uneasy feeling about the nature of the resulting rationing. The dissatisfaction arose from the concept of rationing of more risky borrowers by arbitrary selection. A certain fraction of loan applicants are randomly selected to receive loans while the rest get nothing. Such behavior does not square with my perception of how bankers operate. Whether a banker's reason for not lending are right or wrong, based on either full or inadequate information, he does not select borrowers by lottery. Work in progress at that time had shown that differences in expectations could result in a different type of credit rationing. 1/ Rationed borrowers received smaller loans than under identical expectations.

Among the many possible information problems, the one considered here arises from the different risk characteristics of different borrowers. 2/ For any given loan terms, one consequence of a difference in production risk is a difference in repayment. If loan terms are identical, the high risk borrowers


2/ The same problem is considered in the first part of Stiglitz-Weiss' paper.
will on average repay less than low risk borrowers. Lenders would like to identify the precise risk characteristic of a borrower before a loan is made, but are unable to do so. A high risk borrower will act like a low risk borrower as long as he profits from this misrepresentation. In the Stiglitz-Weiss approach a proportion of high-risk borrowers, the "rationed," lose the incentive for misrepresentation. During the process of solution, it is converted into an incentive to reveal their true high risk character. It becomes more profitable for the "rationed" borrower to obtain a loan after making a full disclosure, than to keep hiding the facts and not get a loan. With full information available to a bank, it is also profitable for it to make a loan to the "rationed." The instability in the behavior of lenders and of higher-risk borrowers implicit in their model appears to belie the existence of a stable solution. Technically, the "non-revelation condition" for asymmetric information equilibrium (Smith, 1983) is violated. 3/

Jaffee and Russell and Smith have defined monopsony rationing as the difference between loan amounts under the monopsony and the competitive equilibrium. The monopsony is exercised by the less risky or more honest borrower. Competitive rationing will be defined as the difference in loan amounts under imperfect or asymmetric information equilibrium (AIE) and those under a full or symmetric information equilibrium (SIE). In both the monopsony and competitive cases a higher risk (or dishonest) borrowers is also rationed a different sense. It would be profitable for rationed high risk borrowers to obtain more loans at the given (or even higher) interest rate.

He does not ask for a larger loan, as it would reveal his high risk character. This would worsen his terms, and lead to lower profits.

The model used in this paper is similar to that in Stiglitz-Weiss. One critical difference is the replacement of the fixed capital requirement assumption by non-increasing returns to scale production. It is shown that asymmetric information equilibrium results in competitive rationing. It is also formally shown how an increase in the average riskiness of the borrower firms could result in an adverse selection equilibrium. An asymmetric information equilibrium (AIE) involves an implicit cross-subsidy from the least risky to the most risky borrowers. The optimal contract is such that the marginal unit of loan results for the least risky firm in a loss through the cross subsidy equal to the marginal net gain per firm from increased production. As the cross subsidy is zero under the symmetric information equilibrium (SIE), the loan amounts are smaller under AIE than under SIE. A worsening of the average riskiness of the borrower group, worsens the terms, and consequently the profitability of the loan for the safest borrower. At some point this would, in general, reduce the expected gains from the loan to zero. Any further increases in riskiness results in an adverse selection equilibrium (ASE), which involve monotonically increasing "dropouts".

The last result contrasts sharply with what happens under symmetric information. In an SIE changes in riskiness of returns have no direct effect on loan amounts. Interest rates merely adjust to keep expected profits unchanged. Under ASE rationing increases with average risk as less risky
firms lose access to loans. 4/ Thus exogenous changes or government policies which change the riskiness of returns to borrowers can have unexpected effects on production. 5/

Collateral has virtually no role in the accepted neoclassical paradigm. This is indeed justified under symmetric information. In an SIE, it is shown that collateral and interest rate are substitutable components of the overall price of a risky loan, so that amount of credit obtained (in equilibrium) does not depend on collateral. 6/ If credit markets are characterized by asymmetric information, collateral plays an important independent role. The paper shows that under an AIE (and ASE) loan amounts are positively related to the amount of available collateral. Higher collateral reduces the implicit cross subsidy from less to more risky borrowers on the marginal unit of loan, reducing safe borrowers' marginal borrowing costs and allowing competitive banks to increase loan amounts. This provides one possible explanation for a previously noted puzzle. That despite the symmetry of capital and labor in the neoclassical firm, it is owners of capital (and therefore of potential collateral) who hire labor rather than the reverse. These collateral affects also provide a channel through which the

4/ Expected marginal returns to equity therefore increase for rationed firms. One would therefore observe a fall in earnings coupled with a sharper fall in dividends as owners try to rebuild the firms' capital. This would induce them to liquidate other assets. Outside observers may, however, be unable to distinguish between this case and one arising from a fall in mean returns to the firm, especially in the short run.

5/ Like a decrease in output of less risky activities as a result of increased risks.

6/ Under the competitive contract setting equilibrium concept used here. See Azzi and Cox (1976), Barro, (1976) and Virmani (1981) for earlier analysis of collateral. Variations in equity should result in similar effects.
initial distribution of material wealth could influence economic efficiency and the subsequent evolution of this distribution. 7/

Smith has previously analysed the role of government policy in a monopsonistic credit market with no adverse selection. 8/ The present paper explores government policy intervention in a competitive loan market. As asymmetric information results in competitive rationing, this affects the allocative efficiency of the credit market. The extent to which this happens depends, of course, on how widespread such asymmetries are. Governments have, however, often intervened in loan markets to influence the flow of capital to specific borrower groups and uses. 9/ One of the policies used has been the provision of an interest subsidy to banks, through the mechanism of subsidized rediscounting of loans made by them to the target group. Such a policy will be shown to reduce and possibly eliminate competitive credit rationing (in both AIE and ASE). As we would expect a reduction in marginal cost of funds increases loan supply to existing borrowers. Competition between banks also ensures that any gains are passed on to borrowers. In an ASE this brings "dropouts" back into the market by compensating partially for the "cross-subsidy" they have to pay.

7/ The analysis also suggests that in credit markets in which the problem of asymmetric information is widespread, loan markets will play a much greater role than bond markets (which are characterised by zero collateral).

8/ The Smith analysis has the advantage of a general equilibrium framework, but at the cost of neglecting production. The present paper uses a partial equilibrium formulation.

9/ In the U.S. such intervention has historically been most prominent in agriculture, small business and housing. In other countries it has also included loans for investment, exports and loans to specific industrial sectors. See, for example, Hodgman (1976), Brimmer (1971).
This subsidy can in principle be coupled with a tax per borrower to reduce the net subsidy. 10/ When there is no adverse selection this is shown to reduce rationing and therefore to unambiguously result in a gain in allocative efficiency. The tax element does not directly affect the marginal value of the loan to banks. Though it necessitates an increase in the loan interest rate, the reduction in loan amount brought about through this factor is less than the direct positive effect of the subsidy. Thus production efficiency still increases. The cross-subsidy from less to more risky borrowers increases simultaneously, however, so that the entire production profit gains accrue to more risky borrowers. In an adverse selection equilibrium this means that it is still unprofitable for the marginal drop-out to take a loan. Such a tax-subsidy policy may not be desirable in markets with adverse selection.

2. THE MODEL

Borrowing firms normally differ from each other in a number of ways which are relevant to banks' lending decisions. Banks then assign these potential borrowers into categories and sub-categories for the purpose of determining their loan terms and/or loan amounts. If information was perfect, each lowest level sub-category would consist of identical firms. As in Stiglitz-Weiss section 1, I focus on the case in which asymmetric information relates only to the degree of uncertainty in a group of firms' returns; all other parameters are assumed to be identical and known to the banks.

10/ Interestingly, in one specific situation a change in contract form may be very similar to this tax-subsidy policy. This is the case in which upfront fees are used and involve both a fixed and a variable (with loan amount) component.
Firms' (gross) returns, $R$, are a non-decreasing function of the capital employed by the firm, and are characterized by multiplicative uncertainty, $u$. The total capital, $K$, is the sum of the firm's own funds (or equity) $e$, and the loan obtained from the bank, $L$. 11/

\[ R = ug(K), \quad g' > 0, \quad g'' \leq 0, \quad K = e + L. \]

Each firm is distinguished by the parameter, $\theta$ which determines the probability distribution of $u$, $F(u, \theta)$ (density $f(u, \theta)$). It is assumed that greater $\theta$ corresponds to greater risk in terms of mean preserving spread (Rothschild-Stiglitz (1970));

\[ \int_0^\infty uf(u, \theta_1)du = \int_0^\infty uf(u, \theta_2)du = 1, \text{ then for } y \geq 0, \quad (1) \]

\[ \int_0^y F(u, \theta_1)du \geq \int_0^y F(u, \theta_2)du \text{ for } \theta_1 > \theta_2. \quad (2) \]

Using the same definition of default as in Stiglitz-Weiss, $(C + R \leq (1 + r)L)$, the repayment function $Z$ can be written for a loan at the interest rate, $r$, and collateral, $C$, as, 12/

\[ Z = \min(C + ug(K), (1 + r)L). \quad (3) \]

This is depicted in terms of the random variable, $u$, in Figure 1. The expectation of repayment from a firm with parameter $\theta$, $X(\theta)$ is, on simplification ($E$ is the expectation operator),

\[ X(\theta) = E(Z) = L(1 + r) - g(K)M(a, \theta), \]

\[ M(a, \theta) = \int_0^a F(u, \theta)du, \quad a = (L(1 + r) - C)/g(K). \quad (4) \]

11/ The present paper represents a partial equilibrium analysis in that, among other things, $e$ is assumed to be held constant.

12/ The firm defaults on the loan when the collateral plus returns are insufficient to repay the contracted amount. The bank has, however, first rights on $C + R$. 
Equation (4) shows that in the presence of uncertain returns, the bank's expectation of repayment is less than $L(1 + r)$, unless a fully collateralized loan ($a = 0$) is given. The following lemma follows by differentiation of (4). It is also implicit in the concave shape of the repayment function (Figure 1).

**Lemma 1.** For given loan terms ($L, r, C$) the expectation of loan repayment is inversely related to a firm's riskiness ($\delta$) of returns.

The competitive equilibrium concept used here is that of contract setting (author (1982)), which bears a close affinity to that in Rothschild-Stiglitz (1976). As in Stiglitz-Weiss it is not the usual "price (contract) taking" one. Firms maximize profits by looking for the best loan terms whereas banks maximize profits by setting loan contract terms subject to the best alternative terms available to the potential borrower. The banks are assumed to obtain their funds on a competitive deposit market at the deposit interest rate, i. Formally the Symmetric Information (SIE), the Asymmetric Information (ASI) and the Adverse Selection (ASE) Equilibria can be defined as follows.

**The Symmetric Information Equilibrium (SIE)**

Profits of the firm with parameter, $\delta$, are equal to the returns, $R$, minus the repayment, $Z$. Firm expectation of profits $\Pi$ are therefore,

$$\Pi(\delta) = g(K) - X(\delta).$$

(5)

Bank profits from a loan to such a firm equal total repayment minus total costs. The latter consist of costs which vary with the size of the loan,
Figure 1: Repayment as a Function of Realized Values of $u$

\[ q = \frac{(1+r)L - C}{g(K)} \]
assumed for simplicity to be merely the cost of deposit funds, and costs, T, which are fixed per loan. Bank expectation of profits, p, are therefore

\[ p(\theta) = X(\theta) - IL - T \]

A bank's problem is, therefore, to,

\[ \max(p) \ subjec{L,R,C}{k}X(\theta) - \Pi_o(\theta) \]

where \( \Pi_o(\theta) \) is the maximum profits that the firm can get by taking a loan from any competing bank. Competition between the banks then ensures that \( \Pi_o \) is adjusted to the point at which, the banks' expectations of profit from the loan transaction, p, are reduced to zero.

\[ p(\theta) = X(\theta) - IL - T = 0. \]

The competitive SIE is therefore represented by (6') and the three equations which represent the solution to (7). \[\text{13}\] Note that a necessary condition for existence is that the expectation of firm's profits at the best available terms be greater than those without taking a loan, i.e. \( \Pi_o \geq g(e) \).

**THE ASYMMETRIC INFORMATION EQUILIBRIUM (AIE)**

The banks in this case do not know the risk parameter (\( \theta \)) for each firm. As noted in the introduction, this is assumed to be the only asymmetry in information. The distribution of \( \theta \), \( H(\theta) \) (and density \( h \)) \( 0 \leq \theta \leq b \leq \infty \) is, however, known. It is assumed that this distribution is characterized by first order stochastic dominance in the parameter, \( \phi \), (see Russell and Hader). That is, for all \( \theta \)

\[ H(\theta, \phi 1) \geq H(\theta, \phi 2) \text{ for } \phi 1 \geq \phi 2. \]

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\[\text{13}\] It is shown in the next section that the solution of this case is the usual neo-classical one.
\( \phi \) can be thought of as an index of the Risk-Quality of this group of borrowers.

As before the banks maximize expectation of profits, but, this operator is now evaluated over both \( u \) and \( \theta \). Using (6) and (7) and simplifying, these can be written as (for given \( \phi \)) \(14/\)

\[
\max \ p = (L(r-i)-T-gM),
\]

\[
M = \left( \int_v^b \ M(\theta)dH(\theta) \right)/(1-H(v)), \text{ subject to,}
\]

\[
\Pi_v(\nu) = g(K)-X(v) \geq \Pi_0(0) \geq g(e) \text{ if } v = 0, \text{ and,}
\]

\[
\Pi_v(\nu) = g(K)-X(v) = g(e) \text{ if } v > 0.
\]

Equation (10) and (11) apply in the absence and presence of Adverse selection, respectively. Equation (11) implies a theta value, given \((r,C,L)\) which separates market participants from non-participants. Using lemma 1. in equation (5), we know that a firm's expectation of profits is positively related to its risk parameter. Fulfillment of equations (10) and (11) means that all firms with risk parameter \( v \), or greater, will have a non-negative expected gain from taking a loan. Finally we have the non-revelation condition (see Smith), that the potential gainer from not revealing the true \( \theta \) actually gain (not loose);

\[
\Pi_0(b) \leq \Pi_0^*(b)
\]

where \( \Pi_0^*(b) \) is the profit for the most risky firm under an SIE (an asterisk will be used to denote an SIE value). Note that if \( C \) is fixed/constrained, the maximization in (9) will only be carried out over \( L \) and \( r \).

\(14/\) The parameter \( \phi \) is dropped from the argument of \( H \) till it is needed for comparative static analysis. Note that in the following, maximization with respect to \( C \) will not be possible if \( C \) is constrained.
The Asymmetric Information Equilibrium is therefore defined by (9), (10), (11), (12) and the competitive zero profit condition (6'). For expositional simplicity we will refer to the equilibrium without adverse selection as AIE (i.e., excluding (11)). In this case the maximization problem can be rewritten as

$$\max p = L(r_i) - T - gM,$$

$$\underline{M} = \int^b_v M(\theta)dH(\theta), \text{ subject to,}$$

$$(9')$$

$$\Pi(\theta) = g(K) - X(\theta) \geq \Pi_0(\theta) \geq g(e)$$

$$(10')$$

$$X - IL-T = 0 \quad , \quad I = l+i$$

$$(6'')$$

The Adverse Selection Equilibrium (ASE) is therefore defined by equations (9), (12), (6'') and (11) or (11'), where the ASE constraint (11) can be rewritten as,

$$\nu \leq \bar{\nu}, \text{ where } \nu \text{ is defined by } X(\nu) - g(K) = -g(e).$$

$$(11')$$

SECTION 3. ANALYSIS

The SIE is an essential element in defining the non-revelation condition, for an asymmetric information equilibrium. We therefore start by showing that, if it exists it is identical to the usual competitive equilibrium. 15/

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15/ Similar results were obtained in a slightly different model by Virmani (1982).
Proposition 1. Under SIE the expected marginal product of loans is equal to the marginal cost of funds \( (g'(e+L^*) = I) \).

The solution to the bank's maximization problem is shown in Figures 2 and 3. The constraint (7) restricts bank profit to the Southeast of \( \Pi_o(\theta_1) \) for firms with risk parameter \( \theta_1 \) (Figure 2(a)). \( p(\theta_1) \) (eqn. (6)) is maximum at the tangency of \( p(\theta_1) \) with \( \Pi_o(\theta_1) \) (for given \( C \)). Competition between banks results in a better (worse) offer to the firm if bank expectation of profits, \( p \), is positive (negative). \( \pi_0 \) rises (falls) till \( \pi(\theta) = \pi_o \) is tangent to \( p(\theta_1) = 0 \), at \( (L^*, r^*) \). A little differentiation shows that for given \( C \),

\[
\frac{\partial r}{\partial L} \bigg|_{p=p_o} = \frac{3r}{2L} \bigg|_{\Pi = \Pi_o} - \frac{S}{L(1-P)}, \quad \text{where} \quad g'(K) = \frac{dg}{dK}.
\]

As \( g'(e+L^*) - I \) is independent of \( \theta \) and \( C \) it must be zero at the tangency point for all firms and for all collateral values. For the constant returns to scale case \( (g' = g_o \text{ a constant}) \), an interior solution exists only if \( g_o = I \).

Figure 3 shows the zero profit condition in \((r, C)\) space, with \( L = L^* \). The interest rate therefore depends on the amount of collateral. The total price of the loan can be thought of as a composite of interest and collateral terms, which are substitutable for each other. The effective "risk premium" implicit in a risky loan depends on the collateral provided. Implicit is common usage of this term is a zero collateral level. Figure 3 also shows that the composite price of the loan, or the interest at given collateral increases with riskiness \( \theta_1 \). The same thing would happen if mean...
Figure 2(a): Symmetric Information Equilibrium for Given Collateral

Figure 2(b): Symmetric Information Equilibrium for Different Risk Classes

Figure 3: Symmetric Information Equilibrium: Interest Collateral Trade-off
return fell. From this figure it is also apparent that if an effective interest ceiling (for given collateral, e.g. \( \bar{r} < r_1 \) for \( C = C_1 \)) is imposed on any borrower, he will receive a smaller loan \( (L < L^*) \) than he would without such a ceiling. Alternatively, he must come up with a greater amount of collateral to obtain the same loan.

In subsequent analysis it will be assumed that the sufficient conditions for the banks' maximization problem are satisfied. Unless otherwise stated decreasing returns in \( g \) will also be assumed. The focus of the analysis is on the necessary conditions for an interior equilibrium. We start by assuming that the risk quality of the borrowers is such that an asymmetric information equilibrium exists without any adverse selection.

Proposition 2. With no constraints on collateral availability asymmetric information between borrowers and lenders results in fully collateralized loans.

Setting up the lagrangian using eqns. \((9')\) and \((10')\), differentiating with respect to \( L, r \) and \( C \), and solving for the interior maxima, we find that (see appendix)

\[
g'(k) = 1, \quad \text{and} \quad F(a, 0) =^\text{P} = \int_0^b F(a, \theta) \, dH(\theta).
\]

(13)

The second equation of (13) is satisfied at the full collateral point \( a = 0 \). If \( F(u, \theta) = 0 \) for \( u \leq u_o \) and \( F(u, \theta) > 0 \) for \( u > u_o \) for all \( \theta \), then this equation is satisfied for all \( a \leq u_o \). With a slight elaboration of the term "fully collateralized" loan, proposition 2 continues to apply. Formally there is a range of collateral levels \( C, C_F \leq C \leq (1+r)L \), with

\[
C_F \equiv (1+r)L - gu_o,
\]

for which this equation holds. But any collateral above \( C_F \) is redundant and full repayment is certain if \( C = C_F \). Therefore a loan with \( C = C_F \) can be thought of as a fully collateralized loan in this
case. For expositional simplicity we will assume that $u_0 = 0$.\footnote{Note that if $u_0 > \frac{(1+i) L^* + T}{g(e + L^*)}$ where $L^*$ is the SIE loan amount, the loan becomes a riskless one, and equivalent to the risk free bond of conventional theory. There is, of course, no possibility of rationing or inefficiency in this case. No giving or taking of collateral will be observed in such a market.}

The second order conditions, and the mean preserving spread assumption suggest that this is the only interior maxima. As the loan amount is identical to that in the SIE, the non-revelation condition (12) is automatically satisfied. The only difference from the symmetric information case is that firms no longer have the option of choosing from a range of interest collateral pairs (including a zero collateral option), but must surrender enough collateral to cover the entire repayment. The asymmetric information problem is effectively solved by eliminating all risks from the loan transaction.

The case of unlimited collateral availability is clearly an unrealistic one. For the rest of the paper it is therefore assumed (as in SW) that collateral is constrained below that required for an efficient full collateral solution. The maximization in (9) or (9') is therefore carried out only for loan amount and interest rate.

We start by considering the ASI equilibrium without adverse selection. As part of this analysis it is shown, what conditions might lead to adverse selection. Using the term rationing in the sense defined in the introduction, the following result can be derived.
Proposition 3. The asymmetric information equilibrium, if it exists, is characterized by the rationing of all borrowers in the group.

The necessary conditions for a maximum of \( (9') \) with respect to loan amount and interest rate, subject to \( (10') \), can be solved using the inequality arising from the collateral constraint to obtain,

\[
g' = I/N , \quad N < 1. \tag{14}
\]

Given the assumption on the shape of \( g \), this obviously involves smaller loans than in the SIE case. \(^{17/}\) The solution is represented graphically in Figure 4(a), with only two sub-types of borrowers having risk parameters \( \theta_1 \) and \( \theta_2 \). Under asymmetric information, expectation of bank profits at the symmetric information equilibrium point \( \text{SIE1} (r^*_1, L^*) \) are negative, and at symmetric information equilibrium point \( \text{SIE2} (r^*_2, L^*) \) they are positive. The AIE zero iso-profit curve lies in between the two zero iso-profit curves for the SIEs, and is rotated anti-clock wise. Intuitively, the asymmetry in information reduces the expectation of repayments from more risky borrowers.

The only way in which the lenders can avoid losses and continue lending, is to raise the marginal returns of the entire group by reducing the loan amount. The AIE equilibrium therefore involves smaller loan amounts than the SIE.

Borrowers from the less risky sub-group \( (\theta_1) \) also receives worse terms in that they have a smaller gains from the loan transaction \( [\pi_o (\theta_1) < \pi_o^* (\theta_1)] \). By definition the extent of rationing is \( R = L^* - L_o \), per borrower.

\(^{17/}\) For the constant returns case, this implies that the ratio of expected returns to capital stock under AIE must be higher than under SIE. Going from this result to the one given in proposition 3 would require modeling of the output market, and take us beyond the scope of this paper.
Figure 4(a): Asymmetric Information Equilibrium

SIE1 = SIE equilibrium point for sub-group with risk parameter $\theta_1$
SIE2 = SIE equilibrium point for sub-group with risk parameter $\theta_2$
AIE = Asymmetric information equilibrium for group containing sub-groups $\theta_1$ and $\theta_2$.

Figure 4(b): Non-Revelation Condition Violated
Proposition 3 is conditional on existence, and as noted previously, one important requirement is the non-revelation condition (12). The more risky borrowers gain from non-revelation, by reducing their expectation of repayment per unit of loan. This is offset by the reduction in loan amounts, and consequently in expectation of returns. The net effect can only be determined given the precise parameter values. Figure 4(a) shows a case in which the non-revelation condition is satisfied. Figure 4(b) shows one in which it is not. The non-revelation condition is represented by the curve labelled $\Pi^*(0_2)$. A stable asymmetric information equilibrium is possible only to the southeast of it. This case is not pursued further in this paper.

By differentiating equation (5) for the firm's expectation of profit, and the bank zero profit condition (6''), the following properties of the ASI equilibrium are easily determined.

**Proposition 4.** In an asymmetric information equilibrium, borrowers will use all the collateral available to them.

**Proposition 5.** In an asymmetric information equilibrium, a deterioration in the risk quality of the borrower group, or an increase in the deposit interest rate, will reduce the expectation of profits of the safest borrower.

**Corollary 1.** A rise in the deposit interest rate, a deterioration in the risk quality of the borrower group, or a fall in the value of collateral available to the safest borrower, can lead to adverse selection.

Proposition 4 follows from the positive relation between collateral and the profits of the safer borrowers. The reason is the same as that leading to proposition 2. Safer borrowers suffer from asymmetric information because in equilibrium, they implicitly subsidize the risky borrowers. Higher
collateral reduces both the risk to the bank and the cross subsidy element. In the limit, with full collateral, the subsidy element is completely eliminated.

For the first part of proposition 5, the explanation is as follows. A deterioration in the risk quality of the borrowers means that there are a greater proportion of higher risk borrowers. This implies that at the same terms, the expected repayment of the higher risk borrowers would be reduced. For bank lending to remain profitable, lower risk borrowers have to increase repayment leading to an increase in the implicit subsidy provided by the lowest risk borrower. The increase in the deposit interest rate leads, on the other hand, to a general deterioration of loan terms, with the sign on the change in amount of subsidy provided by the least risky borrower indeterminate.

As the expectation of profits of the least risky borrower declines with any of the changes mentioned (corollary 1), a point would be reached at which these become zero. Adverse Selection would then result from any further changes in the same direction. One implication of this result is that monetary policy changes which raise the nominal interest rate relative to the prices relevant to the firms' returns, could result in adverse selection in the loan market. As loan terms under both AIE and SIE are affected, the gains from non-revelation are not affected in any obvious way.

By totally differentiating equations (6") and (14) and solving them we can also determine the effect of changes in collateral, the risk quality of the borrower group, and the deposit interest rate on loan amounts. The result can be stated as follows.
Proposition 6. In an asymmetric information equilibrium, the amount of rationing is negatively related to the amount of available collateral, and positively to the (deposit) interest rate.

We might also expect a negative relationship between the extent of rationing and the (risk) quality of the borrower group. Though the analysis produces a presumption in this direction this sign is in general ambiguous. This suggests that the relationship is not monotonic, and there may be regions in which rationing and borrower quality are positively related.

The important question of the role of government policy in such a market can now be addressed. One method which has commonly been used by governments to provide subsidies for lending to specific borrower groups, is through subsidized rediscounting. That is, for the central bank to provide funds to the banks at below market (deposit) rates. If we assume that any increase in the total money supply can be neutralized, this policy is equivalent to providing a deposit interest subsidy; that is, a subsidy, $s$, to banks per unit of loan for lending to the specified group. Assume further that the specified group is small relative to the total market, so that the deposit interest rate remains unchanged. We can then show that

Proposition 7. In an asymmetric information equilibrium, the amount of rationing can be reduced (or eliminated) by the provision of a deposit interest subsidy.

The provision of a subsidy, $s$, reduces the marginal cost of loans to the bank from $i$ to $i-s$. This in turn leads to an increase in loan amounts and the expected profits of the safest borrower. The subsidy provided by the government compensates the safest borrower for the implicit tax (cross subsidy) that information asymmetry imposes on him. By reducing the safest
borrowers' expected marginal costs of borrowing to the symmetric information levels, rationing can be completely eliminated.

The intramarginal subsidy element of this policy can be fully recovered by the government. The government can simultaneously impose a tax per loan $T_o = sL$, where $L$ is the preintervention loan per borrower, and reduce the total subsidy cost. The fixed tax per borrower merely lowers bank profits without affecting the marginal conditions. Despite the elimination of rationing, however, the expected profits of the least risky borrower are unchanged by this tax-subsidy scheme. The efficiency gains, as well as the net subsidy are appropriated by more risky borrowers. The non-revelation constraint, therefore, clearly becomes looser. The tax-subsidy policy is, of course, equivalent to the provision of a subsidy, $s$, per unit amount of loan above the preintervention level.

4. **ADVERSE SELECTION EQUILIBRIUM**

The previous section suggested conditions which increase the possibility of adverse selection. The marginal case is one in which the least risky borrower has zero expectation of gain from the loan transaction. As indicated in section 2, the ASE involves maximization of (9) subject to (11'). As we might expect, the necessary conditions are identical in form to those under AIE, in particular equation (14) holds. The counterpart of proposition 3 is therefore

**Proposition 8.** The adverse selection equilibrium, if it exists, is characterized by rationing.

In contrast to the AIE without adverse selection, there are two subgroups in this case. The partially rationed and the excluded. The first subgroup consists of relatively more risky borrowers, who are still in the
market, but get smaller loans than under symmetric information. The second sub-group consists of relatively less risky borrowers, who, as in Stiglitz-Wiess, get no loans at all. The marginal expected cost of loans is too high to be profitable. The presence of unidentifiable high risk borrowers imposes an externality, which acts as a tax on low risk borrowers balanced by a subsidy to high risk borrowers.

The counterparts of propositions 4 and 5 though formally similar to propositions for ASI, have a slightly different meaning here. Assuming that the adverse selection equilibrium continues to exist under marginal changes, differentiation and solution of (11') and (6') shows, that

**Proposition 9.** In an adverse selection equilibrium, an exogenous worsening in the risk quality of the borrower group, a decrease in available collateral, or an increase in the deposit interest rate, leads to an increase in adverse selection.

An increase in adverse selection is defined in terms of drop outs from the market, or the size of the second sub-group mentioned above. The expectation of profits, of the least risky borrowers still in the market, declines and they no longer find it profitable to borrow. This is because the implicit subsidy they provide to more risky borrowers increases. This will in turn bring about an increase in the average riskiness of the borrowers remaining in the market and worsen the terms for them. As the profit expectation of all remaining borrowers worsens, the non-revelation condition will become tighter. The existence of a stable equilibrium therefore becomes more problematic.

Turning to the effect of government policy intervention, we find

**Proposition 10.** A deposit interest subsidy to banks for lending to the group reduces adverse selection.
Corollary 3. A deposit interest subsidy reduces rationing for the most risky borrowers in the dropout sub-group.

The interest subsidy counters the implicit tax imposed by information asymmetry on the less risky borrowers. It therefore brings marginal borrowers back into the market. Their loans go from zero to positive reducing the extent of rationing. A tax subsidy policy of the kind defined earlier has no effect, however, on adverse selection. The expectation of gains from the loan transaction is unchanged for the marginal borrower so the number of dropouts does not change. Any potential gains from the subsidy resulting from increased loans, goes to the more risky borrowers currently in the market. Therefore this policy has no effect on the dropout sub-group.

The effects of changes in exogenous parameters on the extent of rationing of the borrower sub-group in the market are more difficult to sign. Unlike the ASI case, the distribution of the risk parameters of members in the borrower sub-group is no longer fixed. Changes in it depend on the proportion of borrowers on the margin between borrowing and dropping out. I would hazard a guess that the results of propositions 7 for the partially rationed borrowers can be reproduced, probably under more stringent conditions. As this would not add anything significant to the results presented above, this is not done in the present paper.

5. CONCLUSIONS

The most significant way in which the results of this paper differ from Stiglitz-Weiss is that there is no rationing by random selection of borrowers to be excluded (rationed) out of the market. Here, rationing either implies that all borrowers who are perceived as identical by the banks are equally 'rationed', or that safer borrowers self select (adversely) out of the
market. The latter phenomenon is of course analogous to adverse selection in insurance and other markets characterised by information asymmetry.

The most significant difference from the Smith paper is the demonstration of the effect of policy intervention in a credit market characterised by competitive intermediaries (banks) rather than by direct borrowing by monopsonistic borrowers. The present paper also shows the effect of such intervention under an adverse selection equilibrium, which was not considered by Smith. The type of policy intervention considered by him was quite different. In his paper, the government makes unlimited loans available at the preintervention equilibrium interest rate. In the present paper the policy considered was an interest subsidy (subsidised rediscounting). The Smith policy would have no effect in the present model. This difference in results is probably due to the monopsonistic nature of the credit market in his model.

There is perhaps no other market characterised by asymmetric information which has a variable or term playing a role which matches that of collateral in the credit market. The conventional theory of asset markets is based on riskless bonds in which collateral has no role. The most common treatment of risky credit is to apply some type of risk adjustment to the riskless interest rate. The historical literature on loan markets has in contrast given a great deal of importance to collateral. 18/ The paper formally demonstrates a possible reconciliation of these two divergent views of credit markets. Collateral does have a critical role in credit markets characterised by asymmetric information, but not where information is

18 See reference in footnote 12.
symmetric. This suggests the hypothesis that informationally underdeveloped
credit markets will be much more dependent on collateralised loans, and that
bond markets will appear later in the sequence of development. It is
important to note in this context that traditional (informal) loan markets in
developing countries may consist of segments characterised by a high degree of
informational symmetry. In a market with information symmetry, though
collateral and interests are substitutes for a given (risk-return) sub-class
of borrowers, no such relationship may appear across the entire spectrum of
borrowers. 19/

The paper contains a number of restrictive assumptions. One
direction for further research is to extend the model from a partial to a
general equilibrium framework, which would allow a more satisfactory treatment
of the constant returns to scale (in production) case. Another special
assumption is that of single source borrowing. This may not be a bad
assumption under symmetric information, but interesting possibilities arise
under asymmetric information which cannot be considered within the present
framework.

19/ Recall that collateral is defined additional to (separate from) the
production assets of the firm. Any remaining production assets at the end
of the loan terms automatically become part of the loan repayment in case
of incomplete repayment. See, however, Virmani (1981) for a different
view of collateral.
References


