Does credit rationing imply insufficient lending?

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\section*{Abstract}

By combining hidden types and hidden action, this paper shows that the existence of credit rationing need not imply that lending exceeds the full-information level. In this plausible class of models, the appropriate policy is not to subsidise or tax lending but to make alternatives to entrepreneurship more attractive. Doing so may actually increase the number of those borrowing to set up their own business and yield a strict Pareto improvement. The results extend to equilibria characterised by redlining. So, if interest rates fail to clear credit markets, it does not follow that policy should make loans easier to obtain. © 2000 Elsevier Science S.A. All rights reserved.

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\section*{1. Introduction}

Information problems abound in credit markets. Incriminating evidence is the role of personal wealth and of group membership in determining who becomes an entrepreneur.\textsuperscript{1} Under full information, good projects are funded irrespective of
whether the proprietor has sufficient resources of her own, so lack of collateral would not be a barrier to starting a business. Yet in practice, many potential entrepreneurs are delayed or prevented from entering by lack of finance. In particular, interest rates may not clear loan markets; applicants are denied credit even though willing to pay higher interest rates than banks will offer.\footnote{Evidence of the importance of collateral is provided by Binks et al. (1993) who report that for 85\% of small business loans in the UK, the ratio of collateral to loan size exceeds unity. In the data set used by Leeth and Scott (1989) “about 60\% of firms with commercial bank loans provide collateral as security for the loan agreement”. According to Berger and Udell (1990), in the USA “nearly 70\% of all commercial and industrial loans are currently made on a secured basis”. That interest rates are not used to compensate for risk is indicated by their low level. Risk-premia average some 3\% (see Cressy and Toivanen, 1997 and Bank of England, 1993) and virtually never exceed 6\%. This despite the fact that more than 30\% of new businesses survive less than 3 years.}

The dominant view is that such funding “gaps” reflect a market failure requiring intervention to increase lending. Were full information available, the volume and distribution of lending would doubtless be very different from the outcome under asymmetric information. Still, if a bank refuses a loan because it does not expect to be repaid, there is a real question why the public interest is served by a policy that nevertheless enables the borrowing to go ahead. There are a number of papers in the literature which point to underinvestment. Gale (1990) examines welfare under the assumption of market clearing and concludes that “...with asymmetric information the market will not fund all socially efficient projects” (p. 188).\footnote{According to the data of Blanchflower et al. (1998), in the US more than 30\% of whites are turned down for loans and over 60\% of blacks.} In reviewing the literature on investment and capital market imperfections, Hubbard (1998) states “In the presence of information costs...there is underinvestment relative to the setting with no information costs” (p. 197). Most relevant to the concerns of the present paper is Jaffee and Stiglitz (1990) who state “When credit rationing occurs in markets there are systematic biases against undertaking projects which maximise expected returns” (p. 868).\footnote{Gale allows for both mean reducing and mean increasing spreads, but (implicitly) assumes that entrepreneurs with a high probability of success have a sufficiently low return in this state that their expected payoff is lower. de Meza and Webb (1987) show that this property does not necessarily hold, in which case the market-clearing equilibrium involves overinvestment.}

De Meza and Webb (1987) call into question the extent to which informational problems lead to underinvestment. However, they do so in a model which is inconsistent with credit rationing and redlining. The present paper shows that even a credit-rationing equilibrium may involve excessive lending. In such circum-

\footnote{This quotation is capable of various interpretations, though it definitely seems to imply underfunding. No analysis supports the claim and no references are given. As far as we know, the only explicit treatment of the welfare properties of a credit-rationing equilibrium is de Meza and Webb (1987) which shows that in the Stiglitz and Weiss model with adverse selection (which involves entrepreneurs’ returns differing by mean-preserving spreads) does yield underinvestment whether or not rationing emerges.}
stances the appropriate policy is to increase the attractiveness of alternatives to self
employment rather than to subsidise lending. Similar conclusions apply in the
presence of redlining, where exclusion from the loan market is not random but is
systematically determined by an array of imperfect indicators of entrepreneurial
quality.

Pure credit rationing in the sense of Stiglitz and Weiss (1981) involves
competitive banks choosing to keep interest rates low and randomly selecting
which applicants get loans. They demonstrate that under asymmetric informa-
tion, credit markets may not clear, since there may be an interest rate above which the
default rate rises by so much that bank profitability declines. This follows from the
fact that the expected cost of a rise in the promised repayment is greater for
projects that have a high probability of success. As a result, risk-neutral
entrepreneurs have an incentive to adopt riskier projects as repayments rise. For
the same reason, an adverse-selection effect is possible since those endowed with
relatively safe projects will be the first to drop out as interest rates increase. Now
consider the possibility of an equilibrium at the repayment that maximises a bank’s
expected gross-return per dollar lent. Competition eliminates positive profit so the
volume of lending must expand until the return to depositors is sufficiently high
that the bank expects to break even. If at this rate the supply of deposits is
relatively low, not all loan applicants can be served. Despite the excess demand,
deterioration in loan quality means that banks would lose money by raising the
rate they charge borrowers. So, banks randomly select to whom they give loans.

In appraising the welfare properties of this equilibrium, one point of comparison
is with the outcome under full information. Another is whether a government, with
no informational advantage over the private sector, should adopt policies that
encourage the entry of those excluded from the capital market, or, alternatively,
expel some of those currently active.\(^5\) As demonstrated by de Meza and Webb
(1987), on either criterion the Stiglitz and Weiss assumptions imply that, whether
or not rationing emerges, there is insufficient lending.

The possibility that hidden types may give rise to socially excessive lending has
been demonstrated by de Meza and Webb (1999) and Bernanke and Gertler
(1990). Instead of assuming that heterogeneity concerns risk, as in Stiglitz and

\(^5\)This approach focusses on feasible intervention but begs the question what the welfare objective is.
The most straightforward is maximisation of aggregate income. This objective has its problems as it is
easy to find equilibria which are constrained efficient and yet intervention may raise total income. For
example, giving a borrower a pound may increase her real income by more than a pound because, by
reducing borrowing, it lowers the deadweight cost of moral hazard induced by the credit contract. Even
though aggregate income increases, the original contract could not be rewritten to benefit the borrower
without harming the lender, making the equilibrium constrained efficient. With hidden types, as we
show, strict Pareto gains may sometimes be possible, but in richer environments this will not normally
be possible. So the aggregate income criterion we mostly work with is best viewed as implicitly
assuming that individual incomes are not too unequally distributed, and that utility-of-income and
social-welfare functions are not too concave.
Weiss, in these papers entrepreneurs differ in their intrinsic quality. That is, the return distribution of a better entrepreneur bears a relation of first-order stochastic dominance to that of a lower-quality type. Consequently, the marginal entrant is also the least profitable to the banks, so the pooling interest rate is below the rate that this entrepreneur would be charged under full information. Hence, there is excess entry.

In this world credit rationing is impossible since, as interest rates rise, it is unambiguously the lowest-quality types that exit, thereby improving the composition of the banks’ lending portfolio. The contribution of the present paper is to combine the assumption that entrepreneurs differ in intrinsic quality with the Stiglitz-Weiss moral hazard formulation, whereby the risk of a project is under the entrepreneur’s control. This plausible set up allows for rationing as a result of the moral hazard channel to coexist with overinvestment due to heterogeneous types. Banks randomly select who gets a loan, yet there may be more lending than under full information and subsidising inactivity and taxing lending may yield a Pareto improvement. Moreover, even with pure hidden types, a small change in the original Stiglitz and Weiss (1981) assumptions can yield similar results. In particular, if the Stiglitz–Weiss specification that entrepreneurs’ projects differ by mean-preserving spreads is replaced by one of mean-reducing spreads, credit-rationing equilibria may involve over-lending relative to the full-information equilibrium.

The model is extended in a simple way to examine redlining in the credit market, whereby those failing to score sufficiently highly on set of indicator variables are sure to be denied credit. The equilibria arising are shown to involve excessive lending to entrepreneurs with high values of the indicator variables, whilst entrepreneurs in lower productivity groups may be inefficiently redlined. Both problems are addressed by increasing the return to staying out of the loan market. So, the general message is that if interest rates fail to clear credit markets, it does not follow that policy should make loans easier to obtain.\footnote{In de Meza and Webb (1999) we show that market clearing is consistent with positive wealth effects and overinvestment.}

2. A model with hidden types and hidden action

Individuals differ in ability, denoted by $a$, which is uniformly distributed with support $[0,1]$. Each entrepreneur has access to two mutually-exclusive projects both requiring the same investment, and each with a two-point return distribution. Whatever its type, if a project fails, its gross revenue is zero. If an entrepreneur with ability $a$ undertakes the “good” project it succeeds with probability $ap_G$ where $p_G < 1$, in which event gross revenue is $G$. The “poor” project succeeds with probability $ap_B$, yielding a gross return of $B$. By assumption $p_G G > p_B B$ and...
Entrepreneurs are endowed with no liquid wealth but each project is only viable if effort is applied, which “costs” a fixed amount $F$.

Finance is supplied by banks which are assumed to be risk-neutral expected-profit maximisers who are engaged in Bertrand competition. Banks know the characteristics of the population of entrepreneurs and of the two technologies, but an individual borrower’s type is private information. Which project is selected cannot be verified. Nor can banks verify project returns, but they can observe whether a payment is made. As a result, the only incentive compatible form of finance is a fixed payment, $D$, with the provision that, if the payment is missed, the bank is entitled to seize the project. The entrepreneur is then always better-off making the fixed payment if he can. A regular debt contract therefore emerges.

The crucial feature of our simple model is that the value of indebtedness, $D$, determines the choice of technology. The firm selects the “good” technology if and only if it yields higher expected profit. An entrepreneur of type $a$ is indifferent between projects at repayment $D'$ where

$$a p_a (G - D') = a p_B (B - D')$$

so that

$$D' = \frac{p_B G - p_B B}{p_B - p_B}$$

All entrepreneurs switch projects at the same repayment, $D'$. We assume that there is an opportunity cost of participation in entrepreneurship, which could be the return to a safe occupation. Denote this return by $S$, which is the same for all entrepreneurs. In our formulation, this opportunity cost can simply be added to the effort cost, $F$. Only entrepreneurs with sufficient ability participate in the loan market. So at $D'$, the worst active entrepreneur has ability

$$\hat{a} = \frac{F + S}{p_G (G - D')}$$

The expected return to the bank per loan is therefore

$$\rho = a_p p_G D \quad D \leq D'$$

where $a_p$ is the average quality of participating entrepreneurs.

The convexity of the return function below and above $D'$ in Fig. 1 follows since $a_p$ is increasing in $D$, as entrepreneurs with the lowest $a$ drop out as $D$ increases. At $D$, even the best entrepreneur (that is with ability $a = 1$) is indifferent with regard to participation. If pure rationing is ever to be possible the bank must have a higher return at $D'$ than $D$, which requires

$$\rho' = p_G \frac{(1 + \hat{a})}{2} > p_B D$$
Since the best entrepreneur is indifferent to participation at $\bar{D}$, this implies $p_B(B - \bar{D}) = F + S$, so that (5) can be rewritten as

$$p_B \left(1 + \hat{a}\right) \frac{\bar{D}}{2} > p_B B - F - S$$

Making use of (2) and (3), (6) becomes

$$\frac{1}{2} p_B \left(1 + \frac{F + S}{p_G \left(\frac{G}{p_G p_B - p_B B} - p_G - p_B\right)}\right) > p_B B - F - S$$

which is satisfied for some constellations of parameters.

Let $R$ denote the amount depositors must be paid per loan. At $D'$, the proportion of entrepreneurs applying for funds is $1 - \hat{a}$ but suppose that at $R = \rho$ the supply of deposits is only enough to finance $1 - \hat{a} < 1 - \hat{a}$ projects. As banks lose by
increasing the repayment above $D'$, this is the equilibrium rate and so only
$(1 - \hat{a})/(1 - \hat{a})$ of applicants are funded, a credit-rationing equilibrium.

Now suppose that there were full information, so lenders can identify an
individual’s type. Also, provisionally suppose that costless monitoring is available
to the bank which is thus able to ensure that the good project is adopted. If
depositors must be paid $R'$ per loan, then the worst entrepreneur funded in the
full-information equilibrium has an expected return of

$$p_G \hat{a}G - R' = F + S$$

whereas the worst entrepreneur funded in the market equilibrium has an expected
return of

$$p_G a^\ast (G - D') = F + S$$

where from (5)

$$D' = \frac{2R'}{\hat{p}_G(1 + \hat{a})}$$

Hence,

$$\hat{a} = a^\ast + \frac{R'}{\hat{p}_G G} \left( \frac{1 - \hat{a}}{1 + \hat{a}} \right)$$

The reason $\hat{a} > a^\ast$ is the same as in de Meza and Webb (1987). In the pooling
equilibrium the marginal applicant gets terms appropriate to the higher quality
average applicant, so if required to pay the actuarially fair interest rate, would drop
out.

To determine welfare implications, provisionally suppose that under full
information, the interest rate on deposits remains at $R'$. Relative to the pooling
equilibrium with rationing, loan applicants decrease by $(R'/\hat{p}_G G)(1 - \hat{a}1 + \hat{a})$.
This exceeds the number of applicants rejected in the credit market equilibrium,
$\hat{a} - \hat{a}$, if the supply of deposits is relatively large. In this case, under full
information, at $R$ the demand for loans is below the supply, leading to a fall in the
interest rate on deposits and in the number of loans advanced relative to the
credit-rationing equilibrium.

**Proposition 1.** When the proportion of applicants granted loans is sufficiently
high, a credit-rationing equilibrium involves more lending than under full
information.

This result arises from the conjunction of two ingredients. The credit rationing
feature of the equilibrium is due to the moral hazard; banks do not increase the
interest rate, for to do so would drive borrowers into such risky strategies as to be
counter-productive. However, at the capped interest rate, a variety of entrepreneurs
apply for loans. The banks expect to break even, but if they could identify borrowers’ types, lower-quality entrepreneurs would be excluded, whereas the high-quality types who are randomly unfunded in the rationing equilibrium, proceed. If this group is not too large, which would be the case if rationing is not too great, the de Meza and Webb (1987) result prevails despite credit rationing.

To illustrate the proposition consider a simple numerical example. Assume that there are 100 entrepreneurs and that at all relevant interest rates 50 are sufficiently good that under full information they should be funded whilst the remaining 50 should not. Now suppose that at the lending rate which maximises the bank’s expected gross return, the associated deposit rate at which banks break even attracts a supply of funds sufficient to finance only 80 projects. Then, given that all entrepreneurs find it profitable to apply for funds, 10 good projects and 10 bad projects will be rationed. In the full-information equilibrium only the 50 good projects would be funded, so there is over investment. Alternatively, suppose there were only sufficient funds to finance 20 projects, then 80 projects, 40 good and 40 bad, will be denied finance. In the full-information equilibrium all 50 good projects will be financed, and in this case the market equilibrium exhibits less investment than under full information.

3. Policy

We now examine the policy implications of the model of Section 2 which combines advantageous selection and moral hazard. Ideally, intervention should influence the volume and the composition of lending without worsening moral hazard problems. This is accomplished by making it more attractive for low-quality entrepreneurs to pursue other activities. There are various ways such a policy may be implemented. As Gordon (1998) documents, most tax systems favour entrepreneurial activities. Amongst measures which could be used to offset this bias are equalising personal and corporate tax rates and abolishing favourable treatment of expenses for the self-employed. Such policies, which at first sight appear to limit entrepreneurship, have seemingly paradoxical results.

**Proposition 2.** In a credit-rationing equilibrium, increasing a subsidy to non-participation in the loan market raises participation as long as rationing persists.

**Proof.** At any given fixed repayment $D$, the lowest quality entrepreneurs no longer apply for funds preferring to take the subsidy. So, the average quality of applicants improves. The switch point between projects still occurs at $D'$ and a rationing equilibrium at this repayment remains possible. Now though, the improvement in lending quality means that the break-even payment to depositors, $R'$, is higher. More deposits are thus attracted, and so lending rises. □
Inducing low-quality types to drop out of a credit-rationing equilibrium does not just allow their replacement by an equal number of higher-quality types. Due to the improvement in quality, the banks’ return rises, driving up the return to depositors and so lending is increased.

Notice also that a small subsidy to non-participation necessarily raises aggregate surplus. In the credit-rationing equilibrium, the worst entrepreneurs only apply for loans because the interest rate they will be charged is below the actuarially fair rate for their characteristics. Their disappearance must increase total benefits. More than this, whether or not credit rationing involves lending in excess of the full-information level, a subsidy to non-participation can achieve the full-information outcome.

**Proposition 3.** Whether or not credit is rationed and irrespective of whether lending exceeds the full-information level, a suitable subsidy to non-participation replicates the full-information level and distribution of lending.

**Proof.** Under full information, the demand for loans equals the supply. Were the same number of projects funded as under full information, the asymmetric-information pooling-interest rate must be lower than that charged to the marginal borrower when his characteristics are known. So, if the subsidy to non-participation is set just high enough to make this type indifferent between entering or not, a first-best market clearing outcome is established. □

In view of Proposition 2, it may seem that if credit rationing involves too much lending, a subsidy to non-participation will not help. The point is that Proposition 2 only applies in the credit-rationing regime. Once the subsidy is sufficiently large that the market clears, further increases in the subsidy have the expected effect of decrease lending.

With a random sample of entrepreneurs rationed, a subsidy to lending will also raise welfare. All but the marginal applicant stands to gain if they are selected to receive funding. As banks break even, the opportunity cost of funds is below the expected benefit of a loan. A small subsidy to depositors raises the volume of lending without changing the mix of borrowers, thereby yielding an increase in aggregate income:

**Proposition 4.** In a credit-rationing equilibrium, a small subsidy to lending raises aggregate income.

Note that since the opportunity cost of deposits is increasing in their volume, the optimal lending subsidy may not eliminate rationing. Also, subsidising lending

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7This can also be achieved by subsidising the interest paid on deposits.
does not discriminate between entrepreneurs in the way that the subsidy to inactivity does. Hence, unlike the inactivity subsidy, a lending subsidy cannot achieve the first best. Interestingly, although it raises welfare, the lending subsidy raises the volume of lending, whereas the optimal inactivity subsidy sometimes reduces participation.

4. An example

This example illustrates the properties of the model of Section 2 and its policy implications.

There are two types of agent, each with a choice of two projects:

High ability, with \( a = 1 \),

- Project G: 100 with \( p_G = 1 \) and zero otherwise
- Project B: 120 with \( p_B = \frac{1}{2} \) and zero otherwise

Low ability, with \( a = \frac{1}{2} \),

- Project G: 100 with \( ap_G = \frac{1}{2} \) and zero otherwise
- Project B: 120 with \( ap_B = \frac{1}{4} \) and zero otherwise

We assume that the alternative activity to entrepreneurship yields a return of zero, i.e. \( S = 0 \), however, the cost of effort is \( F = 10 \).

It is easily checked that both high and low ability entrepreneurs are indifferent between \( G \) and \( B \) when the fixed payment \( D = 80 \). In the example, for \( D > 80 \) the high-ability type switch to project \( B \) whilst the low-ability types drops out. Let the two types of entrepreneur be equally numerous, in particular there are 50 of each type. Then the bank’s return function per loan is as depicted in Fig. 2.

There is the potential for a credit rationed equilibrium at \( D = 80 \). Both types apply for funds. At a deposit rate of 60, let there be a supply of funds sufficient to fund 75 projects. Thus, 100 entrepreneurs apply for funds and 75 are selected at random.

First consider the full-information equilibrium. Suppose that a deposit rate of 55 is sufficient to yield enough funds for 50 projects. Even if the less able choose the safe project, at this cost of funds it is not worth lending to them. In the credit rationed equilibrium, 75 projects are funded compared to 50 under full information. Hence, the example supports Proposition 1.

Now consider the policy discussed in Section 3. This requires a more explicit specification of the supply of deposits. Let there also be 50 wealthy agents with no projects, each willing to supply deposits. The supply curve of funds is linear.
Suppose the government pays a subsidy of 22.5 to all non-entrepreneurs (100 as it turns out), levying a poll tax of 15 (on all 150 agents) to cover the cost. This leads to a market clearing equilibrium in which only the high-ability types are active. In such a configuration $D = 55$, so a low-ability entrepreneur would earn $\frac{1}{2}[100 - 55] = 22.5$ by entering, equal to the subsidy available to inactivity. High-ability types must thus strictly gain from entry. In a credit rationing equilibrium the expected return to a low-ability type was $\frac{3}{4}[100 - 80] = 7.5$ under rationing, whereas after intervention the certain return is $22.5 - 15 = 7.5$. For high-ability types the expected return rises from $\frac{3}{2}[100 - 80] = 15$ under rationing to $45 - 15 = 30$ after intervention. The fall in the deposit rate from 60 to 55 results in savers losing surplus of up to 5 but the net per capita subsidy of 7.5 (the difference between the inactivity subsidy and the poll tax) more than compensates. Whereas Proposition 3 shows the possibility of a potential Pareto improvement, this example demonstrates the possibility of a strict Pareto improvement. We state this as a proposition:
Proposition 5. In a credit-rationing equilibrium, levying a poll tax with the proceeds used to subsidise those not applying for loans may yield a strict Pareto improvement.

It is readily seen that a tax on borrowing may also enhance welfare, but as it has counter productive incentive effects, its welfare potential is lower than an inactivity subsidy.

5. Pure hidden types

Proposition 1 can also be obtained in a pure hidden-type model under assumptions which are a variant of those of Stiglitz and Weiss (1981).

Suppose there are two groups of entrepreneurs. The first group, comprising a proportion $\lambda$ of the population, have a risky project which pays $G$ with probability $p_G$ and a second group have a project which pays $B$ with probability $p_B$ and $p_G > p_B$, $G < B$ and $p_G G > p_B B$\textsuperscript{9}. The bank’s profit function is therefore downward discontinuous at $D = G$, and may reach a global maximum here.\textsuperscript{9} Consequently, for some deposit-supply functions, there must be a credit-rationing equilibrium at $D = G$. As $[\lambda p_G + (1 - \lambda)p_B]D = R$ it follows that $p_B B < R$, and though some of the $B$s are financed, their expected return does not cover the opportunity cost of the required funds.

An equilibrium of this sort may involve too much investment relative to the full-information equilibrium. For this to happen, the number of unfunded type $G$s must fall short of the number of funded type $B$s. This condition is sure to be satisfied if the supply of deposits is sufficiently great that the proportion of loan applicants turned down is low. To see how this leads to overinvestment, suppose that under full information all type $B$s were excluded from the market and all type $G$s were financed. Then, compared with the rationing equilibrium, the reduction in lending implies that the return to depositors $R$ falls, say to $R^\#$. So if $p_B B < R^\#$, as must be true if the supply of deposits is sufficiently elastic, the full-information benchmark does indeed exclude all $B$s and so has less investment than the market equilibrium with rationing. Now consider the case where the number of type $G$s excluded in the rationing equilibrium is greater than the number of type $B$s participating, as will be true if the supply of deposits is relatively low. With full-information, it is then certain that only type $G$s will be financed since, if the excluded $G$s replace the included $B$s, more funds are required. As a result, $R$ rises

\textsuperscript{9} Type $B$s are high risk in that relative to $G$s, their probability of failure is higher but the payoff if they succeed is higher. This differs from the Stiglitz and Weiss case in replacing mean-preserving spreads by mean-reducing spreads.

\textsuperscript{9} This requires that $p_G G + (1 - \lambda)(p_G - p_B)G > p_B B$, which must be satisfied for $\lambda$ sufficiently large.
to \( R^* \) so \( p_B B < R^* \) and \( p_G G > R^* \) and this equilibrium certainly has more investment than the rationing equilibrium.

In considering the policy implications, note that a random sample of entrepreneurs are excluded from the market, but as \( \lambda p_G G + (1 - \lambda) p_B B > R \) the expected surplus on a loan is positive. Hence, regardless of whether there is too much or too little lending relative to the equilibrium with full information, a subsidy to lending, by drawing in more entrepreneurs without changing the mix of types, must once again enhance welfare.

Turning to policies which affect the return to non-participation, as the marginal entrepreneurs are type \( Gs \), a tax on inactivity will raise the \( D \) at which they drop out of the loan market. The associated bank return rises, increasing the volume of lending and decreasing the proportion of projects credit rationed. The policy is therefore beneficial, but as \( Bs \) remain active, there remains an inefficient composition of projects financed, so in this model the subsidy policy fails to achieve the first best. However, it is interesting to note that a sufficient bankruptcy penalty will achieve full efficiency, since it hits the high default \( Bs \) the hardest.

This model clearly illustrates how policy conclusions do not follow straightforwardly from a comparison of the volume of lending under credit rationing with the full-information equilibrium. If only second-best instruments are available, such as interest-rate subsidies, it may be best to increase the volume of lending even further in excess of the first-best level.

6. Generalisation

We now generalise the model of Section 2 in which heterogeneous entrepreneurial ability is combined with moral hazard. Projects are described as follows: an investment by an entrepreneur of ability \( a \) in a project with risk characteristics \( \theta \), yields a return stream of \( aX(\theta) \) with probability \( p(\theta) \) and zero with probability \( 1 - p(\theta) \), where \( X(\theta) > 0 \). The project’s expected return varies with the chosen risk-return characteristics. As \( \theta \) increases, the return in the event of success is higher \( (X'(\theta) > 0) \), but the probability of success decreases \( (p'(\theta) < 0) \), eventually by so much that the expected return decreases. In other words, for high \( \theta \), the risk of the project increases at the expense of a lower expected return.

The entrepreneur’s optimal choice of project solves\(^{10}\)

\[
\pi(D,a) = \max_{\theta} p(\theta)(aX - D) - F \tag{12}
\]

and is thus characterized by

\[
p'(\theta)(aX(\theta) - D) + p(\theta)aX'(\theta) = 0 \tag{13}
\]

\(^{10}\)Here we assume that \( S = 0 \).
we denote the optimal choice of $\theta$ by $\theta^*(D,a)$, so that $\partial p^*/\partial a = p'(\theta^*)\partial \theta^*/\partial a > 0$, $\partial p^*/\partial D = p'(\theta^*)\partial \theta^*/\partial D < 0$.

For a given fixed payment $D$, the marginal entrepreneur has an ability $\hat{a}(D)$ such that

$$
\pi(D, \hat{a}(D)) = 0
$$

and since $\partial \pi/\partial a(D,a) > 0$, only entrepreneurs with $a > \hat{a}(D)$ apply for finance. Moreover,

$$
\frac{\partial \pi}{\partial D}(D,a) = -p^*(D,a) < 0,
$$

so we have $d\hat{a}/dD = -(\partial \pi/\partial D)/(\partial \pi/\partial a) > 0$.

In a pooling equilibrium, the average probability of success is

$$
\bar{p}(D) = \int_{\hat{a}(D)} p^*(D,a) \frac{dG(a)}{1 - G(\hat{a}(D))},
$$

and satisfies

$$
\bar{p}(D) > p^*(D,\hat{a}(D)).
$$

The expected return to the bank on this portfolio is given by

$$
\rho = \bar{p}(D)D
$$

and the expected profit, obtained by deducting the return to depositors, is given by $\Pi = \rho - R$.

Assuming that competition drives banks’ expected profits to zero, the marginal entrepreneur has a negative value project since the social surplus on the marginal entrepreneur

$$
\pi(D,\hat{a}(D)) + p^*(D,\hat{a}(D))D - R = 0 + [p^*(D,\hat{a}(D)) - \bar{p}(D)]D < 0.
$$

The effect of $D$ on the default rate is

$$
\frac{d\rho}{dD} = (\bar{p}(D) - p^*(D,\hat{a}(D)) \frac{dG(\hat{a})}{1 - G(\hat{a})}) + \int_{\hat{a}} \frac{dG(a)}{\partial D} D \frac{dG(a)}{1 - G(\hat{a})}
$$

where the first term (the advantageous-selection effect) is positive by (16) and the second term (the incentive effect) is negative. It follows that $\rho$ may be increasing or decreasing in $D$. We assume that at high $D$ moral hazard dominates and $\rho$ has a
unique turning point. If at the $D$ for which $d\rho/dD = 0$, $I > 0$ then the equilibrium is market clearing but if $I < 0$ there is no interest rate at which lending is profitable.

7. Redlining

We now examine the implications of the screening procedures implicit in credit scoring as adopted by many banks. We do this using the generalised formulation of Section 6. The idea is that there is a set of observable characteristics, $e$, which allow lenders to imperfectly sort borrowers into groups with different default probabilities. Assume initially a single index $e$ which takes only two values. The distribution of $a$ conditional upon $e^h$ first-order stochastically dominates the distribution of $a$ conditional upon $e^l$: $G(a|e^h) \geq G(a|e^l)$ for all $a$ and with strict inequality for some $a$. In our model $e$ is not an input into entrepreneur productivity but is simply an indicator variable. The entrepreneur’s expected surplus is still given by

$$\pi(D,a) = \max_p p(\theta(aX(\theta) - D) - F$$

(20)

For given $D$, the default probability of the marginal applicant is the same for both groups since the ability at which it is just worth applying for a loan is independent of the indicator. Hence, $p^*(D,\hat{a}(D),e^h) = p^*(D,\hat{a}(D),e^l)$. However, the average probability of repayment is given by

$$\bar{p}(D,e) = \int_{\hat{a}}^a \frac{p(D,a) \, dG(a|e)}{1 - G(\hat{a}|e)}$$

(21)

so $\bar{p}(D,e^h) > \bar{p}(D,e^l)$. The bank’s return functions for the two groups are given respectively by

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11. When $D$ is zero there is no moral hazard, so the profit function must be upward sloping. Were the supply of deposits upward sloping, the existence of a turning point permits credit rationing. There is, though, an issue of whether an equilibrium in the region of a turning point can exist. The marginal cost of funds to the borrower tends to infinity as the turning point of the profit function is approached. The borrower therefore has a great incentive to take a smaller loan. This could be achieved by opting for a smaller project, deferring the starting date to accumulate private savings, working harder or longer prior to start up to reduce the need for borrowing, gambling to take advantage of what is, in effect, a convex return function. If any of these channels is available then, at any given loan size, all applicants drop out whilst $I$ is still increasing in $D$. With identical applicants there could be an equilibrium with random allocation of funds but those denied credit are no worse off than those getting funding.

12. See, for example, Orgler (1970).

13. An analytically equivalent alternative is that $e$ is a determinant of the individual’s productivity, this could possibly be education.
\[ \rho^h = \tilde{p}(D,e^h)D \]  

(22)

and

\[ \rho^l = \tilde{p}(D,e^l)D \]  

(23)

In Fig. 3 the return required by depositors is fixed at \( R' \). In the equilibrium illustrated, members of the \( e^h \) group get loans at fixed repayment \( D' \) but group \( e^l \) is completely excluded from the credit market (it is redlined). Were a publicly observable, there would be a cut-off value common to both groups. Since \( p^*(D,a(D),e^h) < \tilde{p}(D,e^h) \), some of those getting loans in the \( e^h \) group would go unfunded were the \( a \) observable but the high-ability entrepreneurs in the \( e^l \) group would now be funded. Despite the presence of redlining, the volume of lending may rise or fall were type revealed. This is the analogy of Proposition 1.
Proposition 6. Despite the presence of redlining, the volume of lending may exceed that which would obtain if ability were public information.

Propositions 2 and 3 also have their counterparts. Subsidising non-participation draws off the lowest quality types from each group. So at given $D$, the bank-return function shifts up. Hence, group $e^\ell$ may no longer be redlined. The subsidy reduces the number of those from group $e^h$ participating, but increases from zero the number participating from group $e^r$. If group $e^r$ is sufficiently large, the volume of lending may rise. Hence, we have the following proposition:

Proposition 7. In the presence of redlining, a subsidy to non-participation may increase the level of participation.

The welfare analysis of redlining also parallels the credit rationing case. In particular, subsidising lending to a group just excluded from credit is advantageous. All intra-marginal applicants obtain positive expected surplus and the bank would make a negligible loss. So, even though the worst of the entrepreneurs thereby enabled to borrow have negative expected net-present value, a small subsidy would generate an aggregate welfare gain. However, this observation does not provide a very robust basis for policy. An outsider is not well placed to identify those only just redlined. In practice, redlining will be determined by a vector of characteristics only some of which will be available to policy makers. Subsidising loan applicants on the basis of only one or a restricted number of the characteristics is likely to benefit some groups not redlined and so worsen the excessive entry problem. In contrast, a policy of encouraging non-participation does not raise the delicate problem of identifying the right group to receive the subsidy. At least at low levels, it is beneficial for every group affected, whereas imperfectly targeted lending subsidies are much less certain to be helpful.

To be explicit, suppose the bank has available two binary indicators. Four groups are thus identifiable to the bank, but suppose the only group redlined are those loan applicants for whom both indicators are positive. Consider the policy problem if only the second indicator is observable to those implementing policy. Knowing that there is a positive correlation between the observed indicator and being denied credit, suppose the policy maker subsidises loans to those with a positive value of the indicator. This includes some of those in the group not

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14 Gale (1990) presents an example with this property but does not note the generality of the result.
15 If the banks would make a finite loss on lending to the marginal group there is no guarantee of a welfare gain. This occurs if, as de Meza and Southey (1996) argue, entrepreneurs are afflicted by unrealistic optimism (some direct evidence is reported in Arabsheibani et al., 1999), in which case subsidising even the marginally redlined will be counter-productive.
16 If a finite subsidy is required to induce participation, the gain to borrowers may be less than the cost of the subsidy. The condition for an overall gain is not easily interpretable.
redlined and causes a welfare loss due to exacerbating excessive entry.\footnote{The alternative policy of making the subsidy conditional on a bank turning down applicants for a commercial loan has obvious moral-hazard problems.} In contrast, raising the return to non-participation necessarily has an interval in which welfare rises.

8. Conclusion

This paper has shown that when funding is denied to potential entrepreneurs due to asymmetric information, it does not follow that there is too little lending. Under reasonable assumptions, a credit-rationing equilibrium may involve borrowing in excess of the full-information level. Everyone may be better off if the government makes alternatives to borrowing more attractive, perhaps by eliminating tax advantages to self-employment. Paradoxically, over some ranges such a policy may increase the number of those obtaining loans and becoming self-employed. Similar conclusions apply in the presence of redlining. Of course, such schemes involve monitoring and administrative problems of their own and so may be problematic. We do not positively advocate intervention; our case is that grants and other encouragements to start up businesses may be the wrong direction in which to move.

Lending subsidies also raise welfare in credit-rationing and redlining equilibria (even if borrowing is already excessive), but such policies are less effective than raising the return to non-participation, since they do not improve the composition of loan applicants. The informational requirements for successful implementation of a subsidy programme are also high. When groups are only just redlined, a subsidy may be beneficial. But if the margin by which applicants fall short of getting a loan is greater, then a subsidy would be harmful in terms of overall welfare. Since credit scoring takes into account a variety of characteristics which vary through time, it would be difficult to consistently implement a policy that successfully targets the right borrowers. Intervention to raise the attraction of not becoming an entrepreneur is much less sensitive since it is beneficial in all circumstances. Intervention entails costs not discussed here and may fall prey to political manipulation. Even though there is a reason to think that market failure is present, the best policy may be to do nothing. However, if intervention is to be implemented, we have argued that the appropriate policy is not to increase the supply of credit to borrowers subject to credit rationing and red-lining. The market failure arises because socially unproductive types apply for credit, squeezing out those with socially superior projects. To efficiently counter the problem, what is needed is to discourage the low-quality types from applying for funds and this can often be accomplished by raising the return to alternative activities. At all events,
empirical evidence of credit rationing and redlining does not create a prima facie case for policies to encourage lending.

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