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**David Webb  
And  
David de Meza**

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# Saving Eliminates Credit Rationing

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## **Abstract**

Equilibrium credit rationing, in the sense of Stiglitz and Weiss (1981), implies the borrower faces an infinite marginal cost of funds. Infinitesimally delaying the project to accumulate more wealth is therefore advantageous to the borrower. As a result, the well-known conditions for credit rationing cannot be satisfied.

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## 1. Introduction

This paper shows that equilibrium credit rationing is impossible if borrowers have saving opportunities. The form of credit rationing we consider is that of Stiglitz and Weiss (1981) (henceforth SW). Their celebrated paper demonstrated that competitive banks faced by an excess demand for loans may be worse off if they raise their interest rates. Instead, the banks randomly select which loan applicants receive funds. A necessary condition for this to occur is that, beyond a certain point, raising the interest rate may harm bank profits by precipitating a more than proportionate increase in the default rate. The key to our result is that if a bank is at the turning point of its return function, as is required for credit rationing, the borrower's marginal cost of funds is infinite. It is therefore worth the borrower incurring any finite cost to reduce the required loan size. There are a variety of ways to do this. We focus on an infinitesimal postponement of the project. This allows interest on the borrower's savings to accumulate, thereby reducing the loan needed when the project finally commences.

Alternatives to delay include the entrepreneur increasing the saving rate, scaling down the project, choosing less capital-intensive production techniques, and working harder to accumulate more wealth prior to starting the project. If any of these actions are possible, credit rationing cannot occur.

SW proposed two routes by which higher interest rates may cause bank profit to deteriorate. The selection effect works through changes in the composition of borrowers. When interest rates are high, entrepreneurs with relatively safe projects almost always default whereas those with equal expected returns but a riskier distribution sometimes perform sufficiently well to yield the entrepreneur a jackpot. As rates rise, the safe types are the first to drop out. From the banks' perspective, there is therefore a disadvantageous change in the quality of the loan pool.

Incentive effects arise when entrepreneurs' project choice is not verifiable. The previous logic implies that as interest rates rise, debt-financed entrepreneurs obtain a private benefit from switching to riskier

strategies, causing the bank to lose out. A high interest rate, by diminishing the payoff to success, has the further moral-hazard effect of discouraging effort. This, too, implies that the bank's return function with respect to its loan rate may reach a turning point.

The final step in establishing credit rationing involves the assumption of an upward sloping supply curve of deposits. Suppose that at the loan rate that maximises the banks' gross return, the highest interest rate banks can offer depositors and still breakeven does not attract enough funds for all loan applicants to proceed. Credit rationing then emerges.

In SW the start date of a project is exogenous. What we show is that at the repayment that maximizes the banks' expected gross return, at least some borrowers are better off postponing the project. As a result, a credit-rationing equilibrium is impossible. Since in reality saving is almost always a feasible option, equilibrium credit-rationing is not of practical relevance.

A couple of papers have examined the interaction of saving oppor-

tunities, capital market imperfections and the timing of investment. Parker (2000) utilizes a continuous time model to examine the impact of exogenous borrowing constraints on the decision of whether and when to become an entrepreneur. Inability to borrow more than a prespecified amount may lead to the postponement of a business start up rather than its abandonment. The origin of the borrowing constraint and whether a credit-rationing equilibrium is consistent with endogenous timing is not considered. Lensink and Sterken (2001) analyze a model with hidden types in which delay resolves the uncertainty in project returns. Entrepreneurs are endowed with projects of varying degrees of risk. In a pooling equilibrium, those with safe investments pay actuarially excessive interest rates and so have an incentive to delay and obtain fair rates. Postponement also reveals the project's actual return and thus prevents resources being wasted on undertakings that will perform poorly. The greater the initial uncertainty, the more valuable it is to defer the start decision. These two opposing incentives imply that it is ambiguous whether it is the

safest or the riskiest entrepreneurs that comprise the first-period pool and hence whether the number delaying is socially excessive or insufficient. Although credit rationing as such is not investigated, at first sight it could arise in the excessive delay equilibrium. This though is a feature of the discrete two period modelling. In continuous time a short delay will always profitably separate out the safest types from a pooling equilibrium and so eliminate credit rationing.

The remainder of this paper makes explicit the incompatibility of saving and credit rationing. In the next section we examine the case of moral hazard. Then in Section 3 we look at hidden types. When the nature of heterogeneity is that entrepreneurs' returns differ by mean preserving shifts, a separating equilibrium emerges in which safe entrepreneurs delay their projects but there is no random rationing. When entrepreneurs' return distributions can be ranked by first-order stochastic dominance, there is a pooling equilibrium with no delay. Once again, random rationing does not feature; in fact too many projects are funded.



In the interest of transparency the assumptions are not as general as they might be and, as with much of the literature, we do not embed the analysis in a full general equilibrium model.<sup>1</sup>

## 2. A Simple Moral-Hazard Model

Some fraction of a risk-neutral population are endowed with a project which, when activated, instantaneously yields  $S$  with probability  $p(E)$  or else zero, where  $E$  is the effort of the entrepreneur. Assuming that any project returns are delivered instantaneously is convenient but innocuous. The project can be activated just once, but this can be at any time in the entrepreneur's long life.<sup>2</sup> Although entrepreneurs have some initial financial resources of their own, these are insufficient to self-finance the project. Debt finance is available from competitive banks. The most straightforward justification for debt as the equilibrium financial contract is that it is costly to ver-

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<sup>1</sup>An overlapping generation model in which the young and low-quality or safe entrepreneurs save could be specified to endogenize the supply of funds.

<sup>2</sup>Though  $S$  or  $p$  may decline with  $\tau$ , as later noted, this does not affect the results.

ify project revenue but cheap to verify whether a contracted payment is made. Incentive compatibility is achieved by allowing the bank to seize the project if the payment is missed.<sup>3</sup>

If the project is operated at time  $t$ ; it yields the entrepreneur expected utility of

$$U = e^{-rt} \{ [S - D] p(E) - E \} \quad (1)$$

where  $D$  is the contracted repayment on debt and  $r$  is the safe interest rate.<sup>4</sup> The FOC with respect to effort is

$$p' [S - D] - 1 = 0 \quad (2)$$

The entrepreneur has initial wealth  $W_0$ , so by time  $t$  this has grown to  $W_0 e^{rt}$ , all of which is invested in the project.<sup>5, 6</sup> Project lending is

<sup>3</sup>We assume that borrowers cannot very effectively expropriate returns prior to seizure.

<sup>4</sup>A full general equilibrium analysis would endogenise  $r$ , the safe rate of interest. This though would be a distraction in the present context since our demonstration that borrowers reject all loans offered at the rationing interest rate is independent of the level of  $r$ . Note though that in a closed economy, at any moment the aggregate supply of lending is totally inelastic so were it not for the point made in this paper, credit rationing would be a possibility.

<sup>5</sup> $W_0$  can be regarded as the present value of all alienable income and not just an initial bequest.

<sup>6</sup>Maximum self-finance arises because debt involves a deadweight cost which, due to the competitive assumption, is ultimately borne by the entrepreneur.

risky so competitive banks must charge a premium to cover the chance of default. The equilibrium repayment must satisfies the breakeven condition

$$pD = K - W_0 e^{r\dot{\iota}} \quad (3)$$

where  $K$  is the capital requirement of the project. Substituting (3) into (1)

$$U = e^{-r\dot{\iota}} \left\{ \left[ S - \frac{K - W_0 e^{r\dot{\iota}}}{p} \right] p(E) - E \right\} \quad (4)$$

From (3)

$$\left( p + p' \frac{dE}{dD} D \right) dD = -r W_0 e^{r\dot{\iota}} d\dot{\iota} \quad (5)$$

and from (2),

$$p'' (S - D) dE - p' dD = 0 \quad (6)$$

so

$$\frac{dD}{d\dot{\iota}} = \frac{-r e^{-r\dot{\iota}} W_0}{\left( p + p' \frac{dE}{dD} D \right)} = \frac{-r W_0 e^{r\dot{\iota}}}{p + \frac{D p'^2}{p'' (S - D)}} \quad (7)$$

Making use of (7) and (4)

$$\frac{dU}{d\dot{z}} = -re^{-r\dot{z}} [(S - D)p - E] + \frac{e^{-r\dot{z}} r W_0 e^{r\dot{z}} p}{p + \frac{Dp'^2}{p''(S-D)}} = \quad (8)$$

$$re^{-r\dot{z}} \left\{ \frac{W_0 e^{r\dot{z}} p}{p + \frac{Dp'^2}{p''(S-D)}} - [(S - D)p - E] \right\}$$

The bank's expected gross return is  $R = pD$  so

$$\frac{dR}{dD} = p + p' \frac{dE}{dD} D = p + \frac{p'^2 D}{p''(S - D)} \quad (9)$$

From (9), when the bank is close to the turning point of its returns function ( so  $\frac{dR}{dD}$  is close to zero)  $\frac{dU}{d\dot{z}}$  tends to plus infinity. That is, if the entrepreneur is offered a loan at the credit-rationing interest rate, it is optimal to reject it and postpone starting the project. Doing so allows extra wealth to be accumulated, shrinking the required loan and more than proportionately lowering the debt repayment. It follows that there cannot be a credit-rationing equilibrium.<sup>7</sup> The key to our result is that if a bank is at the turning point of its return function, as

<sup>7</sup> If effort is a discrete variable, the marginal cost of funds is finite and constant for some finite decreases in borrowing, so credit rationing is possible if the interval to the next step is large. Continuity seems though a reasonable approximation in most cases..

is required for credit rationing, the borrower's marginal cost of funds is infinite. It is therefore worth the borrower incurring any finite cost to reduce the required loan size.

The question now arises as to what equilibrium does emerge. In particular, just how long should an entrepreneur wait until he starts his project? We already know that the delay must be at least long enough to fund the project with no prospect of rationing. The trade-off is straightforward. A smaller loan lowers the deadweight cost of the moral hazard induced by the fixed repayment. Under competitive conditions, this cost is ultimately borne by the borrower. This then is the gain to waiting. The cost of delay is that the project is profitable even when moral hazard is high, so other things equal, postponement lowers entrepreneur's NPV. The optimal starting date is determined by equating (8) to zero. The solution must involve less than complete self-financing ( $p' > 0$  and  $D > 0$ ) but a starting date sufficiently distant to avoid rationing.

It is plausible that some investments deteriorate if deferred for too

long. The result is robust to the introduction of temporal decay in project returns. The previous analysis can be modified to make  $S$  a decreasing function of time. It is then straightforward to establish that, unless  $S'(\delta)$  is minus infinity, our principal findings are retained. It is interesting to note though that this formulation implies that the value of initial assets may determine whether an entrepreneur ever proceeds with the project. Suppose that a project is positive NPV if undertaken by a self-financed entrepreneur. Were the same project available to an entrepreneur with insufficient assets to self-finance, the loan required to allow immediate commencement involves a repayment so high that the deadweight cost renders it negative NPV. Delay brings down the deadweight cost involved, but causes the intrinsic value of the project to decline even more rapidly. Hence, the poor entrepreneur does not proceed and is, in effect, redlined.

### 3. Hidden Types

Saving opportunities also preclude the emergence of credit rationing in the presence of hidden types. In their formulation, SW assume that all projects have the same expected return but differ in risk (a mean-preserving spread). That is, the return to the project of entrepreneur  $i$  is  $S_i$  in the event of success, which occurs with probability  $p_i$ , or else the return is zero. If entrepreneurs differ by mean-preserving spreads

$$Z = p_i S_i \quad (10)$$

To proceed a project requires input of funds  $K > Z$ : Were type public information, the repayment would be project specific but all would be undertaken and would be implemented immediately. What we investigate is whether this occurs when project risk is the private information of the entrepreneur.

The game is that the uninformed banks move first, specifying the size of the loan, the interest rate and the start date.<sup>8</sup> Then entrepreneurs decide whether to proceed and if so, choose the contract they prefer. If an entrepreneur decides to postpone the project, during the interval they save at the safe interest rate to reduce the necessary loan. The contrast with SW is that they construct a pooling equilibrium assuming that there is no discretion over starting date. Our contribution is to show that once the start date is endogenized, pooling is impossible but a separating equilibrium can arise.

In outline, the model implies that entrepreneurs' indifference curves in  $(D; t)$  space satisfy the single-crossing property. The expected return to an entrepreneur borrowing  $K - W_0 e^{rt}$  at time  $t$  and promising to repay  $D$  if solvent is given by

$$U = e^{-rt} [S_i - D] p_i \quad (11)$$

Holding utility fixed, it follows that

$$\frac{dD}{dt} = -r(S_i - D) \quad (12)$$

<sup>8</sup>Because of competition, it makes no substantial difference if banks cannot commit to future terms.



Indifference curves are thus convex and are steeper for high-risk types than for low-risk types, labelled respectively  $I_H$ ;  $I_L$  in the Figure. In equilibrium, loans satisfy the banks zero-profit constraint

$$\hat{p}D + (1 - \hat{p})F = K - W_0 e^{r\lambda}; \quad (13)$$

where  $\hat{p}$  is the expected default rate on the particular offer made. From (13), the slope of the bank's offer curve is

$$\frac{dD}{d\lambda} = -\frac{rW_0 e^{r\lambda}}{\hat{p}} \quad (14)$$

In the Figure, the broken convex curves  $B_H$ ,  $B_L$  and  $B_P$  denote the offer curves for high risks, low risks and full-pooling offers respectively. Since the indifference curves cross, an interior pooling equilibrium is impossible for standard reasons. Even a corner pooling equilibrium, in which all types of entrepreneur start at the first possible moment, is ruled out. This is because a slightly smaller loan, which requires a short delay before the project commences, could be charged an interest rate at which only low-risk types apply.

The Figure shows a separating equilibrium in which high-risk types take immediate finance whilst low-risk entrepreneurs delay to get a

lower rate of interest. The mechanics of such an equilibrium are well known and it exists whenever high risks are sufficiently numerous in the population that, for the low-risk types, pooling with  $\zeta = 0$  does not dominate the least-cost separating payoff.<sup>9</sup> Note that as the uninformed types move first in this model, the issue of out-of-equilibrium beliefs is not relevant.

### Figure 1

In the adverse selection context, credit rationing requires that there is a pooling equilibrium from which the safest types exit as interest rates rise. By showing that there is no pooling equilibrium when start date is endogenized, it follows that credit rationing cannot be precluded.

If a separating equilibrium emerges in which entrepreneurs differ by mean-preserving spreads, even though credit rationing is avoided, underinvestment is present in that the low-risk types delay entry relative to the full-information case.

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<sup>9</sup>Here, start date plays a similar role to collateral in Bester (1987). In Bester low-risk types must be endowed with enough collateral to achieve separation. However, in our model entrepreneurs can always accumulate enough capital to achieve separation.

Under different assumptions, hidden types give rise to overinvestment rather than to underinvestment. If entrepreneurs differ in intrinsic quality rather than risk, then, when the other assumptions of SW are retained and start date is endogenous, de Meza and Webb (1987) showed that more entrepreneurs are financed than under public information. The presence in a pooling equilibrium of high-quality entrepreneurs with low default probabilities provides a cross subsidy to low-quality types in the form of interest rates lower than would be actuarially fair for their characteristics. The consequence is that some low-quality types are induced to borrow, though were they to pay the interest rate appropriate to their type, they would choose to be inactive.

When saving opportunities are introduced to this model, the overinvestment equilibrium continues to apply. A simple formulation is to suppose that all entrepreneurs have the same payoff,  $S$ , in the event of success but can be ranked by the probability of success,  $p_i$ . The

expected utility of an entrepreneur is thus

$$U_i = p_i(S - D)e^{-r\zeta} \quad (15)$$

so, as before, the slope of the entrepreneur's indifference curve is

$$\frac{dD}{d\zeta} = -r(S - D) \quad (16)$$

As the indifference curves of all entrepreneurs have the same slope, pooling is sustainable. All entrepreneurs commencing without delay, including some with negative present value projects, is an equilibrium. A bank deviating by offering a loan starting later on terms that attract any entrepreneur, would attract all entrepreneurs. Since delay is inefficient, a bank deviating from a zero expected profit offer can only attract custom by violating the breakeven constraint.<sup>10</sup> Similarly, pooling with a delayed start is always broken by a deviant offering immediate finance, so the equilibrium is unique.

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<sup>10</sup>Note that this result is strengthened if there are three or more states. Were there two solvent states with the distribution of the better entrepreneur bearing a relation of first-order stochastic dominance to that of the worse, then the better entrepreneur is strictly more willing than worse to pay a higher  $D$  to advance the start date. This augments the force making for a pooling equilibrium in which all proceed to borrow as soon as possible.

#### 4. Conclusion

We have shown that the SW credit-rationing result depends on the assumption that the wealth of individual entrepreneurs is fixed and there is no discretion over when they start their project. Since these are very restrictive conditions, there is little reason to think that random rationing will be observed in practice and, as far as we know, it never has been. Under both hidden action and hidden types, it is though quite possible that entrepreneurs with low net worth begin their projects later than if they had greater wealth endowment, and possibly never undertake them at all. There is plenty of empirical evidence to this effect (e.g. Blanchflower and Oswald (1999), Holzh-Eakin and Rosen (1994)). Delays can be regarded as a form of credit rationing and to that extent, our results are not destructive of the underlying concept. It is the pure form involving random rationing that is analytically impossible. Saving opportunities are though consistent with overinvestment. If entrepreneurs' return distributions are private information, but can be ranked by first-order stochastic dominance,

there is no commencement delay and there is excessive participation.

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