UCD Department of Agricultural Economics

WORKING PAPER SERIES

University of California, Davis
Department of Agricultural Economics

ASYMMETRIC INFORMATION AND THE ENTREPRENEURIAL FIRM: CAPITAL STRUCTURE, INVESTMENT AND GOVERNMENT INTERVENTION

by

Robert Innes

Working Paper No. 87-10

Paper presented at the University of Chicago
Dept. of Ag Econ workshop, Oct. '87

ASYMMETRIC INFORMATION AND THE ENTREPRENEURIAL FIRM: CAPITAL STRUCTURE, INVESTMENT AND GOVERNMENT INTERVENTION

I. INTRODUCTION

This paper examines the characteristics of entrepreneurial firms' capital structure and investment choices in a market in which the owner-operators require external funds and are endowed with better information about the quality of their return distributions than are external financiers. The choice problems facing entrepreneurs are characterized by quality-dependent incentives and, thus, permit both self-selection and adverse selection behavior. In deducing the properties of the informational equilibrium, this analysis finds an explanation for these firms' predominant use of debt (rather than equity) instruments to raise investment funds. It then identifies inefficiencies in this equilibrium and shows that, despite a lack of any informational advantage, government can often intervene to improve social welfare. This intervention takes a form which is frequently observed in practice, namely, debt subsidies.

The importance of asymmetric information for market efficiency and for firms' capital structure choices have been noted in several recent papers.[1] However, a number of features of the entrepreneurial firm's capital structure and investment choice problem distinguish it from this other research, including: the entrepreneur's role as both manager and residual claimant (making a Ross (1977, 1978) incentive-signaling mechanism infeasible), his exposure to firm-specific risk (in contrast to Myers and Majluf (1984)), default risk (contrary to sharecropping research), and, most important, a central role for variable investment. The nature of the informational asymmetry posited here is also fundamentally different from that in the recent Gale and Hellwig (1985) and Williamson (1987) analyses of financial contracting; there, asymmetries in the ability to observe ex post profits drive the models, whereas here the informational asymmetry is ex ante in nature, relating to parameters of the profit distribution. Thus fitting best in the adverse selection literature, this paper explores the nature of prospective policy remedies to inefficiencies in screening equilibria, finding implications which have generally escaped academic notice despite the well-known suboptimality of signaling behavior.

These subjects are important for understanding the behavior of small firms, the genesis of their financial troubles and the implications for governmental intervention in related markets. As a sector characterized by predominance of entrepreneurial firms, debt financing and extensive government involvement in credit provision, agriculture is an important case in point.

Generically, asymmetric information implies that low quality agents have an opportunity to disguise their status by behaving as high quality agents. However, since a given contract structure will give different payoffs to different quality types, choice of contract can sometimes serve as a signal of an agent's status. This "signaling" or "self-selection" process generally imposes a cost on high quality agents vis-a-vis the full information case. If this cost is sufficiently high, contract choice will not be capable of signaling quality. In the terminology of the literature, a pooling equilibrium will then emerge and not a separating equilibrium.

Here, both the payoff mechanism specified for external investors (i.e., the debt-equity mix) and the extent of external investment (i.e., the scale of the firm) are contract features which give differential payoffs to different quality types and, in principle, permit self-selection. At the outset (Section III), the following analysis holds the investment level fixed and deduces the properties of the resulting capital structure equilibrium (i.e., the equilibrium set of debt-equity contracts). In particular, if entrepreneurs and investors are risk neutral, a single contract (pooling) equilibrium is shown to emerge, with the equilibrium contract characterized by all debt and no equity.[2] With risk averse entrepreneurs, a pooling equilibrium with all debt can also emerge, as can a variety of other equilibrium types depending upon the economic structure.

Building upon the fixed investments analysis, a variable investment structure is examined in Section IV. Focusing on the case of risk neutral entrepreneurs, all-debt financing is shown to persist in this setting and efficiency issues are explored. Remarkably, the policy conclusions reached here (that debt subsidies can be optimal) are the same as derived recently by Gregory Mankiw (1986). However, the reasons for policy benefits are entirely different. In Mankiw's model, both the informational asymmetry and debt financing are immutable. Benefits of intervention result from a divergence between the bank's return on a loan (which is truncated) and the social return on a loan (which is not); this divergence implies that banks are concerned with certain unknown risk parameters which the government is not, implying differences in optimal decisions. Here, both information and capital structure are endogenous; policy benefits are attributable to their effect on the screening process--that is, on the informational equilibrium. Specifically, debt subsidies to low quality firms reduce their incentive to disguise themselves as high quality firms and thereby permit sorting at efficient investment levels.

These results contradict a conventional view that government lending programs lead to overinvestment.[3] Here, when the free market equilibrium is pooling, subsidized lending leads to a lower, efficient investment level for low quality entrepreneurs and a higher, efficient level for high quality entrepreneurs. When the market equilibrium is separating, subsidized lending can lead to a lower, efficient investment level for high quality entrepreneurs.

The final section of this paper discusses extensions of the analysis to other screening problems, including those found in models of labor, insurance, and product markets. It also examines the implications of an alternative quality definition for present findings, suggesting an explanation for the simultaneous observation of equity predominance in venture capital investments and debt predominance in other small business firms.

What follows next (Section II) is a detailed description of the model. To highlight the agricultural application, entrepreneurs are now called farmers.

II. THE MODEL

A. Farmers

Suppose there is a population of farmers with heterogeneous endowments of quality, q. Each farmer knows his own quality but other do not. Further, each produces a stochastic end-of-period net worth (also called profit) $\pi = \pi(q,A,\theta)$, where A denotes the initial asset value of the farm and θ is a random variable. Higher quality levels give rise to "better" net worth distributions in the sense of first order stochastic dominance; equivalently, with F denoting the induced distribution function of $\pi, \partial F(\pi;q,A)/\partial q \leqslant 0$ for all π, with strict inequality holding for some π. Assets, A, are financed by external funds equal to I dollars and a given amount, (A-I), of the farmer's initial wealth. Without loss of generality, each member of the population is assumed to commit a common amount of his own funds to the farm, thereby avoiding collateral issues.[4] Further, to abstract from portfolio considerations, all remaining wealth is assumed to be invested in a fixed portfolio with returns independent of θ (such as a risk-free bond or an independent market asset).[5]

Facing limited state contingent trading opportunities, farmers must raise external funds with debt and/or equity instruments.[6] $\beta \epsilon [0,1]$ is the proportion of I raised with debt. Debt entitles a financier to the minimum of the net worth of the farm and a promised fixed payment, $z \equiv (1+r)\beta I$, where r is the interest rate charged. With equity, the financier invests $(1-\beta)I$ in exchange for a given share, α, of net worth after debt payments.

Farmers are also assumed to obey the Von Neumann-Morgenstern axioms and to have state-independent ex-post utility functions defined on net worth. Thus, the welfare of a farmer with quality q is measured by the following expression:

$$\begin{aligned} W(z,\alpha;q,A) &= E_{y,\theta}(V^*(y+\max(0,(1-\alpha)(\pi(q,A,\theta)-z)))) \\ &= E_\theta\{E_{y;\theta}V^*(y+\max(0,(1-\alpha)(\pi(q,A,\theta)-z)))\} \qquad (1) \\ &= E_\theta V(\max(0,(1-\alpha)(\pi(q,A,\theta)-z))) \end{aligned}$$

where y denotes the return on the nonfarm portfolio, $E_{x;w}$ = expectation operator over x, given w, the last equality is implied by independence of y and π, and V* is weakly concave (implying that V is also weakly concave).

B. Investors

Though investors are ignorant of any particular farmer's quality, they are assumed to know the structure of the system. In other words, they are aware of the choice problem which faces a farmer of quality q, the distribution of qualities in the population, and the set of contracts available in the market. If different quality types choose different financial contracts, investors will be able to infer quality from this choice; otherwise, the quality of an applicant farmer will be treated as a random variable with its known distribution.

For simplicity, investors are assumed to behave as if they are risk neutral.[7] Risk neutral attitudes imply that expected returns in excess of the risk-free rate ρ measure investor welfare.

They are also assumed to be quasi-competitive in the following sense: due to free entry, investors will offer any set of contracts which is expected to yield non-negative mean profit (i.e., expected returns not less than ρ); however, in contrast to Rothschild and Stiglitz (RS, 1976) price-quantity competition, they are permitted to have nonstatic (i.e., non-Nash) response expectations. As in RS, investors do not only compete over a single attribute, price, but rather over multiple attributes, which here include the fixed payment (z), the external equity share (α) and the investment level (I). Unlike in RS, when investors consider making a new set of contract offers, they do not always assume that competitors will do nothing in response. Response expectations will be allowed to take a particular nonstatic form; specifically, competitors will be expected to respond to a new offer according to the following rules of thumb, which will be called <u>Wilson responses</u> (after Wilson (1977)): (i) withdraw all contract offers that were in their original menu but become unprofitable in the presence of the new offers, and (ii) expand their contract menu to include any contracts in the new set of offers which are profitable after the withdrawal described in (i).[8] To illustrate (i), suppose that a "renegade" investor's new offer attracts high quality farmers away from another contract which becomes ridden with only low quality types; the renegade will then anticipate the withdrawal of the latter contract and will expect the prospective new offer to be burdened with low quality takers. Given that investors can freely enter the market, the second response implies that any set of renegade offers which contains individual losers will be expected to be a loser in aggregate; other investors will be expected to soak up the cream and leave the renegade with the negative expected profit contract.

C. Definition of Equilibrium

Strategic behavior is important to the present analysis because of the well-known existence problems associated with Nash equilibria in models of adverse selection.[9] To avoid these problems, several authors (including Wilson (1977); Miyazaki (1977); and Grossman (1979)) posit the above Wilson response expectations and prove that these expectations imply equilibrium existence, where an equilibrium is defined to have the following property:

> Property I: Given response expectations, no investor will want to offer a nonequilibrium set of contracts in the presence of the equilibrium set.

For this analysis, equilibrium will also be required to have a second property:

> Property II: The equilibrium set of contracts survives anticipated responses.

Property II reflects a process of equilibrium determination by contract proposal; like any new offer, an equilibrium must be proposed and must earn non-negative expected profit when accompanied by anticipated responses.

The two sets of response expectations discussed here (i.e., Nash and Wilson) give rise to two equilibrium definitions which embody these properties and which will provide the focus of attention in the following analysis:[10]

(1) Nash Equilibrium (E1): A set of contract offers will be called an E1 equilibrium if (a) all contracts in the set earn investors non-negative expected profits, and (b) there is no other set of policies which, when offered in addition to the equilibrium set, earn positive expected profits in the aggregate.

(2) Wilson Equilibrium (E2): A set of contract offers will be called an E2 equilibrium if (a) all contracts in the set earn investors non-negative expected profits, and (b) there is no other set of contracts which, when offered in addition to the equilibrium set, earn positive expected profits in the aggregate and non-negative expected profits individually, after the unprofitable contracts in the original set have been withdrawn.[11]

III. FIXED INVESTMENT CAPITAL STRUCTURE EQUILIBRIUM

In this section, investment will be held fixed at a common level and the characteristics of the financial structure equilibrium examined with the aid of two graphical concepts (see Figure 1): (i) farmer _indifference curves_, and (ii) investor _offer curves_.

An investor offer curve is a set of (z,α) contracts which give investors just their required expected return ρ. If the investor knows the quality of applicant farmers, his set of offers (the _separating_ offer curve) will be different for different farmers. In particular, a higher quality farmer will be offered better terms, implying a lower offer curve. If the investor does not observe the quality of applicant farmers, his set of offers (the pooling offer curve) will lie somewhere between the separating offer curves.

A farmer indifference curve is a set of (z,α) contracts yielding payoff distributions that give the farmer a common utility level. Lower indifference curves will be associated with higher utility levels (and vice versa); given α, a lower z gives the farmer a first order stochastically dominant profit distribution. A particularly important indifference curve for this analysis will be the pooling indifference curve for a quality q farmer, that which contains the pooling offer curve's z-intercept.

These concepts are formally defined in the following equations:

Quality q Farmer Indifference Curve (IC_q)

$$\int_z^\infty V((1-\alpha)(\pi-z))f(\pi;q)d\pi = \bar{V} \tag{2}$$

where f denotes the density function of farm net worth and $\bar{V}$ is an arbitrary utility level.

Quality q Separating Offer Curve (OC_q)

$$\alpha\int_z^\infty(\pi-z)f(\pi;q)d\pi + \int_0^z \pi f(\pi;q)d\pi + z(1-F(z;q)) \equiv R(z,\alpha;q) = (1+\rho)I \tag{3}$$

where the first term is the return to external equity and the second two terms are the return to debt, the sum of which must equal the opportunity cost of funds.

Pooling Offer Curve (OC_P)

$$\sum_q R(z,\alpha;q)g(q) = (1+\rho)I \tag{4}$$

where g(q) is the relative frequency of quality q in the population of applicant farmers.

Differentiating these expressions will help determine the relationships between these curves:

$$[dz/d\alpha]_{IC_q} = \frac{-1}{(1-\alpha)^2}\{E_{\pi>z}(\pi^*;q) + \frac{Cov_{\pi>z}(V',\pi^*;q)}{E_{\pi>z}(V';q)}\} \tag{5}$$

where $E_{\pi>z}$ and $COV_{\pi>z}$ are the conditional expectation and covariance operators over net worth states of nature, conditioned on the subscript, and $\pi^* \equiv (1-\alpha)(\pi-z)$.

$$[dz/d\alpha]_{OC_q} = \frac{-1}{(1-\alpha)^2} E_{\pi>z}(\pi^*;q) \tag{6}$$

$$[dz/d\alpha]_{OC_P} = \frac{-1}{(1-\alpha)^2} \sum_q h(q)E_{\pi>z}(\pi^*;q) \tag{7}$$

where

$$h(q) \equiv \frac{(1-F(z;q))g(q)}{\sum_q (1-F(z;q))g(q)}$$

Equations (3), (5), and (6) describe quality-specific payoff tradeoffs for farmers and investors. As is common in the self-selection literature, some correlation between these payoffs and quality is required for any analytically useful implications. Here, this correlation is established by: (1) noting the following implication of the first order stochastic dominance characterization of quality differences (see Appendix A for a proof):

$$\frac{\partial E_{\pi>z}(\pi^*;q)}{\partial q} > 0 \text{ for all } z \tag{8}$$

and (2) assuming that, for a given promised debt payment, high quality farmers have strictly lower default risk; formally, with lower default risk defined in terms of first order stochastic dominance of the debt payoffs:

$$\int_0^z \frac{\partial F(\pi;q)}{\partial q} d\pi < 0 \text{ for all relevant } z \tag{9}$$

With this structure, equilibrium properties can be examined for two farmer preference cases: risk neutrality and risk aversion.

Risk Neutral Farmers

When farmers are risk neutral, the covariance term in (5) is always zero, which implies:

(i) every quality q indifference curve is a quality q iso-expected-profit line for the investor; in particular, one of these indifference curves is the separating offer curve;

(ii) since conditional expected farmer profit, $E_{\pi>z}(\pi^*;q)$, is increasing in quality (equation (8)), the pooling indifference curves will be lower for higher qualities; moreover, for the highest and lowest qualities, these curves will lie, respectively, below and above the pooling offer curve (except at their intersection on the z axis); and

(iii) since the z-intercepts of the highest and lowest quality separating offer curves are different (equation (9)), the pooling indifference curves for these qualities will lie between the pooling and separating offer curves.

These observations give rise to the structure depicted in Figure 1. Here, the pooling, all debt, zero-expected-investor-profit contract e is the unique E1 and E2 equilibrium. (For a formal statement and proof of this result, see Appendix B.) To convince yourself that e is indeed the equilibrium, consider a two-quality economy; "renegade" contract offers could occur in any of three regions: (1) below IC_H, (2) between IC_H and IC_L, and (3) above IC_L. All farmers prefer contracts in region (1) to e; thus, since this region is below OC_P, any contract here will be unprofitable. Only low quality farmers will choose a contract in region (2); thus, since this region is below OC_L, any contract here will also be unprofitable to investors. Finally, no farmer will demand a contract in region (3).

Existence of an all debt pooling equilibrium contradicts findings in two strands of the asymmetric information literature. On the one hand, Rothschild and Stiglitz (1976), Wilson (1977) and others have shown that a pooling E1 equilibrium does not exist in the insurance problem.[12] On the other, Hallagan (1978) and Newbery and Stiglitz (1979) have found that a separating equilibrium exists in the context of the farm landlord-tenant problem. Divergence between present findings and the latter results can be attributed to the non-negativity constraint on α, risk neutrality and default risk.[13]

Rothschild and Stiglitz argue that a pooling E1 equilibrium can always be broken due to the difference between indifference curve slopes for different quality customers (farmers); a contract can be offered which is preferred by the higher quality customers but not by those of lower quality. As shown in Figure 2, this logic is only valid in the present setting if α can be negative.[14]

Hallagan and Newbery and Stiglitz argue that low quality farmers will choose share (equity) contracts while high quality farmers will choose rent (debt) contracts, thereby signaling quality. However, neither of these papers permits default or accounts explicitly for the role of risk aversion. To understand the implications of these conditions, consider the case of two quality types in which neither risk neutrality nor differential default risks pertain. This case is depicted in Figure 3. From equation (5), risk aversion implies that the indifference curves are less steep than the associated separating offer curves. Further, equivalent default risks imply that all the indifference curves intersect on the z axis. Clearly, the equilibrium here is separating contracts e_H and e_L.[15]

Risk Averse Farmers

It was already clear from Figure 3 that the unambiguous results of the risk neutral economy will not carry over to the case of farmer risk aversion. To elicit qualitative properties of equilibrium structure in this setting, a further simplifying assumption will be made: that there are only two quality types in the applicant population. For this case, it is well known that any equilibrium maximizes the utility of the high quality individual subject to the self-selection constraint of the low quality farmer and the investor non-negative expected profit condition (see Figure 4). As with similar models, it can also be shown that an E1 (Nash) equilibrium need not exist and that an E2 (Wilson) equilibrium exists, though it need not be unique.[16]

These observations permit graphical examination of equilibrium structure. Though a wide range of economic configurations are possible with farmer risk aversion, space constraints will restrict our examination to two particularly interesting examples.

Figure 5 presents a specific numerical example which belongs to a curious class of separating equilibrium cases.[17] Generically, these cases are characterized by a crossing of the low quality farmer's pooling indifference curve, IC^P_L (not drawn), and his separating offer curve, OC_L. This crossing may be attributed to a high degree of low quality farmer risk aversion and/or a high proportion of low quality farmers in the population. Further, the high quality farmer's pooling indifference curve, IC^P_H, remains below OC_P due to a relatively low degree of risk aversion and/or a relatively large discrepancy between the conditional expected profits of the two quality types. That the contract pair (e_H, e_L) is an E2 equilibrium in this setting is easily verified by checking that a "renegade" contract offer in any of the following three regions will be unprofitable: (1) below IC_H, (2) between IC_H and IC_L, and (3) above IC_L.

This example is particularly interesting because it implies positive investor profits at the E2 equilibrium, despite the lack of any investor market power. In a competitive environment, these profits will likely be eroded by unproductive efforts to attract farmer applicants (e.g., by advertising expenditures), much as government-generated rents can be eroded by rent-seeking expenditures (Krueger (1974)). The policy implications of this case are obvious. Consider the break-even contract pair (e_H^*, e_L^*); government could tax investors who offer the contract e_H^* and subsidize investors who offer e_L^* such that they earn zero expected profits on each contract, and, hence, the contract pair is a post-intervention equilibrium. Since the pair breaks even, the government program will be self-financing. Moreover, since aggregate expected farm profits are the same with and without government intervention, while investor "rent-seeking" expenditures are eliminated by intervention, farmers can compensate investors such that all agents are made better off by the government program.[18]

Figure 6 depicts an example in which an all debt pooling equilibrium emerges. As in the risk neutral case, each quality's pooling indifference curve lies between its separating offer curve and the pooling offer curve. One set of circumstances which will lead to this outcome is:

(a) approximately equal population proportions of the two quality types, and

(b) relative to the degree of risk aversion, substantial divergence between the two quality type's conditional expected profit levels. Here, strict risk aversion implies that an E1 equilibrium does not exist. With risk aversion, the bank's low quality farmer iso-expected-profit line through e is steeper than IC_L. Hence, there are all equity contracts which low quality farmers prefer to e and which still earn banks higher expected profits than they earn on low quality farmers who take contract e. Contract pairs such as (e_H^*, e_L^*) can therefore break any proposed E1 equilibrium, suggesting the same policy prescription as for the Figure 5 case. Government can tax investors who offer e_H^*, the high quality all debt contract, and subsidize investors who offer e_L^*, the low quality all equity contract, such that all farmers are made better off at no cost to investors or taxpayers.[19]

IV. INVESTMENT, CREDIT RATIONING, MONEY PUSHING, AND FARM DEBT POLICY

In this section, investment is permitted to vary.[20] Given that different quality types will have different relations between investment and net worth, it is not surprising that choice of this "input" may serve as a quality-differentiator under certain circumstances, much as plot size and work intensity serve as indicators in sharecropping (e.g., Newbery and Stiglitz (1979) and rat-race (e.g., Akerlof (1976), Miyazaki (1977)) models. The objective of the following discussion is to shed some light on conditions under which this outcome may or may not occur, on qualitative features of the investment-financial contract equilibrium, and on the policy implications of such an equilibrium. For the sake of simplicity, I focus on the two-quality case with risk neutral farmers.

Risk Neutral Farmers

The preceding section showed that, given I, there will be an all debt pooling equilibrium when farmers are risk neutral. Hence, if the investment/capital structure equilibrium is pooling (implying a given I common to all farmers), the equilibrium will be characterized by all debt financing. With respect to a separating case, note that risk neutral farmers are indifferent between alternate capital structure choices when their qualities are known to investors.[21] In addition, a given quality farmer will always prefer the all-equity point among offers on a higher quality's separating offer curve (Figure 1). These observations imply that a high quality farmer's choice of all debt will costlessly reduce his cost of investment signaling. Thus, any separating investment/capital structure equilibrium will also be characterized by all debt and the three dimensions of the problem can be reduced to two. More specifically, the diagram employed in Section III, which traded off z with α, can be replaced by a diagram which trades off z with I.

Figures 7-9 are examples of such a diagram, depicting three important cases. As before, equilibrium is determined by the configuration of offer curves and indifference curves with the property that high quality farmer utility is maximized subject to a low quality selection constraint and a non-negative investor profit condition. Formally, the curves are defined as follows:

$$IC_q: \quad \int_z^{\infty}(\pi - z)f(\pi;q,I)d\pi = \bar{V} \tag{2'}$$

$$OC_q: \quad \int_0^z \pi f(\pi;q,I)d\pi + z(1-F(z;q,I)) \equiv R(z,I;q) = (1+\rho)I \tag{3'}$$

$$OC_P: \quad \sum_q R(z,I;q)g(q) = (1+\rho)I \tag{4'}$$

Higher farmer indifference curves again correspond to lower farmer utility levels; given z, farmers are always better off with more I. Unfortunately, several other characteristics of these curves are analytically ambiguous. However, there is intuitive basis for the following properties:

(i) concave indifference curves with positive slope;

(ii) weakly convex offer curves with positive slope; and

(iii) indifference curve slopes which are positively related to quality.

Positive slopes are a consequence of positive marginal investment returns and higher investor-required gross returns.[22] The convexity/concavity properties of the curves, though analytically uncertain, are to be expected because declining marginal investment returns imply that (i) as investment rises, farmers can give up a smaller increment in expected profit cost to preserve their utility, and (ii) given well-behaved investment-net worth relations, marginal expected default costs rise with investment.[23] Notably, these second derivative characteristics are unnecessary for deducing the efficiency properties of equilibrium. In contrast, the positive relation between indifference curve slopes and quality establishes a needed correlation between payoffs and quality. Assumption of this positive relation can be justified by the following argument: Higher quality implies higher marginal benefits of investment. Hence, for a given change in investment, higher quality farmers will be willing to give up a higher increment in expected profit cost to preserve their utility. Higher quality farmers will also be willing to give up a higher increment in <u>fixed payment</u> if differences in marginal investment benefits (positively related to quality) are sufficiently large relative to differences in $\partial E\pi_q^*/\partial z$, the tradeoff between expected profit cost and fixed payment (negatively related to quality due to differential default risks).

Incorporating these properties, Figures 7-9 depict three equilibrium types: pooling (Figure 7), suboptimal separating (Figure 8), and optimal separating (Figure 9). Graphically, it is clear that a Figure 7 case is favored when (i) the separating offer curves, OC_L and OC_H, are far apart, (ii) the indifference maps of high and low quality types are similar, and (iii) the pooling offer curve, OC_P, is close to OC_H. The first condition is implied by large inter-quality differences in default risks. The second is implied by inter-quality differences in marginal investment returns which offset differential default risks to produce similar investment-promised payment tradeoffs. Finally, the third condition is implied by a small proportion of low quality farmers in the applicant population. Likewise, a Figure 9 case is favored by small inter-quality differences in default risks and large differences in marginal investment returns. A Figure 8 case is favored by intermediate conditions.

With respect to equilibrium properties, the pooling equilibrium of Figure 7, e, has the following notable features:

(1) e is an equilibrium of the E2 (Wilson) type, but not of the E1 (Nash) type. To see this, consider any contract offer between IC_H and IC_L, above OC_H, and to the right of e (e.g., $\bar{e}$); high quality farmers prefer this contract, while low quality farmers do not, implying that it will be profitable in the presence of e and will break the equilibrium in a Nash sense.[24,25] Since e becomes unprofitable with the new offer, Wilson responses imply that it will be withdrawn, burdening the new offer with low quality takers and

thereby making it unprofitable; thus, e is not broken in a Wilson sense.

(2) High quality farmers under-invest relative to the "first-best" optimum (e_H^*, e_L^*), while low quality farmers over-invest.

(3) If "credit rationing" is defined in the classical way as an excess borrower demand for loan funds at the going interest rate,[26] then high quality farmers are credit rationed in equilibrium due to the convexity of the offer curve; graphically, the tangency between a high quality farmer indifference curve and the "going interest rate" line (i.e., the broken line through e) occurs above e. If "money pushing" is defined analogously, low quality farmers may be either money-pushed or credit rationed at e; as depicted, they are money-pushed.

The suboptimal separating equilibrium of Figure 8 (e_H, e_L), is analogous to outcomes in the rat-race literature; high quality farmers over-invest in order to distinguish themselves from low quality farmers. The equilibrium is clearly of the E2 type; since there may not be a break-even separating pair, (e_H^*, e_L^*) where e_L^* loses money and e_H^* earns positive expected profits, the equilibrium may also be of the E1 type. Further, as depicted, the high quality farmer is money-pushed; if the offer curves were strictly convex, low quality farmers would be credit rationed and high quality farmers would be money-pushed, credit rationed, or neither.

Lastly is Figure 9, in which the separating equilibrium is of the E1 and E2 types. If the offer curves were strictly convex, both farmer types would be credit rationed in this case.

Policy Implications

Given the suboptimality of equilibrium in two of the three cases depicted above, prospects for policy-induced improvement merit attention. At the outset, consider the following policy proposal: Let the government offer a contract $e_L^* \equiv (I_L^*, z_L^*)$ which satisfies the following two conditions: (1) I_L^* is the first best investment level for low quality farmers, and (2) low quality farmers are just indifferent between e_L^* and the first best high quality farmer contract e_H^*. This contract pair is depicted in Figure 10. It is immediately clear that (e_L^*, e_H^*) will be the separating equilibrium contracts in the presence of this policy. Hence, the policy achieves "efficient" investment choices in the sense that aggregate expected net farm profits are maximized. The latter attribute will be called ex-post optimality, with optimality implicitly based on a willingness to pay (or potential compensation) criterion.

The importance of the label "ex-post" is evident from the observation that the subsidized debt contract, e_L^*, must be financed by "expected taxes" on some agents. If the welfare criterion for policy evaluation is the Hicks compensation standard, then the appropriate question to ask is: Can a compensation/tax program be constructed such that, with the policy and compensation, all agents are at least as well off as before and some agent is strictly better off? If the answer is yes, the policy is ex-ante welfare improving. Unfortunately, it is not a priori evident that the subsidized debt program satisfies this criterion. For example, suppose that a large proportion of the farmer population is low quality and that high quality farmer gains from the policy (without taxes) are not very large. Since taxes on high quality agents are constrained by the requirement that the farmers' pre-policy utilities be preserved, they cannot be very high. Moreover, taxes on low quality agents are constrained to be incentive-compatible; that is, they cannot be so high that low quality agents would prefer to masquerade as high quality farmers. Thus, with a high proportion of low quality types and an associated high program cost, utility-preserving and incentive-compatible taxes will not be able to finance the debt subsidy policy. While leading to a Pareto optimum ex-post, the policy will not be ex-ante welfare improving.[27]

To investigate the prospective conflict between ex-ante and ex-post welfare criteria further, the permissable taxation mechanism must first be specified. In order to prevent government from implicitly issuing contractual forms forbidden, by assumption, for private agents, taxes must take the form of debt which is subordinate to contract debt. In other words, a farmer simply faces a higher z with taxes than without.

With this taxation mechanism, we can test for ex-ante optimality of the debt subsidy policy by maximizing expected tax revenues subject to utility preservation and incentive compatibility constraints, and then comparing the maximal expected tax with expected program costs.

For the Figure 7 (pooling) case, note that z's on the high and low quality indifference curves through e, at the respective first-best investment optima, are incentive-feasible; that is, neither quality prefers the other's contract to their own (see Figure 11). Moreover, with these contracts, both farmers receive the same expected profit as at e, but total profit has risen. Thus, expected tax revenues are greater than program costs and the debt subsidy policy is ex-ante optimal.

For the Figure 8 case (separating), note that higher high quality farmer taxes (or, equivalently, higher z) will permit higher low quality farmer taxes by relaxing the incentive compatibility constraint. Thus, the first step is to maximize the high quality farmer z subject to utility preservation; this maximal z will be denoted $\bar{z}_H$ (see Figure 12). The second step is to find the associated maximal low quality z, $\bar{z}_L$, consistent with the self-selection constraint.

Formally, let $\bar{\pi}_q^*(e)$ represent expected net farmer profit (net of debt payments) for a farmer of quality q with contract e. Further, let $\bar{e}_H \equiv (I_H^*, \bar{z}_H)$ and $\bar{e}_L \equiv (I_L^*, \bar{z}_L^*)$ denote the post-policy contracts with maximal (utility-preserving and incentive-compatible) taxes and let $e_L^* \equiv (I_L^*, z_L^*)$ and $e_H^* \equiv (I_H^*, z_H^*)$ represent the first-best contracts. Then the net expected transfer from government to a low quality farmer will be $(\bar{\pi}_L^*(\bar{e}_L) - \bar{\pi}_L^*(e_L^*))$ and the tax on each high quality farmer will be $(\bar{\pi}_H^*(e_H^*) - \bar{\pi}_H^*(\bar{e}_H))$. If v is the proportion of low quality farmers in the population, the necessary and sufficient condition for ex-ante optimality can be stated as follows:

$$v(\bar{\pi}_L^*(\bar{e}_L) - \bar{\pi}_L^*(e_L^*)) \leqslant (1-v)(\bar{\pi}_H^*(e_H^*) - \bar{\pi}_H^*(\bar{e}_H)) \tag{10}$$

In the circumstances described earlier (i.e., high v and a low gain to high quality farmers from moving to the first best contract), (10) will be violated, confirming the above intuition. Nevertheless, there are a wide variety of circumstances for which (10) will be satisfied and, thus, the debt subsidy policy will be ex-ante optimal.

An Example

Given the important positive and policy implications of the Figure 7 and 8 cases, the following example is presented in order to demonstrate that they are non-vacuous and, hopefully, to shed some light on parametric determinants of the economic structures depicted in these Figures, as well as the circumstances under which the ex-ante optimality condition, (10), is or is not satisfied:

Suppose that there are two states of nature and that high quality farmers yield profits of $f(I)(1+q)$ in one state and $f(I)$ in the other, while low quality farmers yield profits of $f(I)$ in the good state and zero in the other. Let P denote the probability of the good state and v the proportion of low quality farmers. Further, assume $f'>0$, $f''<0$ and $f'>(1+\rho)/P$ for $I\epsilon[0,I^*]$, some $I^*>0$; the last property implies that low quality farmers can make positive profits in a separating equilibrium. Finally, and without loss of generality, consider contracts for which $f(I)>z$, so that high quality farmers don't default in either state and low quality farmers can make their loan payment in the good state.[28] The offer curves in this case are:

$$OC_H: \quad z = I(1+\rho) \tag{11a}$$

$$OC_L: \quad z = I(1+\rho)/P \tag{11b}$$

$$OC_P: \quad z = I(1+\rho)/(P+(1-v)(1-P)) \tag{11c}$$

Farmer expected net profits are:

$$\pi_H = f(I)(1+Pq) - z \tag{12a}$$

$$\pi_L = P(f(I)-z) \tag{12b}$$

which give rise to indifference curves with slopes:

$$(dz/dI)_{IC_H} = f'(1+Pq) \tag{13a}$$

$$(dz/dI)_{IC_L} = f' \tag{13b}$$

Note that with this example, there is never credit rationing in the classical sense, though low quality farmers will be money-pushed at a pooling (Figure 7) equilibrium and high quality farmers will be money-pushed at a separating (Figure 8) equilibrium.

A numerical example will permit exploration of parametric influences on equilibrium structure. Specifically, let $f(I)=I^{\eta}$, $0<\eta<1$, and vary the parameters of the problem as follows: $P\epsilon[1,.9]$, $q\epsilon[.1,1]$, $\eta\epsilon[.2,.8]$, $v\epsilon[.1,.9]$, $\rho=1$. Selected outcomes of this example are presented in Table 1.[29] To summarize the salient features of these and other results are the following observations:

(1) Equilibrium Structure. The Pareto optimal equilibrium of Figure 9 emerges when P, q and η are large. Intuitively, high values of these parameters imply a large discrepancy between the two quality types' investment-fixed payment trade-offs and a small difference in default risk, making the cost of low quality masquerading high and the benefits low. Likewise, moderate values of P, q, and η, combined with v, give rise to the case of Figure 8. A high v implies a large disadvantage to high quality farmers of the pooling equilibrium vis-a-vis the separating equilibrium. Thus, when v, p, q, and η are moderate to low, the Figure 7 (pooling) case emerges.

(2) Ex-Ante Optimality. When P, q, η, and v are at the high end of the Figure 8 range, program costs are large though high quality farmers can be taxed only very little to pay for a utility-preserving debt subsidy policy (i.e., policy gains are small); hence, low quality farmers can be taxed only very little to avoid adverse selection. In this instance, ex-ante optimality does not hold.

(3) Social Gains. The percentage gain in aggregate expected profits due to the debt subsidy policy ranges from near zero in Figure 8 cases which are "almost" of the Figure 9 variety to over 750 percent in pooling equilibrium cases with a high cost to high quality under-investment (e.g., $P=.1$, $q=.1$, $\eta=.8$, $v=.9$). In general, gains tend to be negatively related to P and q. Further, percentage gains are predominantly in the 2-30 percent range.

In sum, there are a wide variety of circumstances under which the debt subsidy policy proposed here, complemented by compensating taxes, will lead to Pareto improvements. These policy gains are attributable to an implicit advantage which government has over private agents, namely, an ability to cross-subsidize. While the competitive process described in Section II requires that each and every contract makes non-negative expected profits in equilibrium, government is not constrained by this process. Hence, it can relax selection constraints in ways not available to private investors.[30]

V. SOME EXTENSIONS AND IMPLICATIONS

A. Internal Labor Markets and Education Signaling

The analysis of Section IV can be directly applied to the internal labor market setting following Miyazaki (1977). The analog to Figure 8 for this setting is shown in Figure 13. Here, the free market equilibrium is wage/work-intensity (or wage/education) contracts e_L and e_H for low and high productivity workers, respectively. By subsidizing low quality worker wages, government can (with the same ex-ante/ex-post qualifications as before) induce a Pareto superior allocation.[31]

B. Implicit Contracts

Analogous policy reasoning suggests that suboptimal implicit contract equilibria can be improved upon. Following Azariadis (1983) and Azariadis and Stiglitz (1983), let

$$\pi(\theta_i,\theta_j) = F(h_j,\theta_i) - w_j$$

be the entrepreneur's profit in state i if he announces state j (i,j=1(bad state), 2(good state)), where h denotes number of worker hours, θ the state of nature, and w the worker wage bill. With equi-probable states, the second best contract solves the following programming problem:

$$\max_{\{h,w\}} \; .5(V(\pi(\theta_1,\theta_1)) + V(\pi(\theta_2,\theta_2))) \tag{14}$$

$$\text{s.t.} \quad \text{(i)} \; .5(U(w_1,h_1) + U(w_2,h_2)) \geqslant \bar{U}$$

$$\text{(ii)} \; \pi(\theta_1,\theta_1) \geqslant \pi(\theta_1,\theta_2)$$

$$\text{(iii)} \; \pi(\theta_2,\theta_2) \geqslant \pi(\theta_2,\theta_1)$$

where V and U are entrepreneur and worker utility functions, respectively, and $\bar{U}$ is a competitively determined constant. Suppose (ii) is not binding but (iii) is, giving rise to the underemployment equilibrium (e_1,e_2) depicted in Figure 14. Since (iii) is binding, it is violated at the unconstrained optimum (e_1^*,e_2^*)--that is, the solution to (14) subject only to constraint (i). Violation of (iii) implies that $F(h_2,\theta_2) - w_2 < F(h_1,\theta_2) - w_1$. But this inequality can easily be corrected; an appropriate state 2 wage subsidy (k) will permit (iii) to be satisfied at the unconstrained optimum. Further, this subsidy can be "funded" by a fixed tax on employers, t=k/2, creating no additional adverse selection problems and making the firms better off.

C. Insurance, Product Warranties and All Equity Financing

Several authors (e.g., Pauly (1974); Johnson (1978); Ordover and Weiss (1981)) have suggested that compulsory insurance can lead to social benefits in a model with selection problems. These benefits are attributed to the optimal risk sharing (between risk neutral insurers and risk averse insurance buyers) which this policy induces. In essence, there is a net positive "willingness to pay" for the mandates. With perfect information, both quality types will choose to be fully insured. With compulsory insurance, the high quality agent will have a lower certain wealth level than with perfect information and the low quality agent will have a higher one. But these differences imply pure transfers from one agent to the other which net out to zero; hence, compulsory insurance is equivalent to the first best perfect information equilibrium in terms of willingness to pay.

This argument applies equally well to a caveat venditor rule in the analytically equivalent product warranty model of Ordover and Weiss. It is also relevant to a policy of mandatory all equity financing in the risk averse farmer fixed investment framework of Section III, with one important difference: A move from the perfect information equilibrium to the pooling all equity contract does not involve pure transfers. Instead, distributions are transferred, implying that risk preferences are relevant in valuing the exchange. Consequently, this case requires an homogeneity assumption (such as identical preferences) to ensure that the "willingness to pay" criterion favors mandatory equity.

Unfortunately, for any of these cases, the argument for policy benefits is necessarily ex-post. To see this, recall that the Wilson equilibrium solves a constrained high quality farmer maximization problem, in which an eligible contract is the pooling all-equity (or full insurance or caveat venditor) point. When the latter contract is not the solution to the maximization, compulsory policies must make the high quality agent worse off in the absence of compensation. But in any of these problems, differential taxes cannot be levied on different quality types when there is pooling, unless the taxes themselves introduce debt-financing or imperfect insurance. Thus, compensation will be impossible.

D. Second Order (vs. First Order) Dominance

In the credit rationing literature, the adverse selection problem is generally posed as one of differential riskiness (in the sense of mean preserving spread) rather then one of first order dominance relationships. Recasting the discussion in Section III (fixed investment) with this altered specification reveals important qualitative differences between equilibrium in the two cases. Since debt implies convex payoffs to farmers, conditional expected farmer profit ($E_{\pi>z}(\pi^*;q)$) will be increasing in riskiness or, equivalently, decreasing in "quality." Thus, Figure 1, which represents the case of risk neutral farmers, must be replaced by Figure 15. Rather than a pooling all-debt equilibrium, a pooling all-equity equilibrium emerges. This observation has a number of interesting implications, including:

(1) Credit rationing models which posit both debt financing and a set of borrowers differentiated by riskiness are internally inconsistent.

(2) The different equilibrium types suggest an explanation for different capital structure arrangements in different sectors. For example, venture capital investments may be characterized by uncertain riskiness, explaining predominance of equity financing, while

farmers (and other small businesses) may be characterized by first order uncertainty, explaining a predominance of debt.

(3) The policy benefits discussed earlier will not extend to a context in which entrepreneurs have only differences in risk. In fact, it is easily verified that equilibrium will be characterized by first best investment levels in this setting.

VI. CONCLUSION

Two "stylized facts" provided a central motivation for this analysis: (1) most types of entrepreneurial businesses (e.g., farm firms) rely on debt instruments to raise investment funds; and (2) in many economies, government has a substantial involvement in credit markets for these firms. In the context of a simple selection model, this paper sought to explain (1) and learn the implications of this explanation for (2). Positing a quality variable which corresponded to first order dominance relationships, it was shown that an all-debt equilibrium could emerge. Further, with variable investment and risk neutral agents, the informational equilibrium was found to be inefficient in general. More surprisingly, government debt subsidies to low quality entrepreneurs could often improve upon the equilibrium. While these results were found to have applications in other contexts (including labor, insurance, and product market settings), they were also revealed to be sensitive to the definition of quality. In particular, if quality were instead defined in terms of riskiness, an efficient all-equity equilibrium prevailed. This result, it was conjectured, might explain a third "stylized fact": (3) venture capital investments are principally financed with equity.

Due to the deliberate simplicity of the problem construction here, some important features of the entrepreneurial finance setting were overlooked, including reputation-building behavior, moral hazard and, possibly, an entrepreneur's imperfect knowledge of his own quality. Though none of these extensions promises to fundamentally alter the motivation for present results, they would critically examine informational differences central to the analysis and add important dimensions to the model. In addition, government was treated as an exogenous force in this model, as was its choice of the ex-post optimal policy. Ideally, this behavior should be modeled, the choice among policy alternatives endogenized, and the optimality properties of this choice explored.

APPENDIX A

Derivation of Equation (8)

Milgrom (1981) proves (in his Proposition 2) that, if higher q implies first order stochastic dominance, then the density function $g(q;\pi)$ has the monotone likelihood ratio property (MLRP), where $g(q;\pi)$ is the (conditional) probability of a farmer who has earned profit π being quality q, and the MLRP implies:

$$\frac{\partial}{\partial q}\left[\frac{g_\pi(q;\pi)}{g(q;\pi)}\right] > 0 \tag{A1}$$

Using the definition of a conditional probability and abusing notation somewhat,

$$g(q;\pi) = (g(q)/f(\pi))f(\pi;q) \tag{A2}$$

where $f(\pi)$ is the unconditional probability of observing profit π, and $g(q)$ and $f(\pi;q)$ are as defined in the text. By using (A2) to perform the differentiation in (A1),

$$\frac{\partial}{\partial q}\left[\frac{g_\pi(q;\pi)}{g(q;\pi)}\right] = \frac{\partial}{\partial \pi}\left[\frac{f_q(\pi;q)}{f(\pi;q)}\right] \tag{A3}$$

Therefore, $f(\pi;q)$ also has the MLRP.

Now consider the left-hand side of inequality (8):

$$\frac{\partial E_{\pi>z}(\pi^*;q)}{\partial q} = \frac{(1-\alpha)}{(1-F(z;q))}\int_z^\infty (\pi-z)\left(f_q(\pi;q) + \frac{F_q(z;q)}{1-F(z;q)}\, f(\pi;q)\right)d\pi \tag{A4}$$

Define $f^*(\pi;q) \equiv f_q(\pi;q) + \frac{F_q(z;q)}{1-F(z;q)}\, f(\pi;q)$.

Since $\int_{o}^{\infty} f_q(\pi;q)d\pi = 0$ and $\int_{o}^{z} f_q(\pi;q)d\pi = F_q(z;q)$, $\int_{z}^{\infty} f^*(\pi)d\pi = 0$. Therefore, the MLRP implies that there exists a π^{**} such that $f^*(\pi) \geqslant 0$ for all $\pi > \pi^{**}$ and $f^*(\pi) \leqslant 0$ for all $\pi < \pi^{**}$. (A4) can now be written:

$$\frac{\partial E_{\pi>z}(\pi^*;q)}{\partial q} = \frac{(1-\alpha)}{1-F(z;q)} \int_{\pi^{**}}^{\infty} (\pi-\hat{\pi}(\pi))f^*(\pi;q)d\pi \tag{A5}$$

where $\hat{\pi}(\pi):(\pi^{**},\infty) \rightarrow (z,\pi^{**})$ maps profits in the high interval to profits in the low interval by any rule which satisfies:

$$\int_{\pi^{**}}^{\infty} \delta(\hat{\pi}^+)f^*(\hat{\pi}(\pi))d\pi = f^*(\hat{\pi}^+) \text{ for all } \hat{\pi}^+\epsilon(z,\pi^{**})$$

where $$\delta(\hat{\pi}^+) = \begin{cases} 1 \text{ if } \hat{\pi}(\pi) = \hat{\pi}^+ \\ 0 \text{ otherwise} \end{cases}$$

Since $\pi - \hat{\pi}(\pi) > 0$ for all $\pi\epsilon(\pi^{**},\infty)$, (8) will be satisfied.

APPENDIX B

Statement and Proof of a Proposition on the Fixed Investment Financial Structure Equilibrium

Proposition: If the assumptions of Section II hold, farmers are risk neutral, investment is fixed, and default risk is negatively related to quality (condition (9)), there will exist a unique E1 and E2 equilibrium, e, which is characterized by pooling, all debt financing and zero expected investor profits.

Proof:

(A) Existence of e as an E1 Equilibrium. e will be an E1 equilibrium if there are no profitable sets of new contract offers. Consider an arbitrary set of new offers which attracts a maximum quality level of Q^*. The new offer which attracts Q^* must lie below the quality Q^* pooling indifference curve. Hence, this offer lies below the pooling indifference curves for qualities $q<Q^*$. Since the pooling indifference curves correspond to investor iso-expected-profit lines for contract e taken by quality q, the new set of offers makes lower expected profits than contract e on all qualities less than or equal to Q^* and does not reap contract e's expected profits on qualities higher than Q^*. Hence, expected profits on the new set of offers will be lower than on contract e when it is the only contract in the market. But, as the only available contract, e earns an expected profit of zero. QED (A).

(B) Existence of e as an E2 Equilibrium. Consider the arbitrary set of new offers described in (A). Since these offers attract all quality levels $q<Q^*$, the original contract e continues to attract all quality levels $q>Q^*$ in the presence of the new offers. Hence, e will be profitable offer in the presence of these new offers and will not be withdrawn. If Q^* equals the highest quality level, then e will not be demanded but, from (A), the new set of offers will be unprofitable. Hence, the arguments in (A) also demonstrate the existence of e as an E2 equilibrium. QED (B).

(C) Uniqueness of e as an E1 Equilibrium. this proof proceeds by showing that there does not exist a non-pooling equilibrium and that any pooling equilibrium must be all debt and yield investors zero expected profits. Begin by supposing that there is a fully separating E1 equilibrium, implying that every quality chooses a distinct contract. In particular, the lowest quality L and the next to lowest quality L+1 choose distinct contracts, $e_L \equiv (z_L, \alpha_L)$ and $e_{L+1} \equiv (z_{L+1}, \alpha_{L+1})$, each of which makes non-negative profits. Toward a contradiction, consider the following new contract offer (see Figure A1): $e^* = (z^* - \epsilon, \alpha_{L+1})$, where ϵ is an arbitrarily small positive number and z^* solves the following equality:

$$W(z^*, \alpha_{L+1}; L) = W(z_L, \alpha_L; L)$$

Clearly, e^* will be chosen by both qualities L and L+1 over e_L and e_{L+1}. Further, since e^* is arbitrarily close to the quality L separating offer curve and, therefore, strictly above the separating offer curves for all qualities higher than L, this new contract offer will be profitable, breaking the equilibrium. Hence, a fully separating E1 equilibrium does not exist.

Now suppose that a partially separating E1 equilibrium exists. In this case, there are three possible equilibrium configurations for qualities L and L+1: (a) both qualities L and L+1 choose "separated" contracts (i.e., contracts which no other quality chooses), (b) quality L chooses a "separated" contract and quality L+1 a "pooled" contract (i.e., one which is also selected by other qualities), and (c) quality L chooses a "pooled" contract. For case (a), new contract e* above breaks the equilibrium. For case (b), think of e_{L+1} as the pooled contract chosen by quality L+1; then, again, e* breaks the equilibrium. Finally, for case (c), consider Figure A2, in which e_L is the pooled contract chosen by quality L. If e_L is not all debt, then there exists an alternate contract such as e_L^* which is preferred by all qualities in the original pool except for L, who prefers e_L. Since e_L makes non-negative expected profits when all qualities in the pool, including L, choose the contract, e_L will make strictly positive expected profits when all qualities in the pool, except L, choose the contract. Hence, with e_L^* chosen to be arbitrarily close to e_L, it will be a profitable offer, breaking the equilibrium. This argument implies that the only possible pooled contract for which there does not exist an associated e_L^* to break the equilibrium is an all debt e_L. The all debt e_L now becomes the focus of attention.

The all debt e_L must make exactly zero expected profits in equilibrium; otherwise $e_L^*=(z_L-\epsilon,0)$ will break the equilibrium. Further, any contract which a given quality level q prefers to e_L must lie below quality q's indifference curve through e_L which lies below quality L's indifference curve through e_L. Hence, if any contract other than e_L is offered and accepted in equilibrium, L will choose the other contract, contradicting the assumption that L demands e_L. Hence, a partially separating E1 equilibrium does not exist and the all debt pooling contract e_L which makes zero expected profits (i.e., e_L=e) is the unique E1 equilibrium.

(D) Uniqueness of e as an E2 equilibrium. The contracts proposed above to break any hypothetical E1 equilibrium are single contracts and will also be profitable after unprofitable contracts in the original set are withdrawn. Hence, the arguments above also prove uniqueness of e as an E2 equilibrium.

REFERENCES

Akerlof, G., "The Economics of Caste and of the Rat Race and Other Woeful Tales," Quarterly Journal of Economics 90 (1976):599-617.

Azariadis, C., "Employment with Asymmetric Information," Quarterly Journal of Economics 98 Supplement (1983):157-172.

Azariadis, C. and Stiglitz, J., "Implicit Contracts and Fixed Price Equilibria," Quarterly Journal of Economics 98 Supplement (1983):1-22.

Barry, P.," Capital Asset Pricing and Farm Real Estate," American Journal of Agricultural Economics 62 (1980):549-553.

Barry, P., "Impacts of Regulatory Change on Financial Markets for Agriculture," American Journal of Agricultural Economics 63 (1981):905-912.

Crocker, K., and Snow, A., "The Efficiency of Competitive Equilibria in Insurance Markets with Asymmetric Information," Journal of Public Economics 26 (1985):207-219.

Dasgupta, P., and Maskin, E., "The Existence of Equilibrium in Discontinuous Economic Games," Review of Economic Studies 53 (1986):1-41.

deMeza, D. and Webb, D., "Too Much Investment: A Problem of Asymmetric Information," Quarterly Journal of Economics 102 (1987):281-292.

Duncan, M., "Government Lending: Some Insights from Agriculture," Economic Review - Federal Reserve Bank of Kansas City (1983):3-6.

Gale, D. and Hellwig, M., "Incentive-Compatible Debt contracts: The One-Period Problem," Review of Economic Studies 52 (1985):647-664.

Greenwald, B. and Stiglitz, J., "Externalities in Economies with Imperfect Information and Incomplete Markets," Quarterly Journal of Economics 101 (1986):229-264.

Grossman, H., "Adverse Selection, Dissembling, and Competitive Equilibrium," Bell Journal of Economics 10 (1979):330-343.

Hallagan, W., "Self-Selection by Contractual Choice and the Theory of Sharecropping," Bell Journal of Economics 9 (1978):344-54.

Harris, M., and Townsend, R., "Resource Allocation under Asymmetric Information," Econometrica 49 (1981):33-64.

Hodgman, D., "Credit Risk and Credit Rationing," Quarterly Journal of Economics 74 (1960):258-78.

Innes, R., "Agricultural Policy Analysis in Economies with Incomplete Markets," Ph.D. Dissertation, University of California, Berkeley (1986).

Jaffee, D. and Modigliani, F., "A Theory and Test of Credit Rationing," American Economic Review 59 (1969):850-72.

Jaffee, D. and Russell, T., "Imperfect Information, Uncertainty and Credit Rationing," Quarterly Journal of Economics 90 (1976):651-66.

Johnson, W., "Overinsurance and Public Provision of Insurance: Comment," Quarterly Journal of Economics 92 (1978):693-696.

Judd, K., "Efficiency, Adverse Selection and Production," Discussion Paper No. 606, Kellogg Graduate School of Management, Northwestern University (1985).

Krueger, A., "The Political Economy of the Rent-Seeking Society," American Economic Review 64 (1974):291-303.

Lang, K., "Pareto Improving Minimum Wage Laws," Economic Inquiry (1987):145-158.

Leland, H. and Pyle, D., "Informational Asymmetries, Financial Structure and Financial Intermediation," Journal of Finance 32 (1977):371-87.

Mankiw, G., "The Allocation of Credit and Financial Collapse," Quarterly Journal of Economics 101 (1986):229-264.

Marschak, T. and Selton, R., "Restabilizing Responses, Inertia Supergames and Oligopolistic Equilibria," Quarterly Journal of Economics 92 (1978): 71-93.

Milgrom, P., "Good News and Bad News: Representation Theorems and Applications," Bell Journal of Economics 21 (1981):380-391.

Miyazaki, H., "The Rat Race and Internal Labor Markets," Bell Journal of Economics 8 (1977):394-416.

Myers, S., and Majluf, N., "Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have," Journal of Financial Economics 13 (1984):187-221.

Newbery, D. and Stiglitz, J., "Sharecropping, Risk Sharing and the Importance of Imperfect Information," in J. Roumasset et al., eds. Risk, Uncertainty and Agricultural Development, New York: Agricultural Development Council (1979).

Ordover, J., and Weiss, A., "Information and the Law: Evaluating Legal Restrictions on Competitive Contracts," American Economic Review Papers and Proceedings 71 (1981):339-404.

Pauly, M., "Overinsurance and Public Provision of Insurance: The Roles of Moral Hazard and Adverse Selection," Quarterly Journal of Economics 88 (1974):44-62.

Riley, J., "Informational Equilibrium," Econometrica 47 (1979):331-359.

Rosenthal, R., and Weiss, A., "Mixed-Strategy Equilibrium in a Market with Asymmetric Information," Review of Economic Studies 51 (1984):333-342.

Ross, S., "The Determination of Financial Structure: The Incentive Signalling Approach," Bell Journal of Economics 8 (1977):23-40.

Ross, S., "Some Notes on Financial Incentive-Signalling Models, Activity Choice and Risk Preferences," Journal of Finance 33 (1978):777-92.

Rothschild, M. and Stiglitz, J., "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information," Quarterly Journal of Economics 90 (1976):629-49.

Rubinstein, M., "An Aggregation Theorem for Securities Markets," Journal of Financial Economics 1 (1974):225-44.

Stiglitz, J. and Weiss, A., "Credit Rationing in Markets with Imperfect Information," American Economic Review 71 (1981):393-410.

Townsend, R., "Optimal Contracts and Competitive Markets with Costly State Verification," Journal of Economic Theory 21 (1979):265-93.

Vandell K., "Imperfect Information, Uncertainty and Credit Rationing: Comment and Extension," Quarterly Journal of Economics 99 (1984):841-63.

Williamson, S., "Costly Monitoring, Loan Contracts and Equilibrium Credit Rationing," Quarterly Journal of Economics 102 (1987):135-145.

Wilson, C., "A Model of Insurance Markets with Incomplete Information," Journal of Economic Theory 16 (1977):167-187.

FOOTNOTES

[1]For Example, Ross (1977, 1978) and Myers and Majluf (1984) provide seminal analyses of corporate capital structure choices in a fixed investment setting, with the latter paper also giving a useful literature survey. Townsend (1979), Williamson (1987) and Gale and Hellwig (1985) explain debt contracting with asymmetries in profit observation costs while the latter authors also examine investment choices in this costly state verification setting. Hallagan (1978) and Newbery and Stiglitz (1979) present relevant research on the sharecropping problem. Further, two recent and interesting papers, one by Mankiw (1986) and the other by Greenwald and Stiglitz (1986), discuss efficiency implications of asymmetric information.

[2]Myers and Majluf (1984) come to a similar conclusion with their model of the corporate firm in which managers have inside information about a fixed-size investment opportunity. In addition, deMeza and Webb (1987) have independently derived this result, though in a less general model than employed here. Notably, the latter authors also consider investment choices; however, they do not permit investment to serve as a screening/selection device as done here.

[3]For example, see Barry (1981) and Duncan (1983) for criticisms of government involvement in agricultural lending.

[4]The arguments of Leland and Pyle (1977) suggest that the farmer's commitment of his own resources to the farm can serve as a signal of quality. If so, the farmer can be thought to invest all of his wealth in the farm (as often observed in practice) and the relevant population will be constrained to have homogeneous wealth endowments.

[5]Independence of returns is assumed in order to avoid non-concavities in the farmer's utility-of-residual-farm-profits function (see equation (1)). Notably, this assumption is much stronger than necessary; only large and very negatively correlated non-farm portfolios will cause non-concavities. Moreover, when farmers are risk neutral, neither of the portfolio constraints is necessary.

[6]If markets were complete, the farmer could sell his set of state contingent profits, financing the investment and purchase of his preferred set of state contingent commodities. The debt-equity choice would not arise and asymmetric information would be irrelevant.

[7]A sufficient set of conditions for investors to behave as if they are risk neutral is (from Rubinstein (1974)): (i) investor preferences are such that a composite investor can be constructed, and (ii) farm net worth distributions are independent of aggregate wealth. The second condition is arguably a plausible description of farm enterprises (Barry (1980)).

[8]In the present setting, these responses satisfy Marschak and Selton's (1978) "restabilizing" rationality criterion. Given a renegade's new offer, no series of additional moves (with anticipated responses) can increase the other agents' profits beyond levels achieved with the initial response. This claim is easily verified from the diagrammatic constructions in Sections III and IV.

[9]An alternate approach to resolving the existence problem has been to posit a mixed strategy game (e.g., Dasgupta and Maskin (1986)). Notably, existence results in this setting are sensitive to entry constraints (Rosenthal and Weiss (1984)).

[10]Riley (1979) has proposed an alternate set of response expectations. In his scheme, competitors are expected to react to a new contract offer by adding the contract (or set of contracts) which is most profitable to them, given the expanded set of offers (i.e., the original set plus the renegade's new offer). A "reactive" equilibrium is defined to satisfy Property I with respect to these response expectations, but not Property II. (If the equilibrium were also required to satisfy Property II, it would have to be a Nash equilibrium.) Though Riley's equilibrium will not be discussed in the following analysis, it is consistent with all of this paper's results. In fact, among the settings examined here, the Riley equilibrium differs from the Wilson equilibrium only in the case of a variable investment pooling E2 equilibrium (Figure 7); in this case, the Wilson equilibrium Pareto dominates.

[11]Miyazaki (1977) extended Wilson's equilibrium definition by allowing equilibrium contracts to be characterized by cross-subsidization--that is, a negative expected profit contract subsidized by a positive expected profit contract. Specifically, Miyazaki's equilibrium is a set of contracts such that investors earn non-negative expected profit <u>in the aggregate</u> and there is no other set of contracts which, when offered in addition to the equilibrium set, earn positive expected a profit in the aggregate, after the unprofitable contracts in the original set have been withdrawn. This equilibrium satisfies Property I with respect to Wilson response expectations <u>but not Property II</u>.

[12]Miyazaki (1977) has also shown non-existence of a pooling equilibrium in a labor market model patterned after Akerlof's (1976) rat-race example.

[13]Another source of divergence is an apparent confusion in Hallagan's paper concerning the nature of equilibrium. In his world of certainty, a tenant chooses the contract (share vs. rent) which is least costly given the

tenant's quality level. If there are two qualities, competitive forces will ensure that the share payment of the share-choosing quality type equals the rent payment. But in this case, the share-choosing quality type is indifferent between contract types (as is the landlord) and separation need not occur.

[14]One possible reason for preclusion of negative equity contracts is that such contracts make the farmer a lender; in effect, a negative equity holder receives a portion of the farmer's loan proceeds in exchange for promised end-of-period payment of a net worth share. Particularly when there is an institutional separation between debt and equity holders, this negative α contract structure implies that the ability-to-pay of the negative equity holder is relevant. Debt-holders, not in a position to monitor this added risk, may rationally prohibit these contracts or require extra premiums. Farmers must also consider this added risk, implying that their indifference curves will be kinked at the z axis. Combined, these two effects may eliminate equilibrium-breaking opportunities of the kind depicted in Figure 2.

[15]Even with risk aversion and no default, a separating equilibrium such as shown in Figure 3 need not emerge. With sufficient high quality farmer risk aversion, IC_H may rise above OC_P, implying that a pooling E2 equilibrium will prevail.

[16]Proofs of these observations are available from the author.

[17]The specifics of the numerical example are as follows: the proportions of high and low quality farmers in the applicant population are .1 and .9, respectively. Further, there are two equiprobable states of nature; in state 1, high quality farmers earn profits of 8 and low quality farmers earn profits of 1; in state 2, the respective profit levels are 4 and 1. Finally,

farmers have a common utility function, $V(\pi^*)=\ln(1+\pi^*)$, and the required gross investor return, $I(1+\rho)$, equals two.

[18]If "rent-seeking" expenditures absorb all rents, no compensation will be necessary. If not, some compensation will be required to leave investors just as well off as before the government intervened. If low quality farmers are levied a tax equivalent to the financial contract $(e_L-e_L^*)$ and high quality farmers are levied a tax equivalent to $(e_H-e_H^*)$, expected tax revenues will be greater than the required investor compensation due to "rent-seeking" savings. All agents' utilities will be preserved and the government will run a surplus which can be distributed to improve everyone's well-being.

[19]In both Figure 5 and Figure 6 cases, the best possible (e_H^*,e_L^*) pair is a Miyazaki equilibrium (footnote 11). For the analogous insurance problem, Crocker and Snow (1985) have demonstrated that this equilibrium is second best (in the sense of Harris and Townsend (1981)) and can be supported by an appropriate set of taxes/subsidies. Hence, the foregoing policy discussion reflects a natural extension of these conclusions to the entrepreneurial finance setting of interest here.

[20]Note that with variable investment, the construction described in Section II implicitly assumes that net worth distributions are equilibrium-invariant. In other words, the profit function $\pi(q,A,\theta)$ does not depend on equilibrium investment choices of other quality types. From an analytic point of view, this abstraction makes the analysis tractable. From a methodological point of view, it implies a partial equilibrium setting which is justified if the relation between profits and assets is determined in markets which are large relative to the particular sector being examined. With farmers differentiated by indicators of creditworthiness (e.g., own-farm

investment and recent performance), any one indicator class will be small in the market and this partial equilibrium framework will be sensible for positive analysis. If government policy effects all indicator classes and the sector is "large," this partial approach is not entirely satisfactory for policy analysis. However, some qualitative implications of the policy experiments carried out here will extend to a general equilibrium framework (see footnote 27).

[21]With perfect information and risk neutral investors, a change in capital structure transfers farmer profits from one state of nature to another on a dollar-for-dollar basis. Risk neutral farmers are indifferent between a dollar of marginal income in two states and, thus, are indifferent between alternate capital structures in this case.

[22]That indifference curves have positive slopes can be formally verified by differentiating (2'):

$$\left[\frac{dz}{dI}\right]_{IC_q} = \frac{\int_z^\infty (\pi-z)f_1(\pi;q,I)d\pi}{(1-F(z;q,I))} > 0$$

where the inequality follows from a first order stochastic dominance characterization of investment effects. I could not sign the offer curve derivatives analytically; however, since farmers will always increase investment in a negatively sloping segment of an offer curve, these derivatives must be positive in a relevant range of the variables.

[23]See Innes (1986) for a detailed discussion of conditions under which these curves have the indicated shapes and for proof that with diminishing marginal investment returns, indifference curves are more concave (less convex) than offer curves, ensuring existence of equilibrium.

[24]In fact, it is easily verified that a Nash equilibrium does not exist in the Figure 7 setting.

[25]e is not a Miyazaki (footnote 11) or Riley (footnote 10) equilibrium either. The following contract proposal breaks e as a Miyazaki equilibrium: (i) e'_L on IC_L to the left of e, and (ii) e'_H between IC_H and IC_L close to e. (Since e'_L will earn higher expected investor profits on low quality takers than will e, this new contract pair earns investors positive expected profits in aggregate.) $\bar{e}$ breaks e in a Riley sense; only the contract pair (e_H^R, e_L^*) survives as a "reactive" equilibrium.

[26]For example, see the famous papers by Hodgman (1960), Jaffee and Modigliani (1969), Jaffee and Russell (1976), and Stiglitz and Weiss (1981). Vandell (1984) has recently criticized this notion of credit rationing as one which fails to consider relevant economic costs of lending--namely, default risks. The analysis here tends to support this criticism, indicating that the interesting notion of credit rationing is under-investment.

[27]For a general equilibrium setting (see footnote 20), think of the curves in Figures 7-10 as those associated with equilibrium net worth relations in a perfect information economy. The policy proposed in Figure 10 then leads to a first best optimum, implying ex-post optimality. Unfortunately, the question of ex-ante optimality in this more general setting is not so easily resolved, though recent research by Ken Judd (1985) is an important step in this direction.

[28]In any suboptimal equilibrium (Figure 7 or 8), contracts will be on or below IC_L, as will post-intervention contracts which are incentive-compatible and utility-preserving. Since $f(I) > z$ for all contracts on (or below) IC_L, only an optimal separating (Figure 9) high quality contract could violate this

inequality. However, the latter case will emerge if and only if high quality farmers, when faced with the "naive" OC_H, (11a), would choose a contract above IC_L. Thus, assumption of this inequality costs no generality.

[29]The algorithm and computer program used to solve this example are available from the author.

[30]If Miyazaki's alternate equilibrium concept (footnote 11) had been employed, this advantage would have evaporated; banks could also have offered cross-subsidized contracts and the resulting equilibrium would have been constrained efficient (i.e., intervention would necessarily have had distributive effects). However, the Miyazaki equilibrium can be shown to give a high quality investment level (in Figure 7 and 8 cases) which is always higher than the first-best level (proof available from the author). Thus, while the Miyazaki equilibrium and the debt-subsidy equilibrium (with or without incentive-feasible taxes) are Pareto-incomparable, the latter is socially preferable according to a Kaldor/Scitovsky willingness-to-pay criterion.

[31]Lang (1987) comes to a similar conclusion.

Table 1

A. Selected Results of Numerical Example With v=.5 and P=.5

q	η	Figure Case	Ex-Ante Optimality of Debt Subsidy Policy	Percent Change in Aggregate Expected Profit Due to Policy
.1	.2	7	Yes	2.000
.1	.5	7	Yes	12.620
.1	.8	8	Yes	89.096
.4	.2	7	Yes	2.755
.4	.5	8	Yes	17.949
.4	.8	8	No	1.411
.7	.2	8	Yes	4.347
.7	.5	8	Yes	6.558
.7	.8	9	-	-

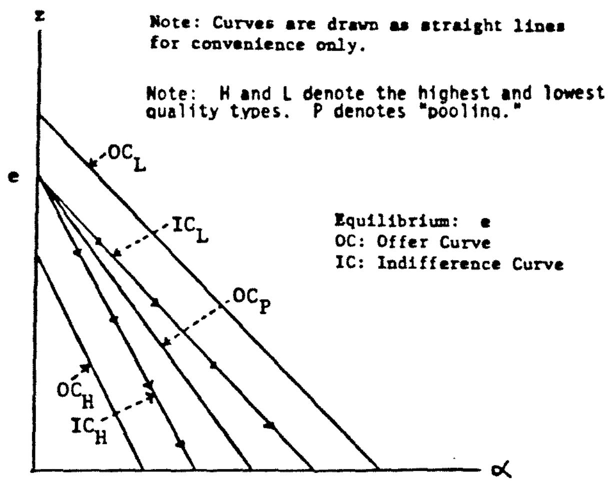
B. Selected Results on Numerical Example With v=.5 and P=.7

q	η	Figure Case	Ex-Ante Optimality of Debt Subsidy Policy	Percent Change in Aggregate Expected Profit Due to Policy
.1	.2	7	Yes	.698
.1	.5	7	Yes	4.450
.1	.8	8	Yes	31.801
.4	.2	8	Yes	1.903
.4	.5	8	No	3.485
.4	.8	9	-	-
.7	.2	8	No	.663
.7	.5	8	No	.123
.7	.8	9	-	-

C. Selected Results on Numerical Example With v=.5 and P=.9

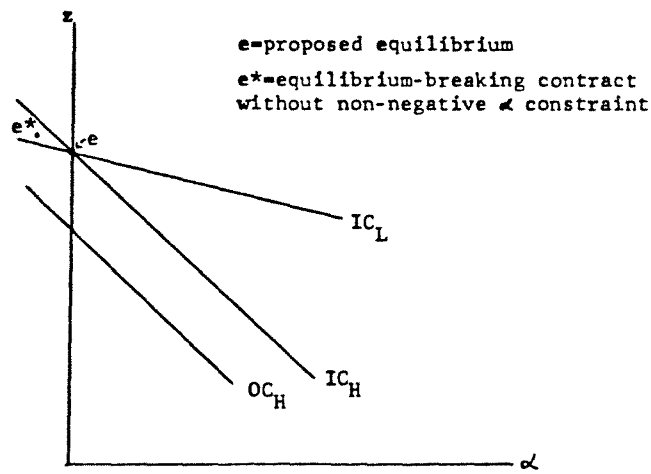
q	η	Figure Case	Ex-Ante Optimality of Debt Subsidy Policy	Percent Change in Aggregate Expected Profit Due to Policy
.1	.2	7	Yes	.168
.1	.5	8	Yes	2.628
.1	.8	8	No	3.408
.4	.2	8	No	.041
.4	.5	9	-	-
.4	.8	9	-	-
.7	.2	9	-	-
.7	.5	9	-	-
.7	.8	9	-	-

FIGURE 1



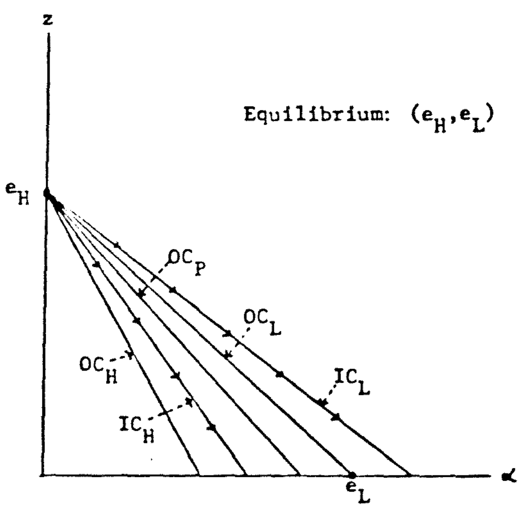
Offer Curves and Indifference Curves for
the Case of Risk Neutral Farmers
with Fixed Investment

FIGURE 2



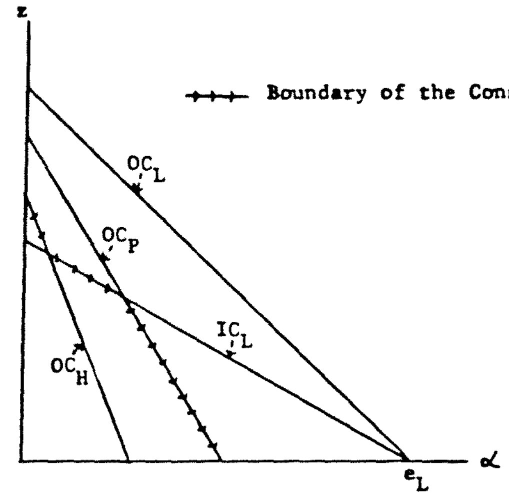
Contrast with Rothschild-Stiglitz Results:
Negative Equity Contract which Breaks
the Risk Neutral Farmer All-Debt Equilibrium

FIGURE 3



Contrast with Sharecropping Results:
A Case of Farmer Risk Aversion and
No Inter-Quality Default Risk Differences

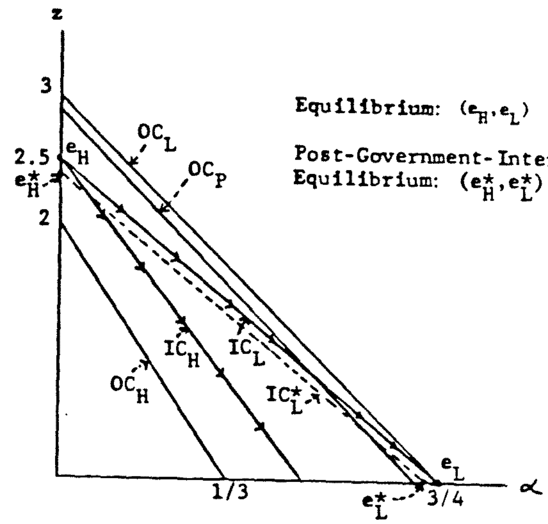
FIGURE 4



Equilibrium with Farmer Risk Aversion

The equilibrium high quality contract is the point on the boundary of the constraint set most prefered by the high quality farmer. If this point is on OC_P, the equilibrium is pooling; if not, the low quality contract is e_L.

FIGURE 5

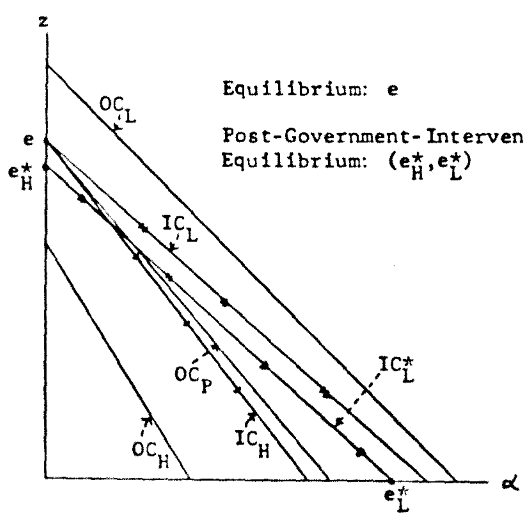


Fixed Investment Financial Structure Equilibrium with Farmer Risk Aversion: An Example of a Separating Equilibrium with Positive Investor Profits

FIGURE 6

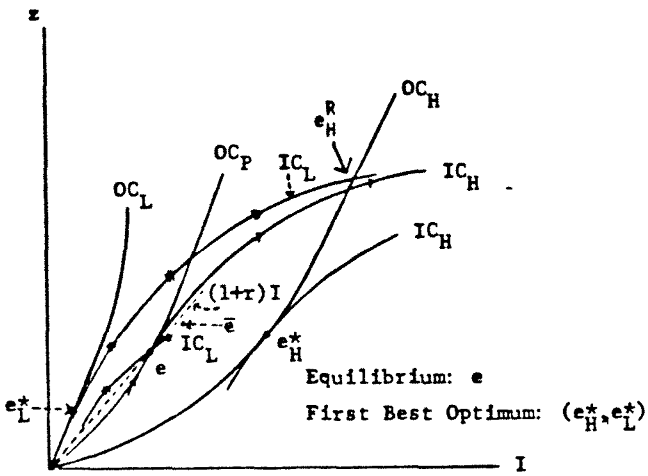
IC_L^P Below OC_L and

IC_H^P Below OC_P



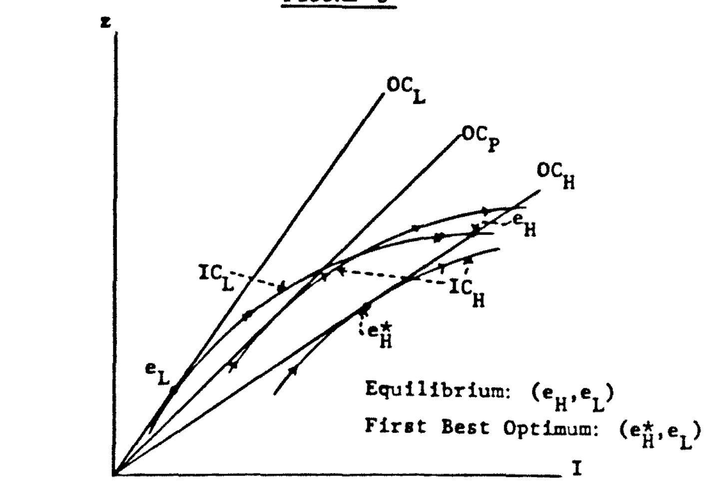
Fixed Investment Financial Structure Equilibrium with Farmer Risk Aversion: An Example of an All-Debt Pooling Equilibrium

FIGURE 7



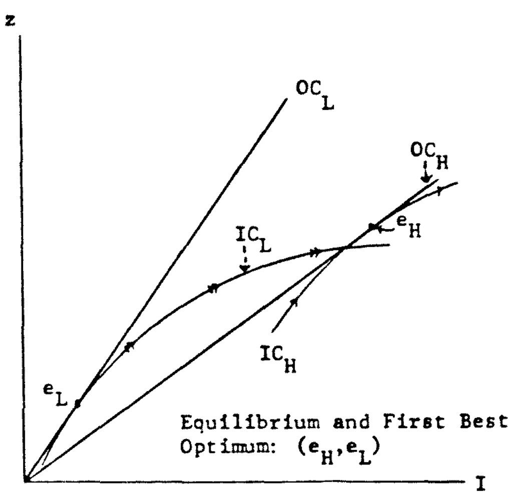
Variable Investment Pooling Equilibrium

FIGURE 8



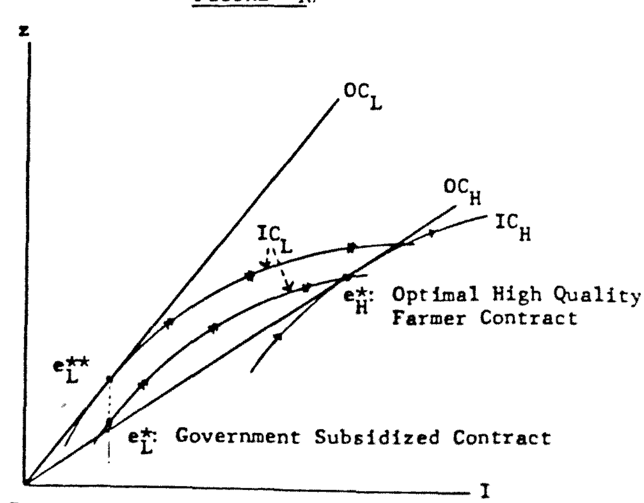
Suboptimal Variable Investment Separating Equilibrium

FIGURE 9



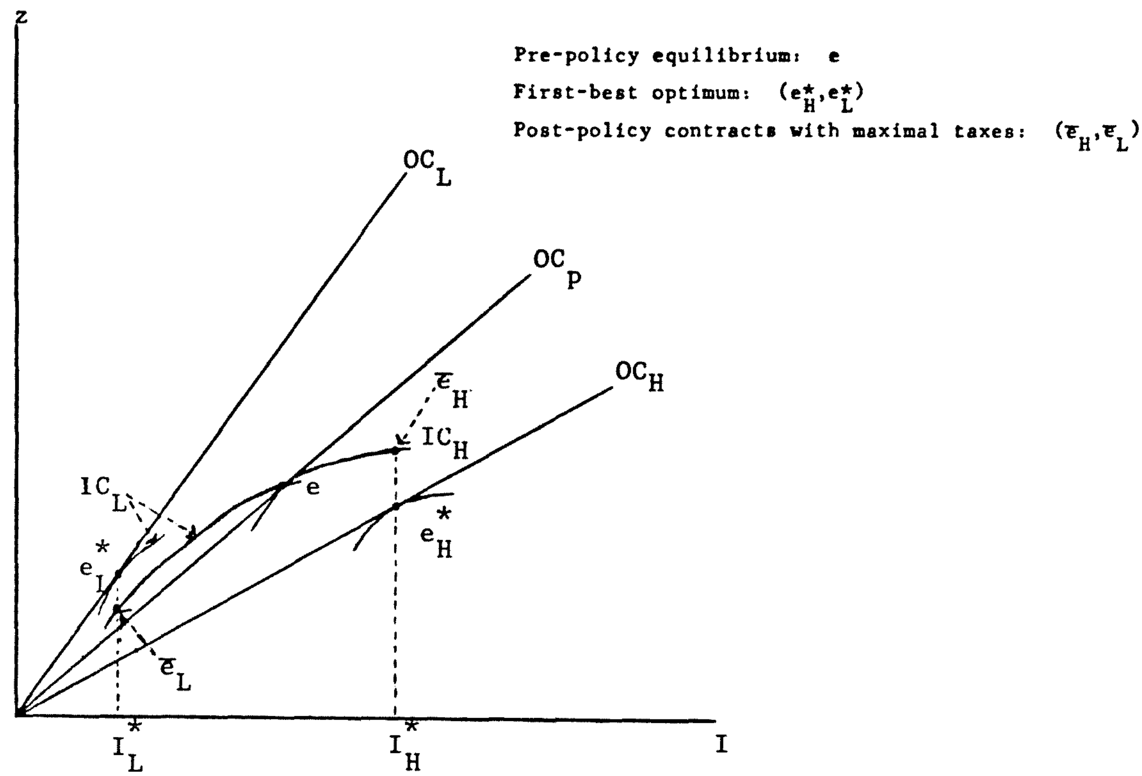
Pareto Optimal Variable Investment Separating Equilibrium

FIGURE 10



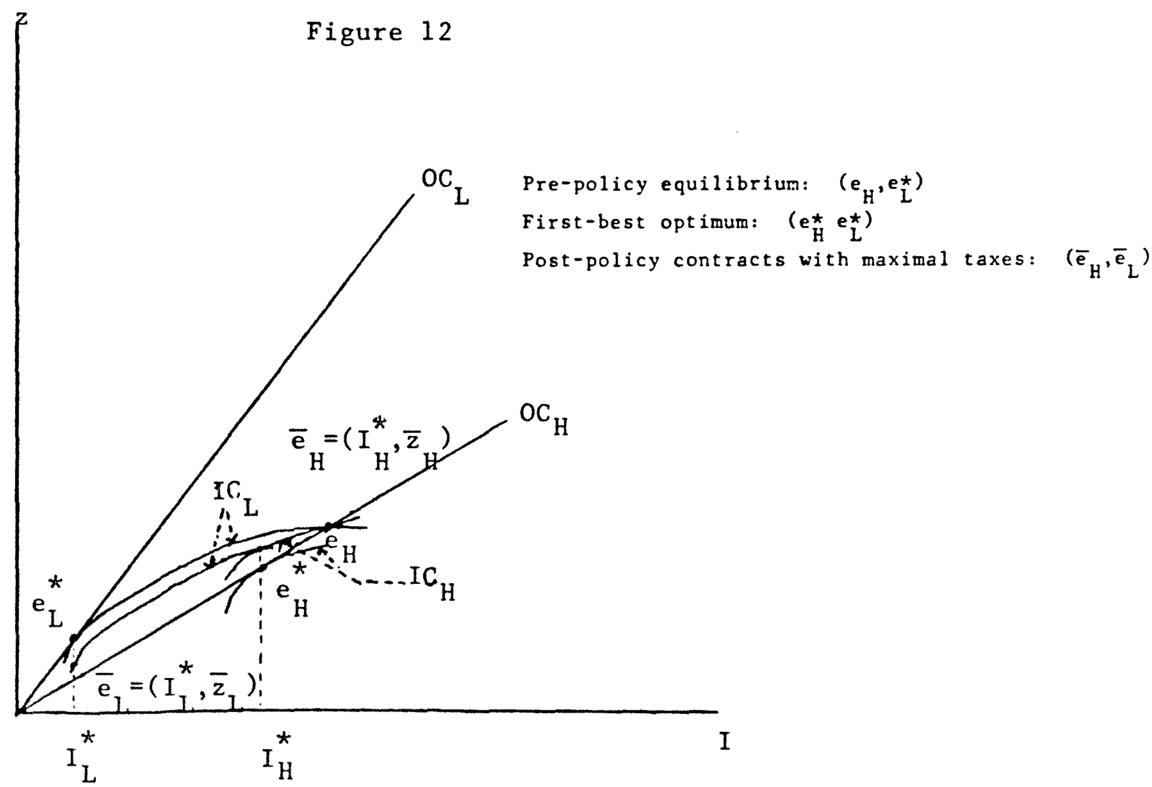
Proposed Government Debt Subsidy Policy

Figure 11



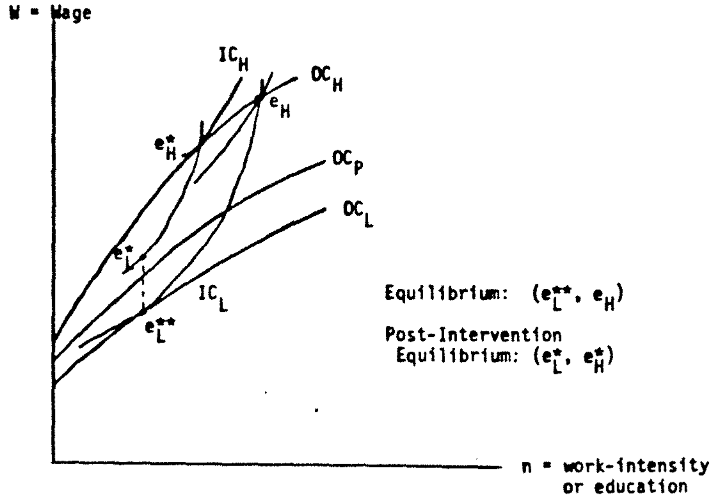
Debt Subsidy and Taxation in a Pooling Equilibrium Case (Figure 7).

Figure 12



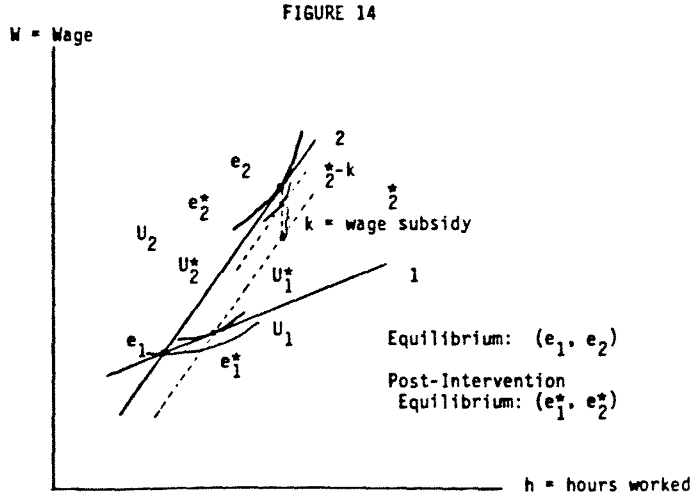
Debt Subsidy and Taxation in a Separating Equilibrium Case (Figure 8).

FIGURE 13



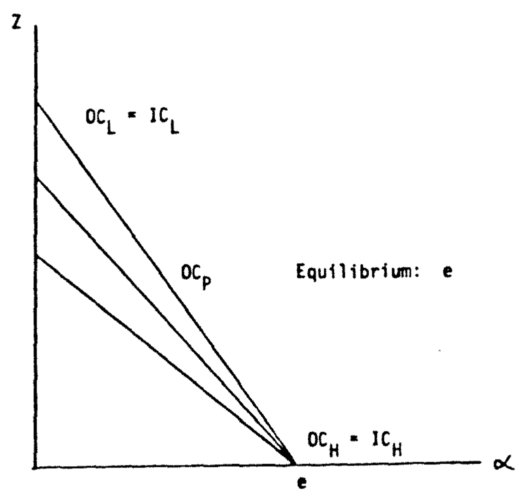
Miyazaki's Internal Labor Market Model

FIGURE 14



An Underemployment Implicit Contract Equilibrium

FIGURE 15



Fixed Investment Capital Structure Equilibrium with Quality Related to Riskiness

FIGURE A1

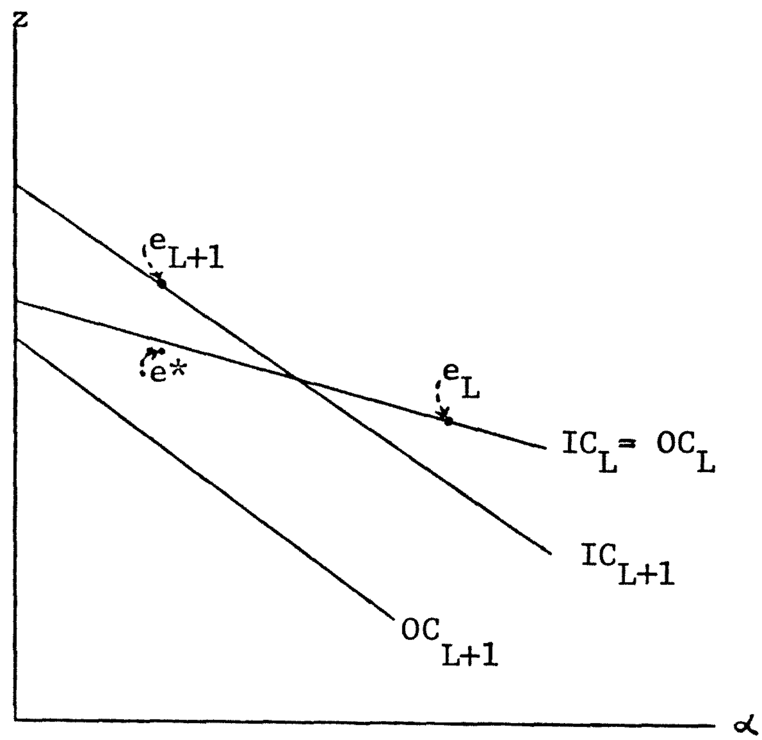


FIGURE A2