

Adverse Selection and Mutuality: The Case of the Farm Credit System*

BRUCE D. SMITH

*Federal Reserve Bank of Minneapolis, Minneapolis, Minnesota 55480;
and Cornell University, Ithaca, New York 14853*

AND

MICHAEL J. STUTZER

*Federal Reserve Bank of Minneapolis, Minneapolis, Minnesota 55480; and University of
Minnesota, Carlson School of Management, Minneapolis, Minnesota 55455*

Recent theories of corporate organization hold that mutually owned firms arise to remedy agency problems associated with ownership by a separate class of stockholders. We propose an alternative theory of mutuality, in which mutuals arise endogenously as a self-selection mechanism to cope with adverse selection and systematic risk. This theory makes predictions about the nature of customer contracts and the pattern of dividend payments adopted by mutuals. We do not systematically test this theory against others. But the behavior of the Farm Credit System, a large financial mutual, is shown to be more in accord with our theory. *Journal of Economic Literature* Classification Numbers: 314, 315, 714. © 1990

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I. INTRODUCTION

Mutual organizations abound in financial intermediation, in direct competition with stockholder-owned corporations. Following Mayers and Smith (1988, p. 353), it is useful to distinguish among "three important

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functions in each ownership structure": the managerial function, the "ownership/risk bearing function," and the function of customers. Explanations for alternative organizational forms emphasize interrelationships among these functions.

Fama and Jensen (1983a,b) hypothesize that different organizational forms arise to cope with the principal-agent problem created by the separation of equity ownership and management control. They argue that financial mutuals' equity claims are always redeemable on demand (e.g., deposits in mutual savings banks), effectively curbing management's control of assets. This form of control, they argue, best lends itself to organizations holding relatively liquid and easily priced assets, facilitating asset expansion and contraction. In their view, other financial organizations, holding less liquid and/or harder to price assets, are more likely to be organized as corporations with a separate class of shareholders, whose claims are not redeemable on demand. The shareholders then must rely more heavily on boards of directors and takeovers to exert management control. In support of their view, they present evidence that the portfolios of nonmutual financials have a higher proportion of nonfinancial assets, which are presumably less liquid and less easily priced than financial assets are.

In contrast, Mayers and Smith (1981) focus on interactions between owners and customers. In the insurance situation they consider, the value of insurance to policyholders might be reduced by various dividend policies that are attractive (perhaps *ex post*) to a distinct group of shareholders. Thus mutual organizations, which tend to merge the functions of owner and customer, arise to internalize these conflicts and reduce the necessity of potentially costly contractual measures otherwise needed to resolve them.¹

This paper is partly motivated by questions concerning these explanations of organizational form. Fama and Jensen rely critically on mutual customer/stockholders' equity holdings being redeemable on demand. Yet this is not the case for the mutually owned Farm Credit System. Second, while the hypothesis of Mayers and Smith provides a rationale for the existence of mutuals, it seems to suggest that all providers of financial services should be organized as mutuals. They avoid this by arguing that owner/manager agency problems are more severe in mutuals,

¹ Other explanations for the existence of mutuals, particularly in banking, focus on regulations and preferential government treatment of mutuals (e.g., O'Hara, 1981, 1983). However, as noted by Rasmusen (1988), the existence of mutuals in the banking industry substantially predates the development of the regulations in question, suggesting that mutuals do serve an important economic role. Also, we offer no explanation for the conversions of mutual savings and loan associations into joint stock form documented by Masulis (1987). But it is debatable how mutual S&L's were to begin with.

where takeovers are more difficult, and hence provide less managerial control. Alternative organizational forms can be observed in the same activity only if these two agency considerations are offsetting. Given the apparent difficulty of quantifying these costs, such a prediction would be hard to confirm or deny.

In contrast, this paper proposes an explanation for the coexistence of mutuals and other corporations that emphasizes the risk bearing and customer functions. In particular, we will focus on what Rothschild and Stiglitz (1976, p. 646) refer to as "the peculiar provision of many . . . contracts" for which effective payments are "not determined until the end of the period (when the individual obtains what is called a dividend)" We propose an explanation of such contracts, That are typically associated with the mutual form of organization.² More specifically, the hypothesis we propose is that mutuals arise endogenously as a self-selection mechanism to cope with the problem of asset valuation in the presence of both adverse selection and systematic risk. For concreteness, we consider a loan market model in which borrowers are privately informed about their own risk of default.³ However, by itself this adverse selection problem is insufficient to cause differences in organizational structure. Once systematic risk is introduced, however, there is a role for the mutual contract. In particular, borrowers with low default probabilities can signal their type by entering into contracts where their effective payment depends on the aggregate profitability of the firm. This is an effective signaling mechanism so long as the relative loan default probabilities of high- and low-risk borrowers are correlated with firm profits. Moreover, by providing an additional signaling device, the mutual contract results in a Pareto improvement (relative to the situation where no contracts specify dividend payments), and thus would be predicted to arise endogenously.

Our analysis predicts the pattern of dividend payments of mutuals. In particular, as we describe in Sections II.C and II.D, optimal signaling considerations dictate that mutual lenders will concentrate dividend payments in states where the loan repayment probabilities of high- and low-risk borrowers are most dissimilar. This prediction is confirmed by the practices of the Farm Credit System (FCS). As we describe in Section III,

² Logically speaking, nothing prevents joint stock firms from paying dividends to customers. However, so long as dividends paid are based on the aggregate profitability of the firm, the payment of such dividends merges the functions of risk bearing and of customer. This is what Mayers and Smith (1988), for instance, identify as the distinguishing feature of mutual organizations, and we will follow them in taking this as the fact to be explained.

³ Models with similar adverse selection problems have been considered by a variety of authors. See, for instance, Besanko and Thakor (1987a,b), Smith and Stutzer (1989), or Azariadis and Smith (1989).

the FCS has made de facto dividend payments by redeeming the stock held by its borrowers at par value, rather than at its lower market value. (FCS stock cannot be redeemed in excess of its par value [Calomiris *et al.*, 1986, p. 472].) Thus, the FCS's de facto dividend payments have been made only in states of low profitability (i.e., poor stock performance), and we argue that this is when repayment probabilities are most dissimilar. Section IV concludes by considering some potential questions regarding the analysis, as well as some possible extensions.

II. THE LOAN MARKET

A. The Environment

Consider an economy where time is divided into two periods ($t = 1, 2$). At $t = 1$ there are three groups of agents. The first group (lenders) has a positive endowment of a single good when young, and no endowment when old. These agents are assumed to have a sufficiently large first-period endowment so that any one of them could service all of the borrowers in the model. (This amounts to assuming that lenders are able to raise all the funds they require without affecting price.) The number of lenders is greater than 1, but finite. Let c_t denote date t consumption. Then lenders have utility functions $V(c_1, c_2)$ defined on R_+^2 given by $V(c_1, c_2) = c_1 + c_2$.

In addition there is a continuum of borrowers who are divided into two "types." Type is indexed by $i = H, L$. The fraction who are of type H is denoted by θ . Borrowers have no endowment of the good when young. When old their endowment, denoted w , is a random variable; $w \in \{y, 0\}$, $y > 0$. Receipt of the old age endowment is observable, so loans must be repaid if $w = y$. Obviously, any borrower with $w = 0$ defaults on his loan.

For a borrower of type i , define $p_i(s) \equiv \text{prob}[w = y \mid s]$, where s is a random aggregate shock, $s \in \{1, 2\}$. Let $\pi(s)$ denote the probability of state s , so that $1 \geq \pi(s) \geq 0 \forall s$, and $\sum \pi(s) = 1$. The actual value of s is realized at the beginning of period 2, so it is not known when borrowing occurs. Thus, s captures the notion of systematic risk in the market for loans. Given the realization of s in period 2, then, since there is a "large number" of agents of each type, a fraction $p_i(s)$ of type i agents receives a positive endowment.⁴ It is assumed that $p_L(s) > p_H(s)$, $s = 1, 2$, so type L agents are "low-risk" borrowers, independent of s . It is also assumed that $p_i(2) > p_i(1)$, $i = H, L$, so that state $s = 2$ is a "good" state with respect to aggregate endowments, as well as with respect to total loan defaults.

⁴ For a justification see Green (1984) or Judd (1985).

Borrowers of type i have utility functions $U_i(c_1, c_2)$ defined on R_+^2 of the form $U_i(c_1, c_2) = \beta_i c_1 + c_2$, with $\beta_i > 1$; $i = H, L$. In addition, it is assumed that

$$\beta_H/\beta_L > \sum_s \pi(s)p_H(s) / \sum_s \pi(s)p_L(s), \quad (\text{SC})$$

which is a standard “single-crossing condition” (see Cooper, 1984).

B. A Market without Mutual Lenders

In this section we model a market of nonmutual lenders analogous to the insurance market of Rothschild and Stiglitz (1976). In this market the strategies of lenders are interest rate-loan (quantity) pairs.⁵ Let x_i denote the quantity borrowed by a representative type i borrower, and R_i the (gross) interest rate offered to type i agents. Then lenders announce (R_i, x_i) pairs, $i = H, L$. These announcements are made taking the announced interest rate-loan pairs of all other lenders as given. Finally, an analog of the Rothschild–Stiglitz–Wilson assumption that rules out cross-subsidization is imposed. In particular, each lender is restricted to offer only a single (R, x) pair. Then, each borrower selects his most preferred pair from the entire set of announced pairs (R_i, x_i) . Finally, it is assumed that all loan contracts entered into are observable by lenders, so that lenders can effectively restrict borrowers to the choice of a single contract. This assumption also follows Rothschild and Stiglitz or Wilson (1977): the consequences of relaxing it are discussed in Section II.D.

We utilize the Rothschild–Stiglitz–Nash equilibrium concept: A set of announced interest rate-loan pairs (R_i^*, x_i^*) , $i = H, L$, is an equilibrium if, given these announcements, no lender has an incentive to announce (i.e., would earn higher expected profit by announcing) an alternate pair.

Note that (R, x) pairs are set prior to the realization of the aggregate state and the endowments of individuals, so that these random variables are realized after loans are made. Then the ex post profits per loan of a lender offering the interest rate-loan pair (R, x) are

$$\psi_i(s) = [p_i(s)R - 1]x \quad (1)$$

if his offer attracts only type i agents, and

$$\psi_p(s) = [\theta p_H(s) + (1 - \theta)p_L(s)]R - 1]x \quad (2)$$

⁵ More specifically, dividend or other payments contingent on the aggregate state are ruled out.

if his offer attracts both types of agents in their population proportions. Clearly, each lender's objective when announcing (R, x) pairs is to maximize the quantity $\sum_s \pi(s)\psi(s)$, given the announcements of other lenders.⁶

Finally, announced (R, x) pairs are required to be incentive compatible. In particular, if type H agents are meant to accept the loan contract (R_H, x_H) and type L agents the loan contract (R_L, x_L) , then these contracts must satisfy the following self-selection conditions:

$$\begin{aligned}\bar{U}_H &\equiv \beta_H x_H + \sum_s \pi(s) p_H(s) [y - R_H x_H] \geq \beta_H x_L \\ &\quad + \sum_s \pi(s) p_H(s) [y - R_L x_L]\end{aligned}\quad (3)$$

$$\begin{aligned}\bar{U}_L &\equiv \beta_L x_L + \sum_s \pi(s) p_L(s) [y - R_L x_L] \geq \beta_L x_H \\ &\quad + \sum_s \pi(s) p_L(s) [y - R_H x_H].\end{aligned}\quad (4)$$

Also, feasibility of an (R, x) pair requires that

$$y \geq Rx. \quad (5)$$

The properties of equilibrium (R, x) pairs (if an equilibrium exists) are exactly as described by Rothschild and Stiglitz. In particular, self-selection of borrowers by contract accepted occurs in equilibrium, or in other words $(R_H^*, x_H^*) \neq (R_L^*, x_L^*)$. Expected (per capita) profits for a lender offering the pair (R_i, x_i) are therefore given by

$$\left[\sum_s \pi(s) p_i(s) R_i - 1 \right] x_i = \sum_s \pi(s) \psi_i(s). \quad (6)$$

In equilibrium $\sum_s \pi(s) \psi_i(s) = 0$; $i = H, L$. Thus, an equilibrium has

$$R_i^* = \left[\sum_s \pi(s) p_i(s) \right]^{-1}; \quad i = H, L. \quad (7)$$

Finally, the equilibrium pair (R_i^*, x_i^*) must be maximal for type i agents (given the set of contract offers accepted by type j agents; $j \neq i$) among the set of contracts satisfying (7) and the relevant self-selection condition.

⁶ Parenthetically, loan contracts are contingent contracts requiring repayment of Rx if $w = y$, and zero otherwise.

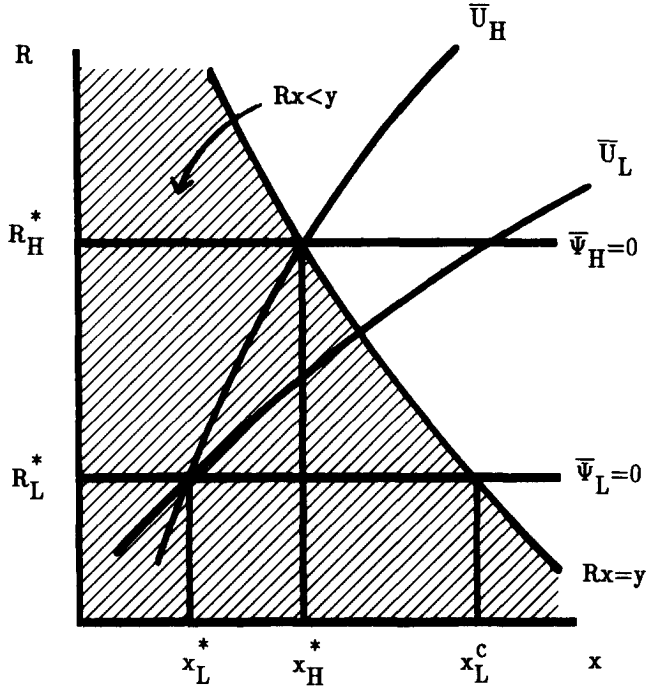


FIG. 1. Market equilibrium without mutuals. Utility increases toward the southeast.

The determination of equilibrium contracts (if an equilibrium exists) can be depicted diagrammatically, as in Fig. 1. Under the assumption (SC), type H borrowers have steeper indifference curves in the figure than do type L borrowers. Thus, as depicted in Fig. 1, (R_H^*, x_H^*) is not constrained by considerations of self-selection. Then, maximality of (R_H^*, x_H^*) for type H agents implies that x_H^* is the solution to the problem

$$\max \beta_H x_H + \sum_s \pi(s) p_H(s) [y - R_H^* x_H]$$

subject to $y \geq R_H^* x_H$. As shown in Fig. 1, the solution is $x_H^* = y/R_H^*$.

The single crossing condition (SC) implies that Eq. (3) must hold with equality in any equilibrium. (Again, see Fig. 1.) Substituting $x_H^* = y/R_H^*$ into (3) and solving for x_L yields the (candidate) equilibrium loan quantity for type L agents:

$$x_L^* = (\beta_H - 1)y/(\beta_H R_H^* - R_L^*). \quad (8)$$

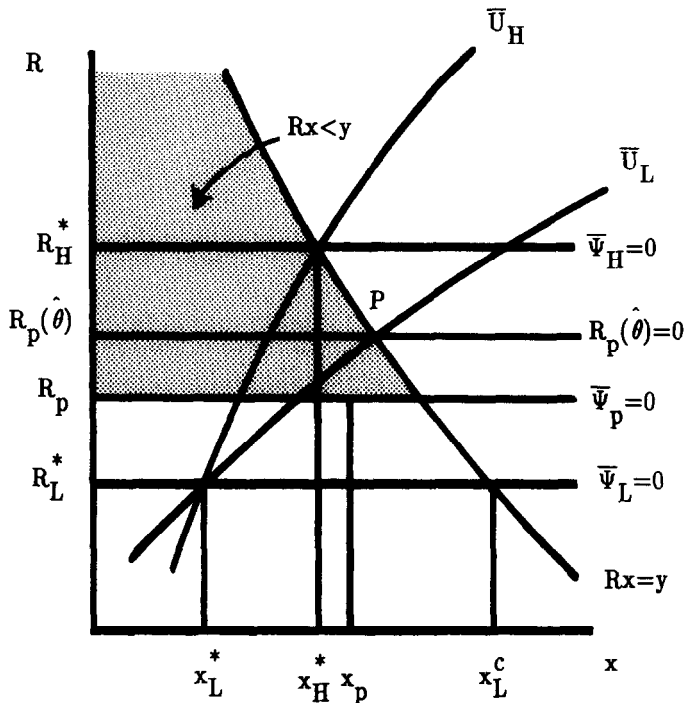


FIG. 2. $\theta > \hat{\theta}$ prevents a pooling contract (R_p, x_p) from breaking the equilibrium.

In Fig. 1, x_L^* corresponds to the intersection of the type H indifference curve $\bar{U}_H$ through (R_H^*, x_H^*) , and the type L zero (expected) profit locus $\bar{\psi}_L = 0$.

Figure 1 depicts the unique Nash equilibrium (if one exists).⁷ However, an equilibrium may fail to exist for exactly the reasons discussed by Rothschild and Stiglitz. In particular, in the presence of the contracts (R_i^*, x_i^*) , no lender has an incentive to offer an alternative contract that attracts only one type of agent. There may, however, be an incentive to offer a pooling contract (R_p, x_p) which attracts both types of borrowers in their population proportions. Such a situation is depicted in Fig. 2 where any value of $R \geq R_p$ satisfies the nonnegative (expected) profit condition

⁷ Note that uniformed agents (lenders) "move first" in announcing contractual terms, while informed agents (borrowers) move second. This avoids the kinds of multiplicities associated with familiar sequential equilibria of games in which the informed agent moves first. Of course the sequencing of moves we adopt seems appropriate to loan markets, where loan terms are well established and borrowers apply for loans at announced terms. We are grateful to an editor for bringing this point to our attention.

$$\sum_s \pi(s)[\theta p_H(s) + (1 - \theta)p_L(s)]R \geq 1. \quad (9)$$

This defines the shaded region in Fig. 2. As shown there, if the type L indifference curve $\bar{U}_L$ through (R_L^*, x_L^*) intersects the shaded area, there exists a pooling contract satisfying (9) that is preferred by all agents to (R_i^*, x_i^*) .

Now define $R_p(\theta) \equiv \{\sum_s \pi(s)[\theta p_H(s) + (1 - \theta)p_L(s)]\}^{-1}$. If $\theta \geq \hat{\theta}$, defined implicitly in Fig. 2, there is no pooling contract satisfying (9) that attracts type L borrowers. Then an equilibrium exists $\forall \theta \geq \hat{\theta}$. It is assumed henceforth that $\theta > \hat{\theta}$.

The equilibrium just derived is intuitive. High-risk borrowers pay higher interest rates than low-risk borrowers. If there were no adverse selection problem, then perfect competition would result in low-risk borrowers obtaining more credit (x_L^c in Fig. 2) than high-risk borrowers. But asymmetric information prevents this, with lenders forced to restrict credit to low-risk borrowers in order to induce high-risk borrowers to select the higher rate contract.

C. A Market with Mutual Lenders

In this section the strategies of lenders are allowed to be more complex, consisting of contract offers that specify a (gross) interest rate R and a loan quantity x , as before, and a fraction of ex post profits α to be rebated (paid out as dividends) to borrowers, possibly contingent on both the state and the borrower endowments. Firms offering $\alpha > 0$ are thus mutuals, paying dividends to borrower/customers and merging the functions of customer and risk bearer.

To be more specific about the nature of these contracts, any announced contract which attracts type i agents specifies a loan quantity x_i and a repayment $R_i x_i$, contingent only on $w = y$. The ex post profits per loan, gross of dividends, are $\psi_i(s) = [p_i(s)R_i - 1]x_i$. Moreover, the contract specifies that each type i agent receives a dividend $\alpha_i(s, w)\psi_i(s)$ if his loan has been repaid. In equilibrium, lenders will never choose to pay dividends to defaulting borrowers.⁸ So, without loss of generality, we assume $\alpha_i(s, 0) = 0$ and suppress w in what follows. Then dividend payments per loan by this lender in state s are $p_i(s)\alpha_i(s)\psi_i(s)$, since a fraction $p_i(s)$ of type i agents do not default in state s . Because dividend shares $\alpha_i(s)$ are nonnegative and lenders have no endowment when old, $\alpha_i(s) \leq 1/p_i(s)$ if $\psi_i(s) > 0$. Then the objective of lenders is to maximize

⁸ The intuition underlying this result is discussed in footnote 11.

$$\sum_s \pi(s)[1 - p_i(s)\alpha_i(s)]\psi_i(s) \equiv \bar{\psi}_i \quad (10)$$

by choice of contract, subject to the announcements of other lenders and considerations of self-selection.⁹

In order to discuss incentive compatibility, it is useful to introduce some additional notation. Therefore, let c_1^i denote the consumption of type i borrowers in period 1, and $c_2^i(s)$ the consumption of type i agents in period 2 given the realization s . Then a contract specifying R_i , x_i , $\alpha_i(1)$, and $\alpha_i(2)$ implies consumption values

$$c_1^i = x_i \quad (11)$$

$$c_2^i(s) = y - R_i x_i + \alpha_i(s)\psi_i(s), \quad \text{if } w = y \quad (12)$$

$$c_2^i(s) = 0 \quad \text{otherwise.}$$

Announced contracts are incentive compatible, then, if they satisfy

$$\beta_H c_1^H + \sum_s \pi(s)p_H(s)c_2^H(s) \geq \beta_H c_1^L + \sum_s \pi(s)p_H(s)c_2^L(s) \quad (13)$$

and

$$\beta_L c_1^L + \sum_s \pi(s)p_L(s)c_2^L(s) \geq \beta_L c_1^H + \sum_s \pi(s)p_L(s)c_2^H(s), \quad (14)$$

where consumption values are obtained from contracts by (11) and (12). Conditions (13) and (14) may be rewritten in terms of the original contracts:

$$\begin{aligned} & \beta_H x_H + \sum_s \pi(s)p_H(s)[y - R_H x_H] + \sum_s \pi(s)p_H(s)\alpha_H(s)\psi_H(s) \\ & \geq \beta_H x_L + \sum_s \pi(s)p_H(s)[y - R_L x_L] + \sum_s \pi(s)p_H(s)\alpha_L(s)\psi_L(s) \quad (13') \end{aligned}$$

⁹ If lenders are viewed as "managers" of the "customer-owned" mutual organization, (10) asserts that they are rewarded in proportion to expected profits net of dividends. In this context this is the natural maximand, since contracts are determined by the "original" owners of the firm—i.e., the lenders. However, readers who still question that this would be the objective function relevant to mutual managers can regard it as an "as if" assumption, adopted for the purpose of generating testable predictions.

$$\begin{aligned} & \beta_L x_L + \sum_s \pi(s) p_L(s) [y - R_L x_L] + \sum_s \pi(s) p_L(s) \alpha_L(s) \psi_L(s) \\ & \geq \beta_L x_H + \sum_s \pi(s) p_L(s) [y - R_H x_H] + \sum_s \pi(s) p_L(s) \alpha_H(s) \psi_H(s). \quad (14') \end{aligned}$$

Also, realized profits net of dividends may be written as $\tilde{\psi}_i(s) = p_i(s)[y - c_2^i(s)] - c_1^i$ and (ex ante) expected profits, in terms of consumption values, are $\sum_s \pi(s) \tilde{\psi}_i(s) = \sum_s \pi(s) p_i(s)[y - c_2^i(s)] - c_1^i$.

As before, suppose type i contracts are constructed to be maximal for type i agents among the set of contracts that earn nonnegative expected profits (when offered singly) and that are consistent with self-selection. Assuming that θ is sufficiently large, these will be equilibrium contracts.¹⁰

Equilibrium contracts will be denoted $[\hat{R}_i, \hat{x}_i, \hat{\alpha}_i(1), \hat{\alpha}_i(2)]$. The proof of our main result is in Appendix I:

THEOREM 1. *Let the values $p_i(s)$ satisfy*

$$p_H(1)/p_H(2) \neq p_L(1)/p_L(2). \quad (15)$$

Then we have the following results. (a) Nash equilibrium contracts have $\hat{R}_H = R_H^$, $\hat{x}_H = x_H^*$, $\hat{\alpha}_H(s) = 0$, $s = 1, 2$, and $\hat{\alpha}_L(s) > 0$ for some s . (b) Equilibrium contracts imply that $c_2^L(1) = 0$ if $p_H(1)/p_H(2) > p_L(1)/p_L(2)$, while $c_2^L(2) = 0$ otherwise. (c) This equilibrium is a Pareto improvement over the equilibrium of the previous section.*

The intuition is as follows. As regards part (a), in equilibrium type H contracts are not affected by considerations of self-selection. Competition among lenders for borrowers then implies that type H borrowers receive contracts that are maximal for them among all contracts earning nonnegative profits. But these are exactly the same contracts as in Section B. In particular, type H borrowers always wish to transfer income from old age

¹⁰ For instance, if, $p_L(s) \geq \beta_L[\theta p_H(s) + (1 - \theta)p_L(s)]$ holds for all s , it is possible to show that there is no pooling contract that earns nonnegative expected profits and that is preferred by type L agents to the contract described below. This condition will be satisfied if both β_L and θ are sufficiently close to one, and is henceforth assumed to hold. This condition implies that type L agents would rather leave the loan market than take type H contracts, and hence violates the second half of Riley's (1979) assumption (A.6). For the remainder of this section we could do with weaker assumptions that satisfy (A.6) of Riley (although see Riley's comment in footnote 6, which also applies here). However, in Section II.D this assumption plays a role in our proof that a separating equilibrium exists when unobservable side contracts are permitted. Since the existence of unobservable side contracts is precluded by Riley (1979), it is not surprising that their inclusion requires some strengthening of other assumptions.

to youth (given the interest rate they face), and hence will never choose to receive any old age dividend payments.

The intuition underlying type L contracts is slightly more complex. Again, competition among lenders implies that type L borrowers must receive contracts that are maximal for them among all contracts that earn nonnegative profits and that are consistent with self-selection (in the presence of the H contract). Then the consumption values implied by type L contracts must solve the problem

$$\max \beta_L c_1^L + \sum \pi(s) p_L(s) c_2^L(s) \quad (P)$$

subject to

$$\beta_H c_1^H = \beta_H c_1^L + \sum \pi(s) p_H(s) c_2^L(s), \quad (16)$$

$$\sum \pi(s) p_L(s) [y - c_2^L(s)] - c_1^L = 0, \quad (17)$$

and $c_1^L, c_2^L(s) \geq 0$. As shown in Appendix I, the solution to this problem has $c_2^L(1) = 0$ and $c_2^L(2) > 0$ if $p_H(2)/p_L(2) < p_H(1)/p_L(1)$, while $c_2^L(2) = 0$ and $c_2^L(1) > 0$ in the opposite case. The intuition underlying this consumption pattern is as follows. Absent concerns about self-selection, type L agents are indifferent among any old age consumption values implying a given level of expected old age consumption. However, optimal signaling dictates that all old age consumption implied by type L contracts should be concentrated in states that minimize the incentive of type H agents to take type L contracts. Thus if type H and L loan repayment probabilities are most dissimilar in state $s = 2$ [i.e., $p_H(2)/p_L(2) < p_H(1)/p_L(1)$], type L contracts should place all old age consumption in that state.¹¹ This is accomplished by concentrating dividend payments in that state.

To summarize, any Nash equilibrium has low-risk borrowers receiving old age consumption streams that depend on the aggregate profit of the "firm" lending to them. Thus, such borrowers are both customers and risk bearers. In credit markets, the most common institutional way of achieving this is to borrow from a mutual lender, although in the insur-

¹¹ It is now easy to see why all dividend payments are made only to nondefaulting borrowers. In particular, given that type H borrowers always want to transfer consumption from old age to youth, they will never want to receive old age dividend payments in the event of default or otherwise. Type L agents must receive some income in old age for incentive reasons. But this income should be received in states that are relatively unlikely to be realized by type H borrowers, as this maximizes incentives for self-selection. Since type H borrowers are always relatively likely to default, no income should ever accrue to type L borrowers in the event of a default.

ance industry some stockholder-owned companies offer similar “participating” contracts. Nonmutuals (or firms offering nonparticipating contracts) are used to serve the higher risk group, since $\hat{\alpha}_H(s) = 0 \forall s$. Thus, organizational form functions as a sorting mechanism, with low-risk borrowers signaling their type, in part, by sharing aggregate risks with those lending to them. This pattern, in which low-risk borrowers are served by mutuals, is loosely consistent with Fama and Jensen’s (1983b, p. 339) argument that “corporate financial organizations” are more involved with activities “that generate uncertain future net cash flows” than is the case for financial mutuals.

D. Unobservable Contracting

Thus far we have followed Rothschild and Stiglitz in assuming that all contracts entered into can be observed, and hence that borrowers can effectively be restricted to the choice of a single contract. In the insurance context of Rothschild and Stiglitz such an assumption seems readily defensible (Rothschild and Stiglitz, 1976, p. 642); it is perhaps less so in the context of credit markets. Therefore, we now consider the consequences of allowing borrowers to enter into multiple contracts (without this necessarily being observed by all lenders).

It is useful to begin by considering what would happen in Section C if borrowers could enter into unobservable contracts. Given the set of offered contracts, type H borrowers have an incentive to take type L loan contracts and borrow against the future income those contracts generate. More specifically, any type H borrower taking a type L contract has an expected future income of $\sum \pi(s)p_H(s)c_2^L(s)$. Given the preferences of borrowers and lenders, type H borrowers can borrow against this future income by selling a security promising to pay off $c_2^L(s)$ next period if state s occurs and if they receive a dividend (have a positive endowment). Since both endowment realizations and realizations of s are observable, this is informationally feasible, and the sale of such a security generates young period consumption of $\sum \pi(s)p_H(s)c_2^L(s)$. Since $\beta_H > 1$, type H borrowers will do exactly this and the contracts described in Section C are no longer incentive compatible.

The argument just given suggests the following modification of the analysis. Since type H borrowers can take type L contracts and borrow against the expected future income they generate, the expected utility of a type H borrower taking a type L contract will be $\beta_H c_1^L + \beta_H \sum \pi(s)p_H(s)c_2^L(s)$. Self-selection will occur iff this does not exceed $\beta_H c_1^H$, so the relevant incentive constraint is now

$$c_1^H = c_1^L + \sum \pi(s)p_H(s)c_2^L(s). \quad (18)$$

When (18) is the relevant self-selection condition, our previous arguments apply without modification. In particular, in Appendix II we prove

THEOREM 2. *Suppose that (15) holds. Then the description of Nash equilibrium contracts given in Theorem 1 continues to apply. Moreover, implied consumption values for type L agents are given by the solution to problem (P), modified by replacing (16) with (18).*

E. A Caveat

One might think that our results imply that the FCS should generally experience lower default rates than other, nonmutual lenders. However, such a conclusion would be inappropriate. Our analysis only considers borrowers who have *unobservably* different default probabilities *ex ante*. The analysis predicts only that, among these indistinguishable borrowers, the relatively low risk will turn out to be served by mutuals. But suppose that there is a third class of borrowers who *can* establish *ex ante* that they are low risk. Nonmutual lenders will serve these borrowers, with a low interest rate and no credit restrictions. If this borrower class is sufficiently large, these nonmutuals will experience lower default rates than mutuals. Default rate comparisons between mutuals and nonmutuals which serve geographically and economically disparate borrowers must thus proceed with caution. In any event, we chose not to model this situation explicitly, where there are observable as well as unobservable differences among borrowers. Such an analysis has been conducted by Hoy (1982) for insurance markets in the absence of aggregate uncertainty and would introduce no new issues here.

The chief empirical implications of the analysis, then, are that loan rates will be correlated with risk (even when the risk distinctions are *a priori* indistinguishable), and that mutual lenders will concentrate dividend payments in states where the loan repayment probabilities of (*ex ante* indistinguishable) high- and low-risk borrowers are most dissimilar. We now consider FCS experience in light of these predictions.

III. THE FARM CREDIT SYSTEM

A. Organization

The Farm Credit System (FCS) is a nationwide collection of lending units making mortgage loans secured by farm real estate, operating loans secured by farm equipment, crops, and livestock, and loans to farmer-owned cooperatives. Its capital structure consists primarily of consolidated, systemwide debt, issued in the national credit market. The FCS also issues voting and nonvoting stock. Prior to the Agricultural Credit

Act of 1987,¹² the Boards of Directors of both the System and its lending units were elected by its borrowers, who were required to purchase voting stock equal to 5% of their borrower funds. This capital served as a reserve for debt issued and was only redeemable at par upon loan repayment (Todd, 1985).

Note that the FCS financial structure is the opposite of that predicted by the Fama and Jensen hypothesis. As noted in Section I, they predict that the controlling agents of financial mutuals will exercise their power through the possession of shares redeemable on demand, necessitating reasonable liquidity of asset holdings to facilitate share redemption. But borrower/controller stock is not redeemable on demand, and in fact can only be redeemed by ceasing to be a borrower/controller (i.e., repaying loans). As argued by Fama and Jensen, claims which are not redeemable on demand should be more common in organizations with less liquid or difficult to value assets, which would then be organized as nonmutual corporations. And indeed, the farm loan assets of the FCS are not very liquid, lacking a developed secondary market.¹³ But the FCS is a mutual, not the nonmutual corporation predicted by Fama and Jensen.

B. Operations

With respect to interest rates charged on loans, prior to 1986 FCS units charged mortgage interest rates independent of individual borrower risk. Starting in 1986, differential rates related to borrower risk were adopted by FCS units.¹⁴

With respect to its loan portfolio, the FCS experienced “good” aggregate realizations during the 1970s. Moreover, unlike its commercial bank and insurance company competitors, the FCS’s cost of funds closely rivaled the U.S. Treasury’s over this period.

But conditions were different during the 1980s. Farm prices, net income, and land values fell dramatically, resulting in high aggregate default rates, both within and outside the FCS. The FCS’s cost of funds advantage disappeared during the 1980s. It continued to issue long-term, noncallable debt between 1980 and 1982, a period when long-term interest rates soared. As interest rates fell thereafter, the noncallable debt unavoidably left the FCS with a relatively high average cost of funds (GAO

¹² The Act lowered the stock ownership requirement.

¹³ The Agricultural Credit Act of 1987 took steps toward the creation of a secondary market, similar to that provided by the Government National Mortgage Association for housing.

¹⁴ (GAO 9/18/86) Incidentally, the analysis of the previous section predicts that only the latter behavior should be observed in equilibrium. We will comment below on the factors which we believe explain the prior absence of differential rates.

9-18-86, p. 18). The problem was exacerbated by a risk premium investors attached to FCS securities late in 1985. The risk premium was due to reported and projected future losses caused by its high cost of funds and default rate (GAO 12-23-85, p. 36).

C. Interpretation

We believe that the operation of the FCS corroborates our model. While FCS units could pay explicit dividends on their borrower/controllers' stock, they have not typically done so. However, we now argue that the FCS's stock redemption policies resulted in the de facto payment of dividends, which occurred only during the "bad" period of the 1980s.

In order to see how de facto dividend payments have been made, recall that borrower stock had to be redeemed at par upon (and only upon) repayment of borrower loans. FCS units unable to do so were supposed to be liquidated. Yet while the actual market value of stock in many FCS units has been well below par, this stock has been redeemed at par. One example of this phenomenon occurred in the FCS's Spokane district, where several FCS units were liquidated. Yet, the FCS paid par value on all stock held at the liquidated units, despite the likelihood that its value after liquidation would be below par (GAO 10/18/85).

In order to prevent widespread liquidations of this sort, Congress permitted the FCS to employ Regulatory Accounting Principles.¹⁵ This permitted FCS units to overstate the value of their stock, so that redemption at par could continue to take place and thereby forestall liquidation. Finally, Congress passed the Agricultural Credit Act of 1987, guaranteeing that all stock issued prior to October 1988 would be retired at par, using Federal revenues if necessary.¹⁶

By redeeming stock at prices in excess of actual value, the above policies constitute de facto payment of dividends. Moreover, these implicit dividend payments occur only when FCS stock is below par (in the event of poor aggregate profitability); FCS borrowers cannot receive capital gains (Calomiris *et al.*, 1986, p. 472). Furthermore, low-risk borrowers were the main factor motivating their adoption. Before these policies were adopted, borrowers at FCS units were concerned that their stock might eventually drop below par value. FCS officials worried that the low-risk borrowers, who had realized ample cash flows, would accelerate loan

¹⁵ See the Omnibus Reconciliation Act of 1986, Subtitle D.

¹⁶ The commitment of Federal revenues in bad aggregate states is of interest, since this also occurred in the 1930s (O'Hara, 1983). It suggests a government commitment to maintain "dividend" payments to the borrowers of mutuals under adverse circumstances. Interestingly, prior to the 1930s the FCS had mutual and joint stock components, but the mutual lenders of the FCS received greater government assistance in the 1930s (O'Hara, 1983, p. 438). Our analysis suggests why this might have been a natural outcome.

payments in order to redeem their stock before this could occur.¹⁷ Losing the low-risk borrowers in this way would exacerbate the problems faced by these FCS units. In order to avoid this, the stock redemption policies were adopted. High-risk borrowers, with inadequate cash flow, were much less likely to accelerate loan payments in order to redeem their stock. High-risk borrowers thus did not pose as much of an early redemption threat to the FCS and were not the target of the new FCS stock redemption policies.^{18,19}

Of course, the de facto dividends of recent years were paid only during the bad aggregate period of the 80s. This outcome is predicted by our theorems iff $p_H(1)/p_H(2) < p_L(1)/p_L(2)$. It is plausible that this inequality held. Relative to the good times of the 1970s, high-risk farm borrowers in the 1980s may have had a much harder time repaying loans than low-risk borrowers did. Unobservable ability and other unobservable risk factors may be less important in good aggregate states, keeping repayment probabilities of high- and low-risk borrowers more nearly equal.

Finally, we should comment on the charging of uniform interest rates prior to 1986 by the FCS. At first glance this may appear to be contrary to the predictions of the model. In particular, the same argument employed by Rothschild and Stiglitz (1976) can be used to show that this pooling of borrowers cannot be an equilibrium (if, as we assume, all lenders have identical costs of and access to capital) because some lender will have an incentive to bid away low-risk borrowers. However, as mentioned, the FCS enjoyed a cost advantage over its competitors in the 1970s, effectively insulating it from the competitive pressures which prevent pooling contracts from being offered. When this cost advantage was eroded in the mid-1980s, the FCS was forced to adopt a policy of charging differential rates. FCS officials even argued explicitly (see, e.g., Minneapolis Star and Tribune 2/26/86) that failure to adopt such a policy would have resulted in the loss of its low-risk borrowers to competitors, as predicted by the model.

¹⁷ Some anecdotal evidence indicates that low-risk borrowers were leaving the FCS for other lenders prior to the enactment of these stock redemption policies. See also Calomiris *et al.* (1986, p. 472).

¹⁸ See Calomiris *et al.* (1986), who also argue that FCS policies affecting stock redemption impact primarily on low-risk borrowers. That is, of course, because stock is redeemed only when loans are repaid.

¹⁹ A referee has raised the question of whether the "dividend" to FCS borrowers was part of the "normal lending arrangement" of the FCS. If by normal one means frequent, infrequent payments are not inconsistent with the analysis if $\pi(1)$ is small (if $s = 1$ is the state in which rebates occur). And if by abnormal one means that these payments were not explicitly contractually specified, that does not imply that FCS borrowers could not have reasonably expected them to occur under adverse aggregate experiences. The fact that recent experience parallels that of the 1930s (see O'Hara, 1983) suggests that such an expectation would not have been unwarranted.

IV. CONCLUSIONS

We conclude by anticipating some questions and discussing potential extensions. One question that arises is whether the FCS arose as a result of economic forces or was a purely political creation. As described by O'Hara (1983), the FCS was originally organized with mutual and joint stock components, although only the mutual component survived the Depression (with substantial government assistance). Furthermore, O'Hara suggests that political rather than economic forces favored the development of the mutual component of the FCS. Two observations are in order. First, the fact that political forces influenced the form of the FCS does not imply that this form has no economic justification. O'Hara herself notes (p. 427) that the actual form of the FCS was motivated by "the success of the (cooperative) land banks flourishing in Europe." In addition, the analysis of Section II can be viewed as suggesting why the mutual rather than the joint stock component of the FCS should have received greater government assistance in the case of bad aggregate realizations, as in fact occurred in the 1930s.

It remains to discuss several issues that we have abstracted from and which suggest some possible extensions. First, we abstract from the possibility that borrowers can post collateral and that lenders grant credit to applicants only with some positive probability. Given the structure imposed, it is possible to show that the latter abstraction is innocuous—credit will always be granted with probability 1. Collateral (as well as random granting of credit) is considered by Besanko and Thakor (1987b), and it would be interesting to investigate the role of collateral in the presence of aggregate uncertainty. Second, our analysis abstracts from the possibility that the amount of credit received affects the probability distribution of future income. (Calomiris *et al.* (1986) estimate some effects of credit market conditions on agricultural output.) Besanko and Thakor (1987a) also consider this situation, which could also be reexamined in the presence of aggregate uncertainty.

Third, the analysis could be extended to include more than two types of borrowers. Following Spence (1978), in equilibrium this would result in contracts solving a nested sequence of problems in which type i expected utility is maximized subject to self-selection constraints involving types $j < i$ (given type j contracts) and a zero profit condition. It seems likely that the solution to all of these problems (for $i > 1$) would involve concentrating old age consumption in one state, so that all types except the riskiest would be served by mutuals (although dividend payments would differ across types).

Finally, we have not investigated the behavior of financial mutuals other than the FCS. In fact, in another paper (Smith and Stutzer, 1988) we

consider this topic in an insurance context and find some empirical support for our hypothesis here in the medical malpractice insurance industry. Mutualization in that industry proceeded rapidly, following a marked increase in aggregate uncertainty, induced by unexpectedly broad court interpretations of contract terms.²⁰ However, a natural topic for further study would be a more extensive examination of credit union and mutual insurer behavior in light of the explanation for alternative organizational form proposed here and elsewhere.

APPENDIX I

The proof of the theorem will be a construction of equilibrium contracts. For the purposes of this construction, it will be convenient to work with consumption values c_1^i , $c_2^i(1)$, and $c_2^i(2)$. As before, the contracts offered to type H borrowers in equilibrium will be unconstrained by (14), the self-selection constraint for type L borrowers. Thus, the consumption values implied by these contracts must solve the problem

$$\max \beta_H c_1^H + \sum_s \pi(s) p_H(s) c_2^H(s) \quad (\text{A})$$

subject to

$$\sum_s \pi(s) p_H(s) [y - c_2^H(s)] - c_1^H = 0 \quad (\text{A.1})$$

$$c_2^H(s) \geq 0, c_1^H \geq 0, \quad (\text{A.2})$$

where (A.1) is the condition that the contracts offered to type H agents must earn zero expected (economic) profits net of dividend payments.

The solution to problem (A) has $c_2^H(1) = c_2^H(2) = 0$, and $c_1^H = \sum_s \pi(s) p_H(s) y \equiv y/R_H^*$ since $\beta_H > 1$. Given this solution, it is possible to reconstruct equilibrium contracts from (11) and (12). In particular, $c_1^H = \hat{x}_H = y/R_H^* = x_H^*$; i.e., the quantity loaned to type H agents is the same as before. From (12),

$$c_2^H(1) = 0 = y - \hat{R}_H \hat{x}_H + \hat{\alpha}_H(1) \psi_H(1)$$

$$c_2^H(2) = 0 = y - \hat{R}_H \hat{x}_H + \hat{\alpha}_H(2) \psi_H(2).$$

²⁰ See Danzon (1985), and Doherty and Dionne (1989).

Thus

$$\hat{\alpha}_H(1)\psi_H(1) = \hat{\alpha}_H(2)\psi_H(2) \quad (\text{A.3})$$

or

$$\hat{\alpha}_H(1)[p_H(1)\hat{R}_H - 1]\hat{x}_H = \hat{\alpha}_H(2)[p_H(2)\hat{R}_H - 1]\hat{x}_H. \quad (\text{A.4})$$

We will prove by contradiction that $\hat{\alpha}_H(1) = \hat{\alpha}_H(2) = 0$. First, suppose that $\hat{\alpha}_H(1) \neq 0$ while $\hat{\alpha}_H(2) = 0$. Then, because $\hat{x}_H = y/R_H^* \neq 0$, (A.4) implies that $\hat{R}_H = 1/p_H(1)$. Substituting $\hat{x}_H$, $\hat{R}_H = 1/p_H(1)$, R_H^* (from (7)), and $\psi_H(1) = 0$ into the expression for $c_2^H(1)$ above yields

$$y \left[1 - \frac{\pi(1)p_H(1) + [1 - \pi(1)]p_H(2)}{p_H(1)} \right] = 0.$$

But this implies $p_H(2)/p_H(1) = 1$, contrary to the assumption. Hence, this is impossible. Second, the same contradiction arises if $\hat{\alpha}_H(2) \neq 0$ while $\hat{\alpha}_H(1) = 0$, because (A.4) then implies $\hat{R}_H = 1/p_H(2)$, etc. Then it must be the case that $\hat{\alpha}_H(1)$ and $\hat{\alpha}_H(2)$ are both positive. Note that (A.3) and $\hat{x}_H \neq 0$ imply that $\psi_H(1) \neq 0$ and $\psi_H(2) \neq 0$ (since if $\psi_H(1) = \psi_H(2) = 0$ held, $\hat{R}_H = 1/p_H(1)$ and $\hat{R}_H = 1/p_H(2)$ would also hold, yielding the same contradiction as above). But then $\psi_H(1)$ and $\psi_H(2)$ must have the same sign. Since in equilibrium expected profits net of dividends must be zero, it must then be the case that $\hat{\alpha}_H(s) = 1/p_H(s)$, $s = 1, 2$. However, substitution of $\hat{\alpha}_H(s) = 1/p_H(s)$ into (A.4) again implies $p_H(1) = p_H(2)$, contrary to the assumption. Therefore, $\hat{\alpha}_H(1) = \hat{\alpha}_H(2) = 0$; i.e., lenders who service high-risk borrowers do not pay dividends. Finally, to complete the characterization of equilibrium contracts, we have seen that $\hat{x}_H = x_H^*$. Then, since expected profits must be zero, $\hat{R}_H = R_H^*$.

It remains to derive equilibrium contracts for type L agents. As above, these contracts must be maximal for type L agents among the set of contracts earning nonnegative profits and which are consistent with the binding self-selection constraint (13). Thus, consumption values resulting from these contracts must solve the problem

$$\max \beta_L c_1^L + \sum_s \pi(s) p_L(s) c_2^L(s) \quad (\text{B})$$

subject to

$$\beta_H c_1^H = \beta_H c_1^L + \sum_s \pi(s) p_H(s) c_2^L(s) \quad (\text{A.5})$$

$$\sum_s \pi(s) p_L(s) [y - c_2^L(s)] - c_1^L = 0 \quad (\text{A.6})$$

$$c_1^L, c_2^L(s) \geq 0. \quad (\text{A.7})$$

Equation (A.5) results from substituting the solution of problem (A) into (13), and (A.6) is the zero expected profit condition.

Solving (A.6) for c_1^L and substituting it into the objective function (B) and the constraint (A.5) reduces (B) to a linear programming problem in the two controls $c_2^L(1)$ and $c_2^L(2)$, with one constraint, (A.5). Thus, there is always an optimal solution with exactly one of the values $c_2^L(s) = 0$. Which state has zero consumption depends on the sign of $p_H(1)/p_H(2) - p_L(1)/p_L(2)$. When $p_H(1)/p_H(2) < p_L(1)/p_L(2)$ holds, then $c_2^L(2) = 0$, while $c_2^L(1) = 0$ in the other case. The entire solution when $p_H(1)/p_H(2) > p_L(1)/p_L(2)$, for example, is

$$\begin{aligned} c_1^L &= y/R_L^* - \pi(2)p_L(2)\gamma \\ c_2^L(1) &= 0 \\ c_2^L(2) &= \gamma, \end{aligned} \quad (\text{A.8})$$

where

$$\gamma = \beta_H y [R_L^{*-1} - R_H^{*-1}] / \pi(2) [\beta_H p_L(2) - p_H(2)] > 0,$$

and the inequality follows from $R_H^* > R_L^*$, $\beta_H > 1$, and $p_L(2) > p_H(2)$.²¹

If $p_H(1)/p_H(2) > p_L(1)/p_L(2)$, for instance, any equilibrium contract for type L agents must induce the consumption values given in (A.8). Then, using (11) and (12) to reconstruct the underlying contract, any Nash equilibrium contract $[\hat{R}_L, \hat{x}_L, \hat{\alpha}_L(1), \hat{\alpha}_L(2)]$ must satisfy

$$c_1^L = \hat{x}_L \quad (\text{A.9})$$

$$c_2^L(1) = 0 = y - \hat{R}_L \hat{x}_L + \hat{\alpha}_L(1) [p_L(1) \hat{R}_L - 1] \hat{x}_L \quad (\text{A.10})$$

$$c_2^L(2) = \gamma = y - \hat{R}_L \hat{x}_L + \hat{\alpha}_L(2) [p_L(2) \hat{R}_L - 1] \hat{x}_L. \quad (\text{A.11})$$

Clearly, (A.9) implies a determinate equilibrium loan quantity. Equations (A.10) and (A.11) constitute two equations in the three unknowns $\hat{R}_L$, $\hat{\alpha}_L(1)$, and $\hat{\alpha}_L(2)$. Many resolutions of the resulting indeterminacy are

²¹ It is straightforward to verify that $c_1^L > 0$, $y \geq \gamma$ holds if and only if $\pi(2)p_H(2)(\beta_H - 1) \geq \beta_H \pi(1)[p_L(1) - p_H(1)]$. If this condition is violated, Eq. (A.8) must be modified in an obvious way.

possible. We suggest two "natural" resolutions: One requires interest rates to be set in an "actuarially fair" manner, so that $\hat{R}_L = R_L^*$, and then (A.10) and (A.11) determine $\hat{\alpha}_L(1)$ and $\hat{\alpha}_L(2)$. But this implies $\psi_L(1) < 0$, however, while $\hat{\alpha}_L(1) > 0$, which would require type L borrowers to receive negative dividend payments when $s = 1$. In practice mutual organizations do not typically impose negative dividend payments. Thus, a more desirable resolution of the indeterminacy is to set $\hat{\alpha}_L(1) = 0$, in which case $\hat{R}_L = y/\hat{x}_L$ and (A.11) determines the desired positive value for $\hat{\alpha}_L(2)$. Then, the equilibrium type L contract has $\hat{R}_L = y/\hat{x}_L$, $\hat{x}_L = c_L^1$ (given by (A.8)), $\hat{\alpha}_L(1) = 0$, and $\hat{\alpha}_L(2) > 0$ (where $\hat{\alpha}_L(2)$ solves (A.11) given $\hat{R}_L$ and $\hat{x}_L$).²² In the other case, i.e., when $p_H(1)/p_H(2) < p_L(1)/p_L(2)$, a similar construction results in $c_L^1(2) = 0$ and $\hat{\alpha}_L(1) > 0$.

To prove part (c) of the theorem, note that it is feasible to set $\hat{\alpha}_L(1) = \hat{\alpha}_L(2) = 0$, or in other words, to set $c_L^1(1) = c_L^1(2)$ in problem (B). Since this is not the solution, the utility of type L borrowers must be (in this case strictly) higher than that in the equilibrium of Section II.B, where $c_L^1(1) = c_L^1(2)$ is imposed. Since type H borrowers are indifferent between the equilibria with and without dividend payment possibilities, this equilibrium represents a Pareto improvement over the equilibrium of Section II.B.

APPENDIX II

Arguments similar to those in Rothschild and Stiglitz (1976) continue to imply that any equilibrium must induce self-selection.²³ We then verify that, in the absence of a pooling contract preferred by type L agents to the solution of modified problem (P), the contracts described do constitute a Nash equilibrium.

To begin, it is apparent that no lender has an incentive to offer a contract that attracts only type H borrowers. In addition, no lender has an incentive to offer a contract which becomes the only contract purchased by type L agents, since by construction any such contract will also be purchased by type H agents (who may also enter into other contracts). This cannot be attractive to type L borrowers, because of the assumed absence of a preferred pooling contract.²⁴

Thus, if there is an incentive for a lender to offer any other contract, it

²² In fact, feasibility of this requires that the value $\hat{\alpha}_L(2)$ solving (A.11) with $\hat{R}_L \hat{x}_L = y$ also satisfies $\hat{\alpha}_L(2) \leq 1/p_L(2)$. This is henceforth assumed.

²³ Here it should be noted that, unlike Jaynes (1978), borrowers cannot purchase fractions of contracts.

²⁴ The absence of a preferred pooling contract continues to be implied, for instance, by the condition given in footnote 10.

must be a contract that is taken by type L borrowers *in addition* to the contract that solves the modified version of problem (P). There are then two cases to consider: (1) only type L agents take the additional contract, and (2) both types take the additional contract.

Case 1. Any contract that is mutually attractive to lenders and type L borrowers will involve type L agents receiving supplemental young period consumption of $\bar{x}$ in exchange for an old age repayment of $\eta \leq c_2^L(s)$ in that state s where they receive a dividend. Then for this contract to benefit type L borrowers and lenders, $\bar{x}$ and η must satisfy

$$\beta_L \bar{x} \geq \pi(s) p_L(s) \eta \quad (\text{A.12})$$

and

$$\pi(s) p_L(s) \eta \geq \bar{x}. \quad (\text{A.13})$$

In addition, since type H agents do not enter into this contract,

$$\beta_H \bar{x} \leq \pi(s) p_H(s) \eta. \quad (\text{A.14})$$

Finally, recall that the dividend payment occurs in state s iff $p_H(s)/p_L(s) \leq p_H(s')/p_L(s') \forall s, s'$.

Now (A.12)–(A.14) imply that $\beta_L/\beta_H \geq p_L(s)/p_H(s)$, while $p_L(s)/p_H(s) \geq p_L(s')/p_H(s')$. But this implies that $\beta_L/\beta_H \geq \sum \pi(s) p_L(s) / \sum \pi(s) p_H(s)$, contrary to assumption (SC). Thus, there is no incentive for any lender to offer a supplemental contract that attracts only type L borrowers.

Case 2. In this case there must be a supplemental value for young period consumption $\bar{x}$ and an old age repayment $\eta \leq c_2^L(s)$ (in that state where a positive dividend is received) such that $\beta_L \bar{x} \geq \pi(s) p_L(s) \eta$. In addition, since this contract attracts all borrowers in their population proportions, it must satisfy the nonnegative expected profit condition

$$\pi(s) [\theta p_H(s) + (1 - \theta) p_L(s)] \eta \geq \bar{x}. \quad (\text{A.15})$$

However, (A.12) and (A.15) imply that $\beta_L [\theta p_H(s) + (1 - \theta) p_L(s)] \geq p_L(s)$. Moreover, since positive dividends are paid in state s , $p_L(s)/p_L(s') \geq p_H(s)/p_H(s')$, so this condition holds for both states. But this contradicts the assumption contained in footnote 10, which was used to rule out pooling. So no lender has an incentive to offer a supplemental contract that attracts all borrowers. This completes the proof.

It might be noted that the solution to problem (P), modified by replacing (16) with (18), is exactly as described in Appendix I, with the following

modification. When $p_H(1)/p_H(2) > p_L(1)/p_L(2)$, for instance, γ in (A.8) is replaced by

$$\hat{\gamma} \equiv y(R_L^{*-1} - R_H^{*-1})/\pi(2)[p_L(2) - p_H(2)].$$

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