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THE ADVERSE SELECTION APPROACH TO FINANCIAL INTERMEDIATION: SOME CHARACTERISTICS OF THE EQUILIBRIUM FINANCIAL STRUCTURE

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ABSTRACT: This paper examines an adverse selection economy in which efficient resource allocation is supported by intermediary contracts (coalitions). Agents differ along an ex ante publicly observeable dimension, so that the equilibrium arrangement yields a diverse set of financial arrangements among borrowers, lenders and intermediaries. Loans made by intermediaries would appear to be mispriced relative to a naive benchmark that ignores the (unobserveable) adverse selection aspects of the environment. The model also yields an equilibrium mix of intermediated and direct finance which is broadly consistent with popular notions about the determinants of that mix.

CORRIGENDUM

On page 12, in part v) of Definition 5, the correct definitions of x'_g and x'_b are:

$$x'_g = \frac{\phi x_g}{\phi x_g + (1-\phi)x_b}$$

and

$$x'_b = \frac{(1-\phi)x_b}{\phi x_g + (1-\phi)x_b}.$$

Accordingly, equation (7) on page 13 should be

$$x_b = \frac{\phi\,[p_g y - (k-1+\frac{p_g}{p_b})r]}{(1-\phi)(kr-p_b y)},$$

so that the total number (measure) of type b's receiving investment goods is increasing in ϕ (subject to existence of an equilibrium for a given ϕ).

Introduction

The theory of financial intermediation has, in recent years, produced a variety of models of the role played by intermediation in the financing of productive activity. In many of these models, intermediary institutions arise as a response to a problem of information.[1] Among the various information problems which may constrain exchange in model economies, adverse selection may be particularly relevant to the use of intermediary organizations. The pre-contract information asymmetry in adverse selection environments has proven to be especially troublesome for the operation of classical market mechanisms.[2] One argument that arises from these difficulties is that social institutions might be expected to emerge that internalize the adverse selection problem. This is the approach taken by Miyazaki (1977) for the case of firms as internal labor markets and by Boyd and Prescott (1986) for the case of financial intermediaries.

In the Boyd and Prescott environment, agents are endowed with resources and with risky productive projects the productivity of which is private information. The allocation problem is, then, to sort agents so that no bad projects are funded with resources before providing before all good projects. This sorting is achieved through the use of two instruments. First, as in many private information environments, outcome contingent payment schedules can help induce self-selection. Second, a technology that delivers a noisy signal of an agent's type can be applied prior to the funding decision. It is this second instrument that links the Boyd and Prescott approach to much of the other recent work on theory of banking. This work often focuses on the information production activities of banks, although such production often takes the form of ex post monitoring as opposed to ex ante evaluation.

While the information production activities of banks and other intermediaries is clearly important, this paper focuses more directly on the implications of adverse selection per se. Indeed, in the Boyd and Prescott environment, it is adverse selection and not the mere presence of an information production technology that gives rise to the need for intermediaries. Under adverse selection, achieving an efficient allocation of resources sometimes requires cross subsidization of some agents by others. This sort of subsidization cannot be achieved in a nonintermediated market where each transaction must meet a common market rate of return. Hence, adverse selection can create a role for intermediation even in the absence of an explicit information production technology. This point was made by Lacker and Weinberg (1993).

This paper extends the adverse selection approach to financial intermediation in a way that seeks to allow the framework to address and interpret observations about cross sectional differences in financial relationships in an economy. This is done by examining an economy in which agents can be imperfectly distinguished by publicly observable characteristics. Agents retain exclusive private information, however, about the true productivities of their productive projects; publicly observed characteristics merely determine an agent's probability of having a particular type.

If all agents were identical ex ante (no public information), the model presented in section 2 below would be a special case of that in Lacker and Weinberg. For this special case, section 3 discusses the possible inefficiency of a non-intermediated market (securities market) equilibrium,

and presents the allocation that meets the requirements of cooperative solution concepts that have been the focus of Boyd and Prescott, Lacker and Weinberg (1993, 1995) and others. Section 4 then extends the results to the case with heterogeneous public information regarding agents and discusses some cross sectional characteristics of the equilibrium arrangement. One such characteristic is the pricing of loans. The presence of adverse selection results in pricing that is "smoother" across risk classes than would be implied by only publicly available information. An outsider's observation may well be based only on such public information, ignoring the fact that loans need to be structures to induce self selection among observationally identical potential borrowers. Hence, this model might provide an interpretation to the claims of some observers that banks tend not to fully adjust their loan pricing in response to observeable differences in credit risk.[3]

Many models of adverse selection imply an economy that is either entirely intermediated or entirely nonintermediated. In section 5, the model is extended to allow agents to overcome the adverse selection problem on their own, without the use of intermediated funds. Such direct financing, however, requires the expenditure of resources to publicly establish one's true type. If one assumes that the resource costs of "convincing the market" are decreasing in an agent's observeable quality, then the result follows that the best borrowers avoid by-pass the intermediated market and raise funds by issuing claims directly to investors. Such a general equilibrium model of an economy's mix of intermediated and direct financing is essential for evaluating and interpreting empirically observed trends in that mix, such as the much discussed "decline of banking."[4]

An additional feature of the adverse selection approach to financial intermediation is that it provides an alternative formalization of the notion of relationship banking. Other authors have noted the importance of multiperiod or multiproduct relationships in overcoming informational constraints. Typically, the formal description of a relationship is one in which the lender produces information about the borrower in the course of providing one product or service. This information then gives the lender a comparative advantage (and sometime monopoly bargaining power over the borrower) in providing an additional service. One example is Nakamura (1993), where information produced in the provision of deposit services enhances the bank's ability to monitor a borrower. In another example, analyzed by Rajan(1992) and Sharpe (1990), information produced in the process of lending to and monitoring a borrower in one period give the an advantage in subsequent lending.

The "relationship" in the present paper is similar to that in Nakamura, in that it involves a complementary between deposit and lending services. This relationship, however, involves no production of information, per se. Rather, the joint structuring of deposit and loan terms allow the bank to sort worthy from unworthy borrowers. This interdependence gives the bank a reason to favor its own depositors as borrowers. One result of this joint structuring of terms is that it would be difficult for an outsider to asses the profitability of bank services on a service by service basis. Some loans might appear to earn excess profits, while some deposit services might appear to be underpriced. In this economy, the margin of competition is the profitability of the entire package of services offered.

2. The Basic Economy

The economy is populated by a continuum of risk neutral agents, with a total measure of one. Each agent is endowed with some combination of productive abilities and productive resources. In particular, each agent is endowed with a single unit of the resource, which can be transformed into the economy's single consumption good either through investment in agents' projects or through investment in a risk free, constant returns to scale alternative. This alternative yields a return of r units of consumption good for each unit of investment.

Each agent has the ability to operate production projects. To operate, a project requires $k > 1$ units of the investment good. Projects are risky, with risk depending on a project's type, $i \in \{g,b\}$. A "funded" project of type i -- one that receives the necessary investment -- is successful with probability p_i. A successful project produces $y > r$ units of the consumption good, while an unsuccessful project produces nothing. Given r, the opportunity cost of investment, only type g projects are positive net present value investments. That is, $p_b y < r < p_g y$.

The type of an agent's project is that agent's private information. Each agent, however, also belongs to a *class*, which is publicly observed. An agent's class, indexed by $i \in (0,1,...,n)$, is informative about his productive type; a fraction ϕ_i $(1-\phi_i)$ of agents in class i have type g (type b) projects. An agent's class will also be referred to as the *observable* quality of the agent's project, with higher i indicating higher quality: $0 \leq \phi_0 < \phi_1 <...< \phi_n \leq 1$. The expected output from a randomly selected member of class i is $[\phi_i p_g + (1-\phi_i)p_b]y \equiv p_\phi y$. A class is identified both by its index i and its quality ϕ.

The distribution of the population across classes is given by the probabilities $f = (f_0, f_1, ..., f_n)$ with $0 < f_i < 1$ and $\sum_i f_i = 1$. The probability f_i gives the fraction of the population that is in class i. The mean of the distribution is $\bar{\phi} \equiv \sum_i f_i \phi_i$. There is a measurable set of agents who are known to have no profitable productive opportunity; that is, $\phi_0 = 0$. These agents participate in the economy only by investing their funds in the projects of others. On the other hand, there are no agents who are known to have a profitable project; $\phi_n < 1$.

Under full information, an efficient allocation of resources would fund no type b projects. Resources would be allocated to some combination of type g projects and the alternative investment. Assume that $\bar{\phi}k < 1$, so that the efficient allocation would include some investment in the alternative ($\bar{\phi}k$ is the total amount of resources required to fund all type g projects). In a full-information efficient allocation, total (expected) output would be

$$y^* \equiv \bar{\phi} P_g y + (1 - \bar{\phi}k) r. \qquad (4)$$

In this risk neutral economy, the social cost of private information, if any, can be measured by lost expected output relative to y^*.

Allocations

A general specification of allocations in this economy would include the allocation of the productive input across agents as well as an allocation of the final consumption good. An allocation of the investment good can be stated in terms of the fraction of agents of each type and class to receive the k units of investment necessary to operate a productive endeavor. Formally, an investment good allocation is a quantity, x_r, and a mapping denoted by $x(\phi) = (x_g(\phi), x_b(\phi))$. Here, $x_t(\phi)$ (t=g,b) is the fraction of type t agents in class ϕ receiving investment of k, and x_r is the amount of resources invested in the risk-free alternative. The consumption allocation, for an agent of type t (t=g,b) and class ϕ, is denoted by $c_t(\phi) = (c_t^s(\phi), c_t^f(\phi), c_t^0(\phi))$; superscript s (f) denotes that the agent operates a project and is successful (unsuccessful), while the superscript 0 denotes that the agent does not run a project. Finally, $c(\phi) = (c_g(\phi), c_b(\phi))$ denotes the overall consumption allocation.

An allocation $(c(\phi), x(\phi), x_r)$ is ***feasible*** if it is ***resource feasible***, ***incentive feasible*** (incentive compatible) and ***individually rational***. Resource feasibility, in turn, has two components. First, an allocation can use more than the total amount of the input available.

Definition 1: An allocation of the investment good, $(x(\phi), x_r)$, is feasible if

$$k\sum_{i=0}^{n}[\phi_i x_g(\phi_i) + (1-\phi_i)x_b(\phi_i)]f_i \le 1. \tag{5}$$

For completeness, one could add $F_0 x_b(0)k$ to the left-hand side. Leaving this term out presupposes that $x_b(0)=0$. The second part of resource feasibility concerns the distribution of the output.

Definition 2: An allocation of the consumption good, $c(\phi)$, is feasible if

$$y\sum_{i=0}^{n}[\phi_i x_g(\phi_i) + (1-\phi_i)x_b(\phi_i)]f_i + x_r$$

$$\sum_{i=0}^{n}\{\phi_i[x_g(\phi_i)(p_g c_g^s + (1-p_g)c_g^f) + (1-x_g(\phi_i))c_g^0] \tag{3}$$

$$+ (1-\phi_i)[x_b(\phi_i)(p_b c_b^s + (1-p_b)c_b^f) + (1-x_b(\phi_i))c_b^0]\}f_i.$$

Like equation (2), equation (3) incorporates the assumption that $x_b(\phi)=0$.

Equations (2) and (3) assume that agents take the allocations intended for their types. That is, resource feasibility is written assuming incentive compatibility.

Definition 3: An allocation $(c(\phi), x(\phi), x_r)$ is incentive compatible if

$$x_g(\phi)[p_g c_g^s(\phi) + (1-p_g)c_g^f(\phi)] + (1-x_g)c_g^0(\phi)$$

$$\ge x_b(\phi)[p_g c_b^s(\phi) + (1-p_g)c_b^f(\phi)] + (1-x_b)c_b^0(\phi) \tag{4}$$

and

$$x_b(\phi)[p_b c_b^s(\phi) + (1-p_b)c_b^f(\phi)] + (1-x_b)c_b^0(\phi)$$

$$\geq x_g(\phi)[p_b c_g^s(\phi) + (1-p_b)c_g^f(\phi)] + (1-x_g)c_g^0(\phi) \qquad \textbf{(5)}$$

for every ϕ in $(0,\phi_1,...,\phi_n)$.

Finally, agents cannot be forced to take an allocation that gives them less expected consumption than they could achieve on their own, by investing their resource endowment in the risk-free alternative.

<u>Definition 4</u>: An allocation $(c(\phi),x(\phi),x_r)$ is individually rational if for each ϕ in $(0,\phi_1,...,\phi_n)$ and t = g,b,

$${}_t(\phi)[p_t c_t^s(\phi) + (1-p_t)c_t^f(\phi)] + (1-x_t)c_t^0(\phi) \geq \qquad \textbf{(6)}$$

<u>Contracts and Institutions</u>

For analytical convenience, the definitions above specify feasibility requirements directly for consumption allocations, or outcomes that might be achieved by whatever market arrangement in which agents interact. The environment is suggestive of a credit market arrangement. Agents who wish to operate productive projects require outside funding. To secure this funding, they will be willing to offer to share some of their output with suppliers of funds. It would be straightforward to recast Definitions 1 - 4 in terms of allocations that specify: how many agents of each type in each class receive credit; the repayment made by an agent of a given type and class who has a successful (unsuccessful) project; and the return paid to an agent of a given type and class who invests funds in the projects of others.

This paper will focus on two particular types of credit market arrangement. In a *securities market* arrangement, agents compete for the funds of investors by offering contracts that specify the division of a project's output, between operator and investors, in the case of success and failure. These contracts are evaluated by the market given the market's expectation of the agent's type. This expectation will typically be affected by the agent's class and the nature of the contract offered. In an equilibrium of such a market, each contract that attracts funds must yield (in expected value) the market rate of return to investors.

The alternative arrangement is an *intermediated* credit market in which coalitions form with some agents participating as investors and others operating projects. In this arrangement, operators make payments to the coalition which, in turn, distributes payments to the investors. One can think of the intermediary coalition as being sponsored by an individual agent who offers a set of terms for prospective participants. Free entry and competition among intermediaries guarantee zero profits for sponsors.

The intermediaries imagined in this framework are essentially the same as those proposed in Boyd and Prescott (1986) and Lacker and Weinberg (1993). In both of those papers, such coalitions were able to achieve allocations that could not be attained by a securities market. The solution concepts used in this work are adaptations of the core. Unlike the earlier papers, section 5 examines a case in which intermediated finance and a direct securities market can coexist.

3. The Case of a Single Class

It is useful to begin with the behavior of a version of the economy in which all agents belong to a single class. That is, the entire population is characterized by a single prior probability of being type g. This probability, ϕ, satisfies $\phi k < 1$. Such an economy is a special case of that studied in Lacker and Weinberg (1993). Hence, proofs of the propositions in this section are omitted. It is, nevertheless, instructive to examine the outcomes of both a securities market and an intermediary arrangement for this case.

It has long been recognized that in this type of adverse selection environment, a securities market equilibrium, in which each transaction stands on its own, can yield inefficient outcomes. For instance, de Meza and Webb (1987) argue that *overinvestment* is a generic characteristic of equilibrium in these economies. In the present case overinvestment means that, in equilibrium, some type b agents attract funds and operate their production projects. The economy, then, suffers the deadweight loss of some amount of negative net value investments. This is stated more formally below.

Definition 5: A securities market equilibrium for an economy with a single class ϕ consists of an allocation (c,x) and a market rate of return ρ such that

i) for t=g,b, $c_t^0 = \rho$;
ii) for t=g,b, if $x_t > 0$, then $p_t c_t^s + (1-p_t)c_t^f \geq \rho$;
iii) for t=g,b, if $x_t < 1$, then $p_t c_t^s + (1-p_t)c_t^f \leq \rho$;
iv) if $x_r > 0$, then $\rho = r$;
v) if $(c_g^s,c_g^f) = (c_b^s,c_b^f) = (c^s,c^f)$ then $(x_g' p_g + x_b' p_b)(y-c^s) - (x_g'(1-p_g)+x_b'(1-p_b))c^f \geq (k-1)\rho$, where $x_t' = x_t/(x_g+x_b)$; and
vi) if $(c_g^s,c_g^f) \neq (c_b^s,c_b^f)$, then $p_t(y-c_t^s)-(1-p_t)c_t^f \geq (k-1)\rho$ if $x_t > 0$.

Condition i) states that an agent that does not attract funds to operate a project earns the market rate of return on his or her endowment of the investment good. Conditions ii) and iii) concern the demand for funds by type t agents; if type t agents can earn more by investing, none will seek to operate projects. Conditions iv) - vi) require that positive amounts of investment only go to type t projects (or to the alternative) if the expected return meets the market rate. Incorporated into condition v) is the condition that, if both type g and b agents offer the same contract, investors evaluate the contract using the proportions of type g and b agents offering it.

Proposition 1: With a single class of agents with $\phi k < 1$, a securities market equilibrium allocation is characterized by:
i) $x_g = 1$, $x_b < 1$, $c_g^f = c_b^f = 0$, and $c_b^0 = \rho = r$:
ii) if $p_g y \leq r[k - 1 + p_g/p_b]$, then $x_b = 0$; and
iii) if $p_g y > r[k - 1 + p_g/p_b]$, then $x_b > 0$, and $c_b^s = c_g^s$.

Part iii) of this proposition is an example of the "overinvestment" result of deMeza and Webb (1987); if the good type is sufficiently good, and if the bad type is not too bad, a securities market equilibrium under adverse selection cannot prevent at least some bad investments from being made. These results can be understood in terms of Figure 1. In (c^s,c^f) space, an investor's consumption, in an equilibrium with positive investment in the risk-free alternative, can be represented by the point (r,r). A separating contract, one that will be offered only by type g agents, must lie on or below

the type b indifference curve through (r,r), the line labeled B. Type g indifference curves are flatter and correspond to iso-profit curves for investments in type g contracts. Hence, the lowest return a type g agent can offer, without inducing type b's to offer the same contract, is at the intercept of B, ($0, r/p_b$). If $p_g(y - r/p_b) > (k-1)r$, this contract strictly exceeds the opportunity cost of investors' funds. This cannot be an equilibrium, since there are not enough type g investments to satisfy the demand for the return stream. As the return gets bid down, type b's are drawn into the role of operating projects.

The equilibrium characteristics identified above are conditional on the existence of an equilibrium. An equilibrium always exists when the condition in part ii) is satisfied. Under part iii), existence depends on the size of x_b, which is found by solving condition v) in definition 5, at equality, with $c^f = 0$ and $x_g = 1$. The result is

$$x_b = \frac{p_g y - (k - 1 + p_g/p_b)}{kr - p_b y}. \qquad \textbf{(7)}$$

An equilibrium exists if *it is* possible to fund x_b of the type b agents, together with all type g's, without exhausting total resources. That is, if

$$[\phi + (1-\phi)x_b]k \le 1. \qquad \textbf{(8)}$$

Note that as ϕ gets close to 1 (8) will be violated. Assume for now that this is not the case.

While the securities market arrangement requires that every transaction stand on its own, theories of financial intermediaries in adverse selection environments have posited multilateral arrangements that break-even across all the parties to the arrangement but in which some individuals may pay or receive more than their apparent "market values." In the present case, such "cross-subsidization" takes the form of some project operators paying (and some investors receiving) more than r in expected value.

The notion of an intermediary is formalized by a core-like requirement on allocations. That is, an equilibrium allocation is one that leaves no incentive for any coalition of agents to break-off and allocate their own resources among themselves. Such a deviation would have to satisfy incentive and resource feasibility constraints for the deviating coalition. Such core-like solutions for adverse selection economies typically involve additional requirements on deviating coalitions, reflecting a coalition's inability to prevent unwanted members from joining (see Boyd and Prescott (1986), Boyd, Prescott and Smith (1988), Marimon (1988) and Lacker and Weinberg (1993)). While there are differences in the way a solution is defined, the prediction tends to be the same across definitions. Since an efficient, feasible allocation often requires subsidization of "low types" by "high types," the high types (type g in the present model) have the greatest potential incentive to deviate. In a core-like solution this fact drives the allocation to that most favored by the high types among all resource and incentive feasible allocations. In the present model, that allocation can be found as the solution to:

$$\max_{(c,x)} \; x_g[p_g c_g^s + (1-p_g)c_g^f] + (1-x_g)c_t^0 \qquad (P\ )$$

(subject to) (2), (3), (5) and (6) (note that (6) states the individual

rationality constraint for both types, while for the purposes of this problem, only individual rationality for type b is relevant).

While this solution concept is cooperative, Asheim and Nilssen (1994) have recently presented a market setting that has the same allocation as its unique noncooperative equilibrium.[5] Relatedly, Wilson (1979) and Hellwig (1987) have noted that changes in the strategic form assumed for noncooperative analysis of adverse selection environments can have significant effects on predicted outcomes. The cooperative approach represents an attempt to treat the institutional setting (which determines the game played by market participants) as endogenous. Miyazaki (1977) was among the first to make such arguments for a cooperative solution based on a problem like (P) in adverse selection settings.

In some cases, the cooperative solution coincides with the securities market equilibrium described above. In particular, when condition ii) of proposition 1 is satisfied, type g agents can do no better than to accept a contract $(c^s_g, c^f_g) = (y - (k-1)r/p_g, 0)$. This contract, when taken only by type g agents, pays a rate of return r to investors and lies below the type b indifference curve through (r,r) (B in Figure 1). In this case, one might say that a securities market is an efficient institutional setting.

In other cases, when condition ii) of proposition 1 is not satisfied, the securities market is not an efficient institution. In these cases, the solution to problem (P) is quite different from the securities market equilibrium.

<u>Proposition 2</u>: With a single class of agents with $\phi k < 1$, a solution to problem (P) is characterized by:

i) $x_g = 1$, $x_b = 0$, $c^f_g = c^f_b = 0$;

ii) if $p_g y \leq r[k - 1 + p_g/p_b]$, then $c^0_b = r$ and $c^s_g = y - (k-1)r/p_g$; and

iii) if $p_g y > r[k - 1 + p_g/p_b]$, then $c^0_b = p_b c^s_g > r$ and $c^s_g = [\phi p_g y + (1-\phi k)r]/[\phi p_g + (1-\phi)p_b]$.

The fact that $c^f_g = 0$ follows from the linearity and differences in slopes of type g and b indifference curves. Since the type g indifference curve is flatter, in trying to separate from type b's type g agents will want to move as far up and to the left as possible along the type b indifference curve. When the inequality in the condition for part ii) is strict, there is an indeterminacy in the solution; in Figure 1, c_g can lie anywhere on G_0 between the verticle axis and B. Part iii) follows directly from the constraints (3) and (5) with $x_g = 1$, and $x_b = c^f_g = 0$. Constraint (5) reduces to $p_b c^s_g \leq c^0_b$. Using this equation at equality and substituting into (3) at equality yields c^s_g. The result is an incentive compatible consumption allocation that implements the full information efficient allocation of resources. Further, it is clear that this allocation is the best such allocation for type g; any other would require introducing slack into either (3) or (5).

The case identified by part iii) in each of the propositions above is a case in which a securities market is not an efficient institutional arrangement. An alternative arrangement takes the form of an intermediated market. Imagine a market in which intermediaries (with free entry into the role of intermediary) seek to attract the funds of agents by offering a fixed return on investments. An intermediary then makes offers of credit to those agents who have placed their funds with that intermediary. Such an arrangement is very similar to the game analyzed by Asheim and Nillsen. Here, the offer of credit to agents who have already placed their funds with the intermediary takes the form of the renegotiation stage. Agents will rationally anticipate the outcome of this stage, so competition among intermediaries can alternatively be thought of as competition in the offer of bundled credit and investment services. This suggests a reinterpretation of the allocation in part iii) of proposition 2. In a zero-profit (due to free entry) equilibrium, intermediaries issue a claim worth c_b^0 for each unit deposited of the investment good endowment. Each intermediary then offers a loan to all of its depositors. The promised return on the loan is $y + c_b^0 - c_g^s$. The loan is secured by a borrower's deposit claim; if the borrower is unsuccessful, the claim to c_b^0 is forfeited. This loan offer induces self-selection; only the type g agents prefer to take out a loan.

In this environment, if investment (deposit) services and lending were both required to stand on their own, then there would be no distinction between intermediated and nonintermediated arrangements. Simultaneous competition among intermediaries in two distinct markets (raising funds and attracting borrowers) would lead to the same (overinvestment) equilibrium as the securities market arrangement. Intermediaries have a role here because of their ability to offer bundles of services which may not break even on a service-by-service basis.

The above discussion has assumed that the aggregate endowment of investment good is more than sufficient to fund all type g projects. That is, $\phi k < 1$. If, instead, ϕ is big enough that funding all type g's more than exhausts the aggregate resource endowment, the solution to problem (P) is somewhat different from that given in proposition 2. Also, when $\phi k > 1$, the securities market equilibrium, if it exists, coincides with the solution to (P).

Proposition 3: If $\phi k > 1$, then in a solution to (P) or in a securities market equilibrium

i) $x_b = 0$, $x_r = 0$, $x_g = 1/\phi k$, $c_g^0 = 0$;

ii) if $p_g y \le [1 - \phi + \phi p_g/p_b]kr$, then $c_b^0 = r$ and $c_g^s = [p_g y - (1-\phi)kr]/p_g$; and

iii) if $p_g y > [1 - \phi + \phi p_g/p_b]kr$, then $c_g^s = \phi p_g y/[\phi p_g + (1-\phi)p_b]$ and $c_b^0 = p_b c_g^s/\phi k$.

In this case, only a fraction of the type g agents receive funding. Setting $c_g^0 = 0$ provides the least cost (in terms of type g's expected consumption) means of inducing self selection. Then, as in proposition 2, the consumption allocation is found by solving the resource feasibility constraint and type b's incentive compatibility constraint at equality. A single-class economy with $\phi k > 1$ is constrained in the sense that both types of agent receive lower expected consumption than that identified by parts ii) and iii) of proposition 2. Such a class of agents could benefit from coexistence with an unconstrained class, one with positive investment in the alternative ($x_r > 0$) in a solution to (P); the marginal value of investment in the constrained class is $p_g y/k$, compared to r in the unconstrained class.

4. Multiple classes

The behavior of this economy is not significantly changed by the presence of multiple classes of agents. Under the securities market institutional arrangement, the market can be effectively segmented by class,

since an agent's class is observed. Hence, there are n securities offered, each a claim to the residual from a contract ($c^s(\phi_i)$,$c^f(\phi_i)$) for each i from 1 to n (there is no security for class 0 since class 0 agents are known to be type b with certainty). Each security yields an expected rate of return equal to r, and there is positive investment in the risk-free alternative (so long as $\phi k < 1$).

Notice that the conditions in parts ii) and iii) of proposition 1 do not depend on ϕ. From equation (7), it is apparent that x_b is also independent of ϕ. Therefore, a securities market equilibrium, if one exists, is the same for all classes. Types of agent are efficiently separated either for all classes or for none. A sufficient condition for existence of an equilibrium for all classes would be for equation (8) to hold for $\phi = \phi_n$. An alternative, weaker sufficient condition is for there to be enough agents in class 0 to cover the financing need for all classes for which (8) fails. That is, suppose ϕ_e is the quality of the first class for which (8) fails, $1 \leq e \leq n$. Given that class quality (ϕ) is increasing in the index, (8) also fails for all classes above e. Assume that

$$\sum_{i=e}^{n}\{[\phi_i + (1-\phi_i)x_b]k - 1\}f_i \;\leq\; f_0, \tag{10}$$

where x_b is given by (7). Under this assumption, the securities market equilibrium exists and is the same for all classes.

The cooperative solution for the multiple classes also follows directly from the case of a single class. A similar potential difficulty arises; a high quality (high ϕ) class may not have enough resources to finance all of its type g agents without drawing resources from one or more other classes. This will be the case if $\phi k > 1$. Let class m be the lowest class for which this is true. Notice that this is at least as high as class e, defined above as the lowest for which (8) fails. Classes e and m are the same when $p_g y \leq [k - 1 + p_g/p_b]r$, (the case when $x_b = 0$ in the securities market equilibrium). Otherwise, e is lower than m. Hence, under assumption (10), there is a big enough class of pure investors that classes m through n can fully fund their type g agents. Note that this means that these classes will have a different allocation from what they could achieve in isolation. It is true, however, that a class's stand-alone allocation puts limits on the consumptions of agents in a cooperative (intermediated) solution.

<u>Lemma 1</u>: If $p_g y > [k - 1 + p_g/p_b]r$, then, in a cooperative solution, there is no subsidization across classes. That is, each type in each class receives at least the expected consumption that would result from that class's stand-alone solution to problem (P).

This result would follow immediately from the construction of a weighted maximization problem where the maximand is the weighted sum (across classes) of that in (P), with the weights equal to population fractions of each class. The equivalents of constraints (2) and (3) would have to hold across classes, while there would be a constraint (5) and (6) for each class. However, proposition 2 relied on results obtained elsewhere in the literature to argue that the solution to problem (P) met the core-like requirement of being immune to deviations from coalitions of agents. It may not be obvious that those results transfer to the multiple class case. Note, then, that no type g agents can be given expected consumption less than what they would get in

their own class's solution to problem (P). If type g agents in some class are receiving less, while type b agents in the same class are receiving no more, than they can deviate from the allocation and provide themselves with their solution to (P); this follows from the pareto optimality (within a class) of solutions to (P). If type g agents in some class receive less than in their single class solution to (P), while type b agents are receiving more, then the type g's can deviate together with some of the type b's in the class to achieve the solution to (P) for a higher ϕ; this follows from the fact that the expected consumption of type g's in solutions to (P) is increasing in ϕ. This last argument is a direct application of the logic in Lacker and Weinberg (1993).

While agents in each class must receive at least the expected consumption they can achieve in the class's stand-alone solution to (P), some classes may receive more. In particular, under the assumption that $\phi k < 1$, all type g agents can be funded, even though some classes would be constrained if required to stand alone. Imagine that each class acts as a coalition. A class with $\phi k > 1$ can offer a class with $\phi k < 1$ a return of r on resources that the latter would otherwise invest in the risk-free alternative. The latter class would, then, be indifferent between investing the funds itself and forwarding them to the class with $\phi k > 1$. In this scenario, the constrained class ($\phi k > 1$) collects all the gains from the inter-class transaction. One might imagine that those gains could be allocated in some other way. The existence of a sizeable number (measure) of agents in class 0, however, will serve to keep the cost of inter-class funding at the "competitive" rate of r. In short, we have the following.

<u>Proposition 4</u>: If (10) is satisfied, a multiple-class cooperative solution is is given by an allocation ($c(\phi), x(\phi), x_r$) with $x_r = 1-\phi k$, and for i = 0,1,...,n, ($c(\phi_i), x(\phi_i)$) is given by proposition 2.

One implication of the above is that agents in class 0, all of whom are type b, earn a return of r on their investments, whether they invest in the risk-free technology or in the projects of agents in other classes.

As before, this allocation can be interpreted as the result of an intermediated market in which intermediaries first attract deposits of agents' resource endowments by offering a fixed consumption-good payment of c_b^0. Next intermediaries offer loans to their depositors. The loans, collateralized by the deposit claim, require a repayment of $R_g = y + c_b^0 - c_g^s$. The difference in the multiple class case is that these contractual terms must be functions of agents' class. Since class is public information, contractual terms to different classes can be treated as distinct products in a competitive, intermediated market (in which any agent can act as an intermediary).

The essence of the intermediated solution is that there is cross subsidization between types. The return to depositing one's funds with an intermediary must be sufficient to induce type b agents to not claim to be type g's by seeking to take out loans. In the case identified by parts iii) of propositions 1-3, such a return must exceed r. To support such a return with zero profits or losses for the intermediary, expected payments on loans must exceed r. Hence, loans in this economy might appear to be "mispriced" when observed in isolation from the broader arrangement determining allocations.

One way of viewing the apparent mispricing of loans is by comparison to an admittedly "naive" benchmark. Suppose that one observed loans made to

agents in an array of risk classes, but that one was unaware of the underlying adverse selection problem. That is, suppose that one assumed that no participant in the economy had more prior information than simply that the probability of success for a member of class i was $\phi_i p_g + (1-\phi_i)p_b \equiv p_\phi$. Then, one might expect competitive pricing of loans to result in the following. Agents with $p_\phi y \geq kr$ receive loans with a repayment, upon successful production of $R(\phi) \equiv (k-1)r/p_\phi$. Agents with $p_\phi y < kr$ do not receive loans. The comparison of $R(\phi)$ to $R_g(\phi) = y + c_b^0(\phi) - c_g^s(\phi)$ is as depicted in Figure 2.

There are two notable features of the comparison given in Figure 2. First, $R_g'(\phi) > R'(\phi)$ (over the range of ϕ for which $p_\phi y \geq kr$), so that intermediary loan pricing is less sensitive to public information than the benchmark. Second $R_g(\phi)$ crosses $R(\phi)$, so that there is a range of (relatively high quality) classes for which intermediary loans appear to be overpriced. This apparent overpricing might seem to make the intermediated allocation vulnerable to deviations by agents in high classes, if they can make credible securities offers directly to investors. The next section introduces a technology for making such offers.

5. A Certification Technology

Since type g agents pay a subsidy to type b's in the intermediated allocation, they may have an incentive to spend resources to distinguish themselves, if such distinction allows them to raise funds without paying the subsidy. Suppose that type g agents have the ability to certify their type at a cost. Suppose, further, that the cost to a type b agent of mimicking such actions is prohibitive. Finally, suppose that the cost of certification depends on an agent's class. This last assumption is intended to capture the notion that it is harder to establish that one is a type g if one comes from a class that is mostly type b's than if most of one's classmates are also g's. A type g agent's certification cost is, then, represented by a function $\gamma(\phi)$ with $\gamma(1)=0$, $\gamma'(1)=0$, $\gamma'(\phi)<0$ and $\gamma''(\phi)>0$ for $0<\phi<1$, and $\gamma(0)>y$. The last assumption assures that there are some ϕ for which certification would never be worthwhile.

If a type g agent sought to incur the certification cost and raise funds at the "competitive" rate, r, the total amount of funds needed is $k + \gamma(\phi) - 1$. The agent will need to make a payment upon success such that the expected payment is $[k + \gamma(\phi) - 1]r$. Hence the agent's expected consumption is

$$c_\gamma(\phi) = p_g y - (k + \gamma(\phi) - 1)r.$$

A type g agent will incur the cost of a demonstration if doing so raises expected consumption. That is, type g agents in class ϕ will issue securities directly to the market if $c_\gamma(\phi) \geq p_g c_g^s(\phi)$. Given the assumed properties of the function $\gamma(\phi)$, the following is straightforward.

<u>Proposition 5</u>: There is a ϕ^*, $0 < \phi^* < 1$, such that $c_\gamma(\phi) > p_g c_g^s(\phi)$ for all ϕ,

$\phi^* < \phi < 1$ and $c_\gamma(\phi) < p_g c_g^s(\phi)$ for $\phi < \phi^*$.

Type g agents about whom public information is the most favorable find it worthwhile to incur the cost of distinguishing themselves from type b agents. This suggests an organizational structure that includes both intermediated and direct financing of projects. With this basic structure it is possible to perform a number of comparative statics exercises. How, for instance, is the mix of direct and intermediated financing affected by a general improvement in technology that increases y? What is the effect of a tax on intermediated finance? The answer to the latter question is what one would expect. A tax on intermediation lowers ϕ^*, leading more agents to seek direct financing. This occurs simply because a tax shifts $p_g c_g^s(\phi)$ down (at all while not affecting $c_\gamma(\phi)$.

Many current discussions of trends in banking focus on such affects of the (presumably rising) regulatory tax on banks. By allowing a treatment of the first question, the present model helps put such discussions in a clearer context. It turns out that an increase in y has qualitatively the same effect as the introduction of a tax; ϕ^* falls. Hence, the model allows one to examine what would happen to the equilibrium financial structure in the absence of regulatory and tax effects. Such examination can strengthen one's understanding of observed trends in financial structure.

Other features of the model contribute to the determination of the financing mix. Clearly, the distribution of agents across classes (F) has implications for the size of the relative sizes of the intermediated and direct finance sectors. Changes in this distribution might be caused by demographic changes or by changes in technology that affect the economy's mix of skills and activities that are matched in productive projects.

Conclusion

This paper has followed in the line of research examining the role that financial intermediation can play in allocating resources in the presence of adverse selection. The intermediated solution to the adverse selection problem typically involves some subsidization of "bad types" by "good types." Hence, it may appear to someone observing the behavior of such an economy that the good types are getting a raw deal. In fact, there is a sense in which the apparent severity of the raw deal increases as the severity of the adverse selection problem decreases. In the model above, this shows up in the "smoothing" of loan pricing across classes. Good types in high quality classes pay a greater subsidy than do those in lower classes.

In the model above, direct financing emerges as a way for high quality borrowers to by-pass the cross subsidization inherent in intermediated financing. There is a sense in which the resources spent in this by-pass activity represent socially wasteful expenditures. Aggregate consumption in an economy in which such by-pass was impossible would be greater than in an otherwise identical economy with by-pass. Note, however, that this aggregate improvement would not be a pareto improvement, since high quality borrowers are made better off by the availability of the direct finance route. Nevertheless, the difference in aggregate consumption might lead some to read this model as an endorsement of bank-dominated financial systems, such as that in Germany, as compared to systems like that in the U.S., in which securities markets play a greater role. Such a reading would be mistaken, because the model assumes that there are no resource costs associated with financial

intermediation. It would be possible to introduce such a cost into the model; its treatment would be similar to that of a tax on intermediation. With such an addition, movement of some borrowers from intermediated to direct finance could well have an ambiguous affect on the aggregate use of resources in financial activities.

Arguments concerning the relative merits of alternative financial structures or interpretations of observed changes in such structures are often made without explicit reference to a coherent model of the determination of the mix of financial arrangements. Without such a model, normative statements are difficult to evaluate. Since the financial structure of a modern economy is rather complex, the modelling task is challenging. Perhaps we must begin with small steps, such as that offered in this paper.

1. Recent surveys of financial intermediation theory are found in Bhattacharya and Thakor (1994) and Dewatripont and Tirole(1994).

2. The problems with standard types of competitive market interaction can be seen in the possible non-existence or non-optimality of equilibrium in the Rothschild and Stiglitz (1976) insurance model. In a more general setting, Prescott and Townsend (1984) find that the adverse selection environment is the only one of the private information environments they examine for which they cannot prove a standard welfare theorem on the optimality of competitive equilibrium.

3. Such comments have been made, for instance, in speeches by Federal Reserve Chairman Greenspan.

4. See, for instance, Boyd and Gertler (1994).

5. Asheim and Nillsen examine a two stage game in which intermediaries (insurance firms in their model) first compete for customers by offering sets of contracts. In the second stage, intermediaries are allowed to engage in multilateral renegotiation with the customers they attracted in the first stage. In equilibrium, the contracts offered in the first stage are immune to such renegotiation.

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