NBER WORKING PAPER SERIES

FINANCIAL FRAGILITY AND ECONOMIC PERFORMANCE

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Working Paper No. 2318

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 1987

We thank Andrew Caplin, Douglas Diamond, Avinash Dixit, Mark Feldman, Greg Mankiw, Robert Moore, Barry Nalebuff, and David Romer. The research reported here is part of the NBER's research programs in Financial Markets and Monetary Economics and Economic Fluctuations. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

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ABSTRACT

Applied macroeconomists (e.g., Eckstein and Sinai (1986)) have stressed the role of financial variables, such as firm balance sheet positions, in the determination of investment spending and output. Our paper presents a formal analysis of this link. We develop a model of the process of investment finance in which there is asymmetric information between borrowers and lenders about the quality of investment projects and about the borrower's effort. In this model, the cost of external investment finance under the optimal contract is higher, the worse the borrower's balance sheet position (i.e., the lower his net worth). In general equilibrium, the lower is borrower net worth, the further the number of projects initiated and the average quality of undertaken projects will be from the unconstrained first-best.

We characterize a "financially fragile" situation as one in which balance sheets are so weak that the economy experiences substantial underinvestment, misallocation of investment resources, and possibly even a complete investment collapse. Our policy analysis suggests that, under some circumstances, government "bailouts" of insolvent debtors may be a reasonable alternative in periods of extreme financial fragility.

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1. Introduction. Given tastes and productive technologies, is there some sense in which general financial conditions (e.g., financial "stability") exert an independent effect on the macroeconomy? Policy-makers appear to think so: Concerns about financial stability are a principal motivation for regulation of banking and securities markets and are a factor in monetary policy. Applied macroeconomists, also, have stressed the role of financial conditions (specifically in most cases, the state of aggregate and sectoral balance sheets) in the propagation of aggregate fluctuations. In the DRI model, for example, procyclical movements in the ratio of net worth to liabilities of borrowers feed back into the determination of real activity; Eckstein and Sinai (1986) claim that this mechanism is in fact important for explaining the volatility of output. Kaufman (1987) and Friedman (1987) have discussed the implications of the recent buildup of aggregate and business-sector inside debt for the economy and for economic policy. Mishkin (1978) and Bernanke (1983) have argued that balance-sheet factors contributed to the severity of the Great Depression.

Recently, the development of models of financial and credit markets which focus on the assumption of asymmetric information has allowed economic theorists to begin an investigation of the real effects of financial market imperfections.[1] This growing theoretical literature, however, has so far not produced a consensus on what mechanisms are most central for understanding the interactions of the real and financial sides of the economy.

Our own work (Bernanke and Gertler (1986, 1987)), like the applied literature, has pursued the notion that balance sheets are critical. In particular, we have singled out the net worth positions of borrowers as the key factor. Our basic argument is as follows: Generally, the more a borrower is able to invest in

1 Recent articles with a macroeconomic emphasis include Smith (1983), Farmer (1984), Boyd and Prescott (1986), Williamson (1985), Mankiw (1986), Greenwald and Stiglitz (1986), Calomiris and Hubbard (1986), and de Meza and Webb (1987). For a very general analysis of competitive markets under asymmetric information, see Prescott and Townsend (1984).

his own "project" (equivalently, in the models we have used, the more he is able to put up as collateral), the less his interests will diverge from the interests of those who have lent to him. When the borrower has both superior information than the lenders about his project, as well as the ability to take actions that affect the distribution of project returns, a greater compatibility of interests reduces the agency costs associated with the investment process. Thus, if borrowers as a whole have stronger balance sheet positions (have a higher ratio of net worth to liabilities) then, ceteris paribus, the macroeconomic equilibrium is more efficient. In this view, a "financially fragile" situation is one in which potential borrowers (those with most direct access to investment projects, or with the greatest entrepreneurial skills) have low wealth relative to the size of their projects. Such a situation (which might occur, e.g., after a prolonged recession or a "debt-deflation"[2]) leads to high agency costs and thus to poor performance in the investment sector and in the economy as a whole.[3]

The present paper develops the financial fragility theme further. We study an economy in which entrepreneurs (or, possibly, corporate managers) evaluate potential investment projects, then undertake those projects which seem sufficiently worthwhile. Evaluation is costly, with the cost varying across individuals. (Individuals with low evaluation costs endogenously become the entrepreneurs.) An important assumption is that entrepreneurs (who must borrow in order to finance projects) know more about the success probabilities of the project they evaluate than do potential lenders. As in Myers and Majluf (1984) and others, this informational asymmetry introduces an Akerlof (1970) "lemons"

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2 The term is due to Irving Fisher (1933); see Bernanke and Gertler (1986) for an analysis.

3 As emphasized in Bernanke and Gertler (1986), the mechanism through which financial factors affect real activity need not involve credit rationing. The agency costs of investing could manifest themselves in an increased cost of capital, for example. We believe economists often incorrectly use "credit rationing" as a generic term to describe a situation where financial factors matter. More importantly, whether credit rationing exists is not key to the debate over whether financial factors matter.

problem in the issuance of securities. This lemons problem (which is more severe, the lower is borrower net worth) raises the prospective costs of finance and thus affects the willingness of entrepreneurs to evaluate projects in the first place. We show that, in general equilibrium, both the quantity of investment spending and its expected return will be sensitive to the net worth positions of potential borrowers (i.e., the entrepreneurs). This result is quite robust to a number of extensions of the model.

The model used here is richer than those of our previous work in a number of respects. Perhaps most importantly, the framework employed here applies to firms which may issue a variety of liabilities, including equity as well as debt. In our earlier papers (and in much of the literature on credit markets and imperfect information), the analysis is limited to markets in which debt is the only instrument for raising funds.[4] Thus, the theoretical link that we establish here between balance sheet positions and investment is potentially applicable to a broad class of firms. The approach of this paper also makes it easier to motivate quantitatively significant real effects for financial factors: Indeed, in this setting, a decline in borrowers' net worth below an endogenously determined limit will (in some variants of the model) precipitate a complete collapse of credit markets and investment.

The paper also contains some novel policy results. The most striking of these is that, if good entrepreneurs are to some degree identifiable, then a policy of transfers to these entrepreneurs (akin, perhaps, to the mass "bailout" of debtors that occurred during the New Deal) may increase output and social welfare.

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4 A distinction between the preponderance of the literature and our earlier work is that most authors have simply assumed that borrowing is done via debt, while we have focused on environments in which debt can be shown to be the optimal contract form.

We have organized the paper as follows: sections 2 through 4 develop the basic model. Extensions of the model are taken up in section 5. Section 6 discusses optimal policy in this framework, and section 7 concludes.

2. The basic model. This section begins our study of the process of investment finance. The context is a simple two-period general equilibrium model with informational asymmetries. The analysis is intended to illustrate the relation between the net worth of entrepreneurs/borrowers and the degree to which capital markets are able to allocate savings efficiently to alternative uses. In particular we show that, the more that entrepreneurs must rely on external finance in order to undertake projects, the greater are the agency costs of investment; and the more likely it is that the economy will suffer from "underinvestment" (relative to the first-best), or even experience an "investment collapse".

The basic assumptions of the model follow:

A.1. The economy consists of a countable infinity of agents indexed by the non-negative integers. Individuals have identical preferences but differ in their endowments and in their "entrepreneurial talent" (see A.2, A.4, and A.9 below).

A.2. There are two periods, an investment period and a consumption period. At the beginning of the first period (the investment period), each individual i is endowed with a quantity w_i, $0 \leq w_i \leq 1$, of a nonconsumable input good. During the first period, this endowment may either be "stored" or "invested". The output of either storage or investment is a consumption good. This good is "eaten" in the second period.

A.3. One unit of stored endowment yields r units of the consumption good. There is no indivisibility, uncertainty, or asymmetric information associated with the storage process.

A.4. The investment technology comes in indivisible packets called "projects". Projects are identical ex ante. No project can be successfully undertaken unless it is first evaluated by an individual. (Think of evaluation as essential to the proper setting up of the project.) Individuals differ in their entrepreneurial skill, as reflected in their cost of evaluating a project: An individual of type θ has an evaluation cost of $e(\theta)$ units of effort. We assume that $e(\cdot)$ is continuous, positive, and nondecreasing. Individual types θ (which are given before contracting takes place) are drawn independently from a uniform distribution on [0, 1]. These assumptions imply that, if m is the fraction of individuals who evaluate projects, <u>per capita</u> evaluation costs can be approximated arbitrarily well by $\int_0^m e(\theta)d\theta$, and per capita marginal evaluation costs can be approximated by $e(m)$.[5]

An entrepreneur (defined to be an individual who evaluates and operates a project) can evaluate no more than one project during the investment period.

A.5. The process of evaluation yields a probability, p, that the evaluated project, if undertaken, will "succeed". Naturally, $0 \leq p \leq 1$. The random variable p is independent across projects and is drawn from a continuous cumulative distribution function $H(p)$.

A.6. Once the entrepreneur learns the project's quality, as measured by its success probability p, he decides whether to undertake the project or not. A project which is undertaken requires exactly one unit of the endowment good as input. (When each individual's endowment is less than one, this fixed input requirement makes "external finance" necessary.) A project that is not undertaken uses no input (beyond the initial evaluation effort); the entrepreneur is free to store his full endowment or to lend it to other entrepreneurs.

A.7. If an undertaken investment project succeeds (which it does with probability p), it pays a gross return of R units of the consumption good in the second period, $R > r$. If the project fails, it pays zero.[6]

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5 This uses a law of large numbers result on the convergence of sample to population distributions. See Theorem 5.5.1 in Chung (1974), p. 133.

6 None of our results depend on the return in the bad outcome being zero, as opposed to some value less than r.

A.8 The quality of an individual entrepreneur's project (the "p") is private information. It can also not be publicly observed whether an individual who claims to have evaluated a project has in fact done so. Individual endowments w_i are observable.[7] Also, whether a given project has been undertaken (i.e., is up and running) and whether it succeeds or fails is assumed to be observable.

We initially assume that the entrepreneur's cost of evaluation (his "skill") is private information; however, as the scope for policy turns out to be very sensitive to this assumption, we consider the alternative case as well. The distribution of entrepreneurial skills in the population and the c.d.f. H(p) are assumed to be common knowledge.

A.9. Individuals choose how to invest their endowments and whether to become entrepreneurs. Each individual's objective is to maximize expected second-period consumption less effort expended at project evaluation (i.e., individuals are risk-neutral, and the cost of effort is measured in consumption equivalents.)

Discussion. 1) The nonconsumable endowment w represents an individual's net worth. Given that project sizes are fixed at unity, a borrower's balance sheet position (the ratio of net worth to total liabilities) is w/(1-w), which increases in w. Here, we take w as given; but it is not difficult to make this variable endogenous (see Bernanke and Gertler (1986)).[8]

2) Our modelling of the investment process as taking place in two stages, an evaluation stage and an operational stage, differs from the standard assumption that entrepreneurs are endowed with projects (so that there is no evaluation

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7 We could give individuals the ability to "hide" endowment, but it turns out that in the equilibria studied below they would have no incentive to do so.

8 We emphasize that net worth is not measured by the total equity the firm issues, since the latter includes securities held by outside lenders. For large, publicly held firms our concept of borrower net worth corresponds best the personal stake of the managers and directors. Morck, Shleifer, and Vishny (1986) present evidence that managerial stake in many large corporations is non-trivial.

stage).[9] We include the evaluation stage in our formulation both because it is realistic, and because a two-stage process appears necessary to generate the intuitive and (probably) practically important result that pervasive informational problems in a sector may lead to underinvestment in that sector.[10]

3) The key assumptions which give rise to the agency problem are: (i) that knowledge obtained about project quality is private to the entrepreneur, and (ii) that it is possible for an individual to claim falsely to have evaluated a project. Many alternative specifications that give the entrepreneur the option of enjoying some type of unobservable "on-the-job consumption" at the expense of outside lenders could have been used in place of (ii); however, some assumption like (ii) is required to rule out a flat compensation schedule for entrepreneurs as a solution to the incentive problem introduced by assumption (i).[11] It is not strictly necessary to our analysis to allow project evaluation costs to differ among individuals. Doing so does add considerable realism and interest to the problem; it is also a technically simple way to ensure interior solutions (so that resources are both invested and stored in equilibrium).

4) Assuming that an entrepreneur can process only one project per period simplifies the analysis without affecting the qualitative results. It is important for our results, however, that scale diseconomies preclude the entrepreneur from handling enough projects to completely diversify away the agency problem, as do financial intermediaries in Diamond (1984).

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9 Boyd and Prescott (1986) and Hargraves and Romer (1986) also analyze two-stage investment processes in general equilibrium settings.

10 DeMeza and Webb (1987) employ a model similar to ours but omit the evaluation stage, which allows them to obtain an "overinvestment" result. We elaborate on this issue in section 4.

11 This differs from Myers and Majluf (1984) in that we explicitly model the process by which borrowers obtain information about projects, and in that we permit contracting prior to information acquisition.

3. The social optimum without asymmetric information. To provide a benchmark against which to measure the effects of information asymmetries, we first consider the solution to the social planning problem of this economy when there is no private information.

Let w be per capita endowment; let m be the fraction of individuals who evaluate projects; and let p^* be the reservation success probability (i.e., projects with evaluated success probabilities equal to or above p^* are to be undertaken). Then $H(p^*)$ is the fraction of evaluated projects that is rejected (and $1 - H(p^*)$ is the fraction accepted). Let $\hat{p}$ be the probability that a project will yield a good outcome, conditional on being undertaken; that is, $\hat{p} = E(p|p > p^*)$. Then

$$[\int_{p^*}^{1} pR\ dH]/(1 - H(p^*)) \equiv \hat{p}R$$

is the average expected return (per unit of endowment invested) to undertaken projects. Note that, here and below, $\hat{p}$ is a function of p^*.

With risk-neutrality, the utilitarian social planner cares only about expected per capita consumption, less per capita effort expended in evaluating projects. Formally, the planner's problem is

$$\max_{p^*,m} \quad r[w - m(1 - H(p^*))] + m(1 - H(p^*))\hat{p}R - \int_{o}^{m} e(\theta)d\theta \tag{3.1}$$

where the first two terms are expected per capita returns to storage and to "accepted" investment projects, respectively, and the final term is minus the per capita project evaluation effort. Note that the final term imposes the obvious feature of the optimal allocation that projects are evaluated by the most efficient entrepreneurs.

Let the subscript "fb" designate a "first-best" value. The first-order necessary conditions are:

$$p^*_{fb}R - r = 0 \tag{3.2}$$

$$(1 - H(p^*_{fb}))(\hat{p}_{fb}R - r) - e(m_{fb}) = 0 \tag{3.3}$$

These conditions are easily interpreted. (3.2) says that the optimal reservation probability is such that the expected return of going ahead with the project is just equal to the opportunity cost of the required input, if put into storage. That is, the first-best reservation probability of success p^*_{fb} is given by $p^*_{fb} = r/R$. Any project whose evaluated probability of success is greater than or equal to r/R should, in the first-best, be undertaken; others should be rejected.

In (3.3), the expression $(1 - H(p^*_{fb}))(\hat{p}_{fb}R - r)$ gives the return, gross of evaluation costs, to evaluating an additional project. In the planning solution, this marginal benefit is equated with the marginal cost of evaluating a project, $e(m_{fb})$. If the e(m) function takes a sufficiently broad range of values[12] then (3.3) will imply an interior solution, i.e., some endowment will stored and some will be invested.

The determination of p^*_{fb} and m_{fb} is shown in Figure 1. The vertical line graphs (3.2), $p^*_{fb} = r/R$. The curved line shows gross expected investment return as a function of p*; note that this return is maximized at p* = r/R. (3.3) implies that, at the point where the two lines intersect, the effort level $e(m_{fb})$ can be read off the y-axis. Since $e(\cdot)$ is monotonic, knowledge of $e(m_{fb})$ implies knowledge of m_{fb}.

12 (3.3) must be positive for some m > 0, negative at $m = m_{max}$ where $m_{max} = w/(1 - H(p^*))$.

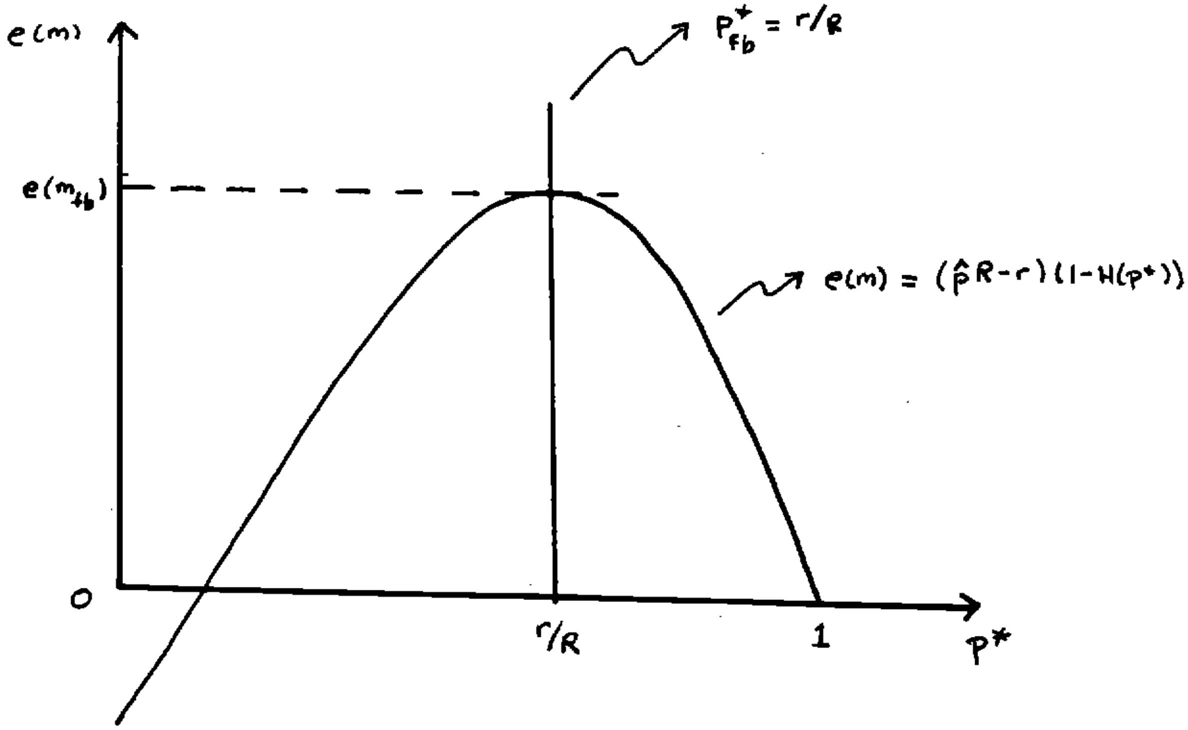

Figure 1.

Welfare maximization has no implications for income distribution in this setup, since the risk-neutrality (constant marginal utility) assumption makes the distribution of the consumption good irrelevant to the measure of total welfare. Further, the optimum is independent (as is usually the case) of the initial distribution of endowment. With private information, however, one feature of the initial distribution - the correlation of endowment with entrepreneurial ability - will in fact have an important effect on the constrained optimum, as we shall see.

4. The model with asymmetric information: a decentralized solution. We now re-introduce asymmetric information, as specified in assumption A.8. It is convenient to consider first a particular decentralized (competitive) equilibrium for our model economy, in which zero-profit financial intermediaries sign optimal contingent contracts with individual entrepreneurs. As noted in A.8, for the time being we maintain the assumption that individual evaluation costs $e(\theta)$ are private information. For expositional simplicity, we also temporarily impose the following restrictions: (1) Individuals all have the same endowment, i.e., $w_i = w$, all i. (2) Entrepreneurs deal with intermediaries only as individuals; entrepreneurial coalitions are not allowed. (3) Randomized allocations ("lotteries") are ruled out. The case with observable evaluation costs and the implications of relaxing (1)-(3) are all developed below. Below we will also discuss the relations of the proposed competitive equilibria to the associated social planner's solutions.

If $w < 1$, so that individual endowments are less than the input required to operate a project, entrepreneurs who evaluate projects and then decide to proceed must borrow endowment from non-entrepreneurs. We may think of this borrowing as being organized by competitive financial intermediaries. (These intermediaries are convenient fictions; they use no resources in intermediation and will earn no profits in equilibrium.) Let us consider now how such an intermediary would behave.

Assuming that there is positive storage in equilibrium, intermediaries are able to obtain "funds" (i.e., endowment) at opportunity cost r. The intermediary's problem is how to structure credit arrangements with entrepreneurs so as to maximize expected profits.

Without loss of generality, we may consider credit contracts of the following form. Intermediaries sign contracts with entrepreneurs (or potential entrepreneurs) at the beginning of the investment period, before any project evaluations have been done. Entrepreneurs "deposit" their endowment w with the intermediary. They also must give the intermediary the proceeds from successful projects. The intermediary promises to fund the entrepreneur's project, if he decides to undertake it, and to pay the entrepreneur a quantity of consumption goods at the beginning of the consumption period. This quantity of consumption goods is contingent on what happens during the investment period.

If:	The intermediary pays:	And the intermediary's profit is:
A project is undertaken and is successful	C_s	$R-r(1-w)-C_s$
A project is undertaken and is not successful	C_u	$-r(1-w)-C_u$
No project is undertaken	C_o	$rw-C_o$

Note that the three contingencies on which the consumption payment is based (as well as the contingencies in which the intermediary must furnish input or receive output) are assumed to be distinguishable by the intermediary. Importantly, though, for the contingency "no project is undertaken", the intermediary cannot tell whether the entrepreneur evaluated a project but decided not to go ahead, or whether he simply did not evaluate in the first place.

The intermediary's contract is a general contingent contract in form and could be thought of as representing a variety of financial instruments. One useful way to think of this contract is as a "credit line", in which the entrepreneur is able to draw working capital as needed. In this contract, the net cost of credit to the entrepreneur depends on whether he uses the credit line and, if he does, on whether his project pays off or not.

4a. The intermediary's optimization problem. For any given contract, let $\bar{C}$ be the expected quantity of the consumption good to be paid to the entrepreneur, and let V be the amount of expected consumption the entrepreneur can obtain elsewhere in the economy. (V, which is exogenous to the intermediary, will be determined in general equilibrium.) Then the intermediary's maximization problem can be written out as follows:

$$(4.1) \qquad \max_{p^*,\, C_s,\, C_o,\, C_u,\, \bar{C}} \quad (1-H(p^*))[\hat{p}R - r(1-w)] + H(p^*)rw - \bar{C}$$

subject to

$$(4.2) \qquad (1 - H(p^*))(\hat{p}C_s + (1-\hat{p})C_u) + H(p^*)C_o = \bar{C}$$

$$(4.3) \qquad \bar{C} \geq V$$

$$(4.4) \qquad p^*C_s + (1-p^*)C_u = C_o$$

$$(4.5) \qquad C_s \geq C_u$$

$$(4.6) \qquad C_u \geq 0$$

$$(4.7) \qquad \max(\bar{C} - e(\theta),\, rw) \geq C_o \qquad \forall\, \theta$$

The intermediary's objective, given by (4.1), is to maximize expected profits. The intermediary's direct control variables (not all of which are independent) are the contingent payments, C_s, C_o, and C_u, and the expected payment, $\bar{C}$. Although it is the entrepreneur who actually chooses the reservation success probability p*, the intermediary can indirectly choose p* (if the entrepreneur responds rationally) by the values it assigns its direct controls. For mathematical convenience, then, we also treat p* as under the control of the intermediary.

Equation (4.2) defines the expected payment to the entrepreneur, $\bar{C}$, in terms of the state-contingent payments and the state probabilities.

(4.3) is a voluntary participation constraint. It is straightforward to show that (4.3) will hold with equality at the optimum; we simply impose this below.

Constraints (4.4) through (4.7) are relevant because of the asymmetry of information. Equation (4.4) expresses the relationship between the reservation success probability p* that will be chosen by the entrepreneur and the payments offered by the intermediary: p* is the success probability such that the entrepreneur is just indifferent between proceeding with the project (which has expected return $p^*C_s + (1 - p^*)C_u$) and not proceeding (which has return C_o). The inequality (4.5) is necessary to ensure that the entrepreneur will undertake projects with success probabilities above p* rather than below p*.

(4.6) is a non-negativity condition on the consumption of the entrepreneurs; it is often interpreted as a limited liability condition. This restriction makes borrower wealth a critical determinant of agency costs. (See Sappington (1983)). (4.4), (4.5), and (4.6) together also imply that $C_s \geq 0$ and $C_o \geq 0$.

Constraint (4.7) is an important one. Recall that intermediaries cannot tell if an individual who does not proceed with a project has actually performed an evaluation. (4.7) imposes truth-telling: It requires the contract to have the property that any individual will prefer either to actually perform an evaluation (which has expected return $\bar{C} - e(\theta)$) or simply to store or lend to an intermediary (with return rw) rather than to claim falsely that an evaluation has been performed (which yields C_o). Since we know that in equilibrium not all individuals will evaluate projects, (4.7) can here be simplified, without loss of generality, to

$$(4.8) \qquad rw \geq C_o$$

4b. Characterizing the optimal financial arrangement. We now solve the intermediary's optimization problem and use the results to derive several propositions about the optimal financial contract. First, it is easy to verify that (4.5) is never binding, so we drop that constraint. Next, using (4.4) to eliminate C_s and (4.3) (which must bind) to eliminate $\bar{C}$, we can re-write the constraints as follows:

$$(4.3)' \qquad [(\hat{p}/p^*)(1 - H(p^*)) + H(p^*)](C_o - C_u) + C_u = V$$

$$(4.6)' \qquad C_u \geq 0$$

$$(4.8)' \qquad rw \geq (C_o - C_u) + C_u$$

where the left side of (4.3)' is an alternative expression for the intermediary's expected payments. These constraints are written in a form that facilitates thinking of C_u and $(C_o - C_u)$ as control variables. The objective (4.1) now becomes

$$(4.1)' \qquad \max_{p^*,\ (C_o - C_u),\ C_u} \quad (1 - H(p^*))(\hat{p}R - r) + rw - V$$

subject to (4.3)', (4.6)', and (4.8)'. Let the non-negative multipliers associated with the three constraints be μ, Ψ, and γ, respectively. The first-order necessary conditions are

$$(4.9) \qquad (r - p^*R)dH(p^*) = \mu(\hat{p}/p^{*2})(1 - H(p^*))(C_o - C_u)$$

$$(4.10) \qquad \gamma = \mu[(\hat{p}/p^*)(1 - H(p^*)) + H(p^*)]$$

$$(4.11) \qquad \Psi = \gamma - \mu$$

We are now able to show:

<u>Proposition (4.1)</u>. The incentive compatible reservation success probability for the entrepreneur is less than or equal to the socially efficient level; that is, $p^* \leq r/R = p^*_{fb}$ is induced by the optimal contract.

<u>Proof</u>: According to (4.9), $p^* \leq r/R$ if $\mu \geq 0$. But $\mu \geq 0$ follows from the Kuhn-Tucker theorem. Q.E.D.

Proposition (4.1) shows the nature of the inefficiency induced by asymmetric information; namely, that under the optimal contract the borrower may have an incentive to be insufficiently selective when deciding whether to undertake his project. The reasons for this inefficiency are, first, that the intermediary's ability to reward entrepreneurs who turn down inferior projects is constrained: Entrepreneurs who do not go ahead cannot be paid so much that it tempts non-entrepreneurs to claim falsely that they have also evaluated (and turned down) projects. Second, the limited liability constraint ($C_u \geq 0$) restricts the ability of intermediaries to punish entrepreneurs who undertake inferior projects.

We now characterize fully the intermediary's optimal contract.

Proposition (4.2). [The optimal contract when evaluation costs are unobservable]

(i) If $p^* < r/R$, then the entrepreneur's state contingent payoffs under the optimal contract are $C_u = 0$, $C_o = rw$, and $C_s = \frac{1}{p^*} rw$; further, p^* is the solution to

$$[(\hat{p}/p^*)(1 - H(p^*)) + H(p^*)]rw = V \tag{4.12}$$

(ii) If $p^* = r/R$, then the state-contingent payoffs are indeterminate; there exist multiple solutions that satisfy the requirement that the expected payoff equals the entrepreneur's opportunity cost.

Proof: Part (i) follows directly from the constraints on the intermediary's maximization problem, if the multipliers γ and Ψ are positive. So we must show $\gamma > 0$, $\Psi > 0$. (4.9) implies that $\mu > 0$ when $p^* < r/R$. (4.10) then implies $\gamma > \mu > 0$; this together with (4.11) implies $\Psi > 0$.

When $p^* = r/R$, $\mu = 0$ by (4.9). From (4.10) and (4.11) it follows that in this case $\gamma = 0$ and $\Psi = 0$. Thus the constraints (4.6)' and (4.8)' do not bind. Since only (4.3)' holds with equality, there is only one equation to determine C_o and C_u. Any combination (C_o, C_u) that satisfies (4.3)' and the inequality constraints is consistent with the optimality conditions. This proves (ii.)

Q.E.D.

The difference between the inefficient and efficient cases ($p^* < r/R$ and $p^* = r/R$, respectively) is that in the inefficient case the incentive constraints bind, whereas in the efficient case they do not. In the inefficient case (with p^* "too low"), the intermediary would like to reward entrepreneurs who are selective and punish those who are not, but is prevented from doing so as much as it would like by the moral hazard constraint $rw \geq C_o$ and the limited liability constraint $C_u \geq 0$. The optimal contract in the inefficient case goes as far in this direction as possible by setting $C_o = rw$ and $C_u = 0$.[13] Thus entrepreneurs who "fail" receive no consumption, while those who do not proceed with projects "get their deposit back". C_s and p* are then uniquely determined by the requirement that entrepreneurs receive the opportunity cost of the marginal borrower, and by the incentive constraint that relates p* to the three contingent payments.

4c. General equilibrium. We now consider the equilibrium of this economy under competition. The difference between general and partial equilibrium is that V, the expected consumption payment required to induce an entrepreneur to sign with an intermediary, becomes endogenous. The extra condition that allows V to be determined is that expected intermediary profits equal zero. We focus on the inefficient case, in which $p^* < r/R$ in equilibrium. The efficient case is simple, and is discussed below.

Again, let m be the fraction of individuals who evaluate projects in equilibrium. Then e(m) is the marginal evaluation cost. Since e(·) is continuous, in equilibrium the marginal entrepreneur must be just indifferent between evaluating a project and storing (or lending) his endowment. This implies

$$V - e(m) = rw \tag{4.13}$$

Using (4.13), intermediary expected profits per borrower can be written as (see (4.1)'):

$$(1 - H(p^*))(\hat{p}R - r) - e(m) \tag{4.14}$$

13 We emphasize that the result $C_u = 0$ does not arise because the project yields a zero return in the unsuccessful state. It occurs because the limited liability constraint is binding. If unsuccessful projects did yield positive returns, then under the optimal contract the lender(s) would receive all the proceeds in the bad state; the borrower would still receive nothing.

With free entry into intermediation, intermediaries must earn zero expected profits[14] in equilibrium. Zero expected profits implies the equilibrium condition

$$(4.15) \qquad (1 - H(p^*))(\hat{p}R - r) = e(m) \qquad \text{(zero expected profits)}$$

From Proposition (4.2), we also know that the incentive-compatible p^* satisfies the following equation (which is (4.12) re-arranged):

$$(4.16) \qquad (1 - H(p^*))(\hat{p}/p^* - 1)rw = e(m) \qquad \text{(incentive-compatible } p^*)$$

(4.15) and (4.16) jointly determine the equilibrium values of p^* and m. We can now characterize the general equilibrium solution. This solution turns out to be sensitive to the value of borrower net worth (endowment) w.

Proposition (4.3). [Equilibrium when evaluation costs are unobservable]

(i) If $w < 1$, then both p^* and investment m are below their respective socially efficient levels. Further, both p^* and m are monotonically increasing in w, assuming an equilibrium with positive investment exists.[15]

(ii) If $w = 1$, then the economy attains the unconstrained optimum; $p^* = r/R = p^*_{fb}$ and $m = m_{fb}$.

Proof: (i) Substitute (4.15) for e(m) into (4.16) to obtain the following expression for p^*:

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14 Because of universal risk-neutrality and the observability of intermediary profits, we need not worry about the distinction between zero expected profits and zero realized profits. For example, depositors will be perfectly willing to bear intermediary profit risk.

15 Proposition (4.4) describes the case for which investment is zero in equilibrium.

(4.17) $$p^* = [p^*/\hat{p} + w(1 - p^*/\hat{p})](r/R)$$

If $w < 1$, then $[p^*/\hat{p} + w(1 - p^*/\hat{p})] < 1$ and hence $p^* < r/R$. If $p^* < r/R$ then the expected gross surplus from investment $(1 - H(p^*))(\hat{p}R - r)$ is below its maximum value; hence $e(m)$, and therefore m, are below the unconstrained social optimum. Straightforward differentiation of (4.15) and (4.16) yields $\frac{\partial p^*}{\partial w} > 0$, $\frac{\partial m}{\partial w} > 0$ when $w < 1$, given that both (4.15) and (4.16) hold.

If $w = 1$, then (2.7) implies $p^* = r/R$. Since $p^* = r/R$, the gross expected surplus from investment is at maximum. It follows from (2.15) that m is also at the unconstrained maximum.

Q.E.D.

Proposition (4.4). ["Investment collapse"]

Suppose that the unconditional gross project return (the expected gross return if $p^* = 0$) is less than the evaluation cost of the most-efficient entrepreneur; that is $\int_0^1 pRdH(p) - r \equiv \hat{p}^u R - r < e(0)$. Then there exists a positive level of borrower net worth (call this level $\underline{w}$), such that, for levels of net worth $w < \underline{w}$, the investment market "collapses"; no positive investment is sustainable in equilibrium. The minimum wealth level $\underline{w}$ and the associated success probability $\underline{p}^*$ are the values of w and p^* that satisfy the equilibrium conditions (4.14) and (4.15) at $m = 0$. Specifically, $\underline{w}$ and $\underline{p}^*$ are given by

(4.18) $$(1 - H(\underline{p}^*))(\hat{\underline{p}}R - r) = e(0)$$

(4.19) $$(1 - H(\underline{p}^*)((\hat{\underline{p}}/\underline{p}^* - 1))r\underline{w} = e(0)$$

Proof: To see first that $\underline{w} > 0$, suppose $w = 0$. Then, by (4.16), $p^* = 0$. Then the expected net surplus from evaluating an investment is $\hat{p}^u R - r - e(0)$, which is negative by assumption. Thus there can be no investment if $w = 0$. By continuity, this is also true for sufficiently small positive w. Hence $\underline{w} > 0$.

To see that (4.18) and (4.19) define $\underline{w}$ and $\underline{p}^*$, compare these equations with (4.15) and (4.16). Clearly, $\underline{w}$ is the value of borrower wealth such that only the most efficient entrepreneur could generate a surplus net of evaluation costs. By Proposition (4.3), p^* and $e(m)$ are increasing in w. Thus if $w \leq \underline{w}$, then $e(m) \leq e(0)$. This implies $m = 0$, i.e., investment "collapses" if $w < \underline{w}$. Q.E.D.

The possible equilibrium solutions are depicted graphically in Figure 2. The hump-shaped curve (equation (4.15)) gives the expected surplus from initiating a project, gross of evaluation effort, as a function of p^*; this same curve appeared in Figure 1. The downward-sloping line (equation (4.16)) gives the relation between p^* and $e(m)$ as determined by the optimal intermediary contract.[16] When $w < 1$, the equilibrium lies to the left of the socially efficient point E (as drawn, the equilibrium is at point A), with m and p^* below their first-best levels. (Recall that $e(m)$ is monotonically increasing in m.)

The reason that m is less than the social optimum is that, with $w < 1$, there is an agency problem: As we have seen, entrepreneurs have an incentive to be insufficiently selective when deciding whether to proceed with projects. But, since lenders recognize this problem, and since lenders are always able to earn a return of r by storing, this agency cost is reflected only in the equilibrium cost of capital. The lower expected net return to initiating projects reduces m in equilibrium.

To see how the equilibrium depends on borrower wealth w, note that increases in w cause the downward-sloping curve in Figure 2 to move up and to the right. (As we have seen, for a given $e(m)$, greater borrower wealth leads to a higher p^* under the optimal contract.) As w increases, p^* and m approach their first-best

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16 The slope of this curve is $-(\hat{p}/p^{*2})(1 - H(p^*))rw < 0$.

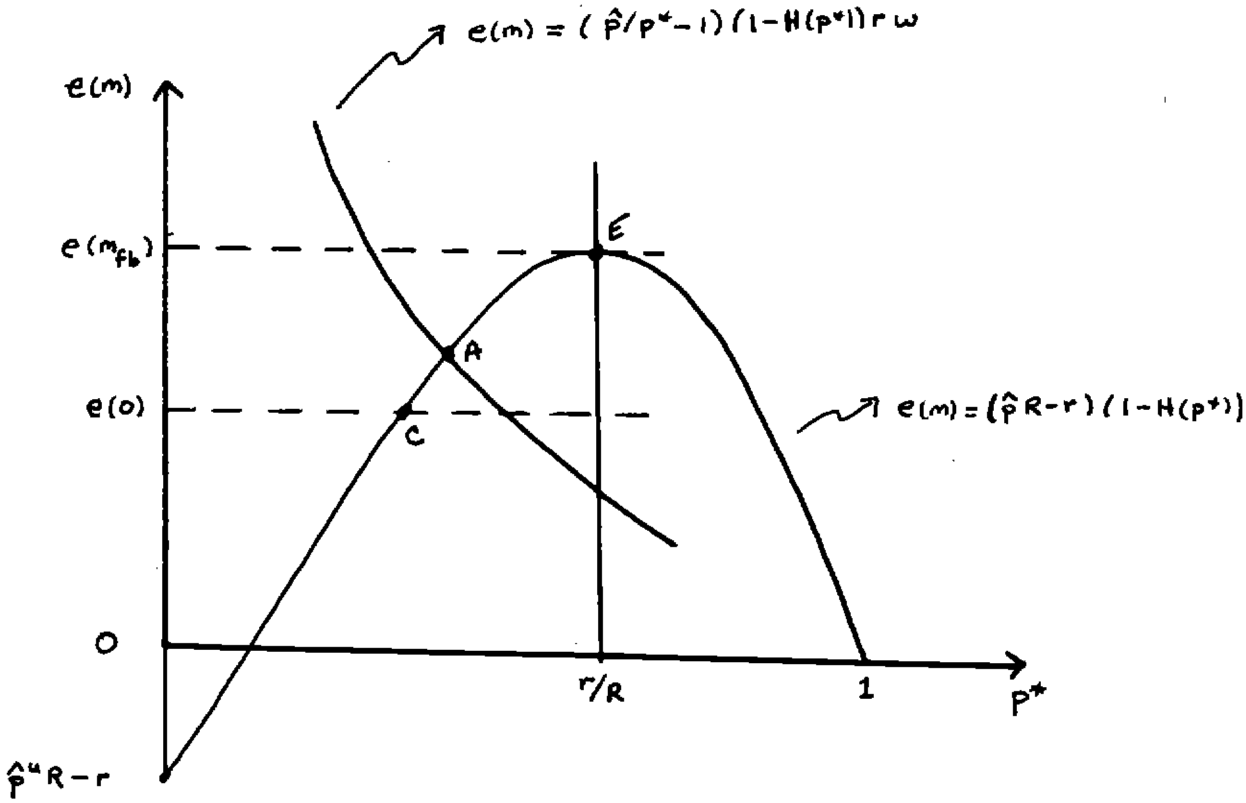

Figure 2.

levels; that is, the agency problems become less serious. When w = 1 (full collateralization), the equilibrium is at point E, the first-best.

In contrast, suppose that borrower net worth w declines so far that the downward-sloping curve in Figure 2 intersects the hump-shaped curve at point C or below. In that case, the potential gross surplus generated by initiating a project is less than the evaluation cost of the most efficient entrepreneur. Here there can be no positive investment in equilibrium (m = 0); this is the "investment collapse" described by Proposition (4.4).[17] The minimal value of w which permits positive investment, $\underline{w}$, is the value of w which causes the two curves to intersect at point C. Thus, declines in borrower net worth induce a "financially fragile" situation.[18]

There has been some controversy as to whether the presence of asymmetric information typically leads to "underinvestment" or "overinvestment" (deMeza and Webb (1987)). Our basic result is that in economies with w < 1, there will be underinvestment in the sense that entrepreneurs will initiate too few projects relative to the first-best, i.e., $m < m_{fb}$. For macroeconomic analysis, however, it is also worthwhile to consider the behavior of investment spending, as measured by the total resources devoted to investment. Although entrepreneurs initiate too few projects, they are also insufficiently selective when deciding to proceed with the projects which they do evaluate ($p^* < p^*_{fb}$), so that investment spending, $m(1-H(p^*))$, is not in general unambiguously greater or less than in the

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17 Mankiw (1986) obtains a similar result, which, like ours, is in the spirit of the Akerlof (1970) "lemons" model. Mankiw's model is rather different from ours in that he restricts attention to debt contracts and does not link lenders' payoffs to borrowers' returns. Our paper and Mankiw's both make a case for government intervention in financial markets, but we differ in the specific recommendations.

18 In analogy to Mankiw (1986), a collapse is more likely if the payoff to successful projects R is low and if the riskless interest rate r is high. This can be seen by noting that the hump-shaped curve in Figure 2 moves up with an increase in R and down with an increase in r.

first-best.[19] Building on the investment collapse result, however, we can show that, for w sufficiently low and for convex e(·), there will always be underinvestment (in the sense that total spending is too low).

Proposition (4.5) [Underinvestment or overinvestment?]

Let $I = m(1 - H(p^*))$ be the total quantity of endowment devoted to investment, and let I_{fb} be the first-best value of this variable. If e(m) is convex in m, then there exists some common endowment level $\bar{w}$, $\underline{w} < \bar{w} < 1$, such that

(i) for $w \leq \bar{w}$, $I \leq I_{fb}$ (underinvestment)

(ii) for $1 > w > \bar{w}$, $I > I_{fb}$ (overinvestment)

Proof. Use (4.15) to define the equilibrium relationship $m = m(p^*)$. Implicit differentiation of (4.15) yields $m'(p^*) = (r - p^*R)H'(p^*)/e'(m)$.

Since $I = m(1 - H(p^*))$, we have $\frac{\partial I}{\partial w} = [m'(p^*) - mH'(p^*)] \frac{\partial p^*}{\partial w} = [(r - p^*R)/e'(m) - m]H'(p^*) \frac{\partial p^*}{\partial w}$, using the expression for $m'(p^*)$. Since $H'(p^*) > 0$, $\frac{\partial p^*}{\partial w} > 0$, then $\frac{\partial I}{\partial w}$ has the same sign as $[(r - p^*R)/e'(m) - m]$. We know that this latter expression is positive at $w = \underline{w}$, negative at $w = 1$, and (given that e(·) is convex) continuously decreasing in w in the intermediate range.

Thus $\frac{\partial I}{\partial w}$ is first positive and then negative. Since $I = 0$ when $w = \underline{w}$ and $I = I_{fb}$ when $w = 1$, by continuity there must exist some $\bar{w}$, $\underline{w} < \bar{w} < 1$, such that $I < I_{fb}$ for $w < \bar{w}$ and $I > I_{fb}$ for $w > \bar{w}$. Q.E.D.

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19 De Meza and Webb's (1987) "overinvestment" result is essentially the same as our finding that $p^* < p^*_{fb}$, i.e., given that they have evaluated, entrepreneurs are too eager to proceed with projects. But this result depends on the number of evaluations (m) being given exogenously in their model. When the investment process includes a costly evaluation stage, entrepreneurs internalize the cost of insufficient selectivity, so that underinvestment can occur.

The relation of I to I_{fb} as w changes is shown in Figure 3. The important point here is that, even if investment doesn't "collapse", a "financially fragile" situation implies both that investment spending is low and that the investment which is undertaken is inefficient.[20]

Finally, we may ask who bears the welfare losses associated with financial fragility. The distribution of expected utility in equilibrium is straightforward to determine. Non-entrepreneurs receive rw, as does the marginal entrepreneur (who by definition is just indifferent between evaluating a project on the one hand and lending or storing his endowment on the other). The inframarginal entrepreneur's return is the expected consumption payment V, less his evaluation $e(\theta)$. By (4.13) this return can be written as

$$V - e(\theta) = rw + e(m) - e(\theta) \tag{4.20}$$

or, substituting for e(m) from (4.15),

$$V - e(\theta) = rw + (1 - H(p^*))(\hat{p}R - r) - e(\theta) \tag{4.21}$$

(4.21) shows that all of the social surplus associated with the existence of investment projects is appropriated by the efficient entrepreneurs in equilibrium; thus, in this model it is the entrepreneurs who bear the deadweight losses created by asymmetric information.

5. Generalizations. The last section adopted a number of simplifying assumptions for expositional purposes. We turn now to a brief discussion of the effects of relaxing these restrictions.

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20 Figure 3 also shows that investment spending will be increasing in borrower net worth ("procyclical") whenever w is less than the value at which I is maximal.

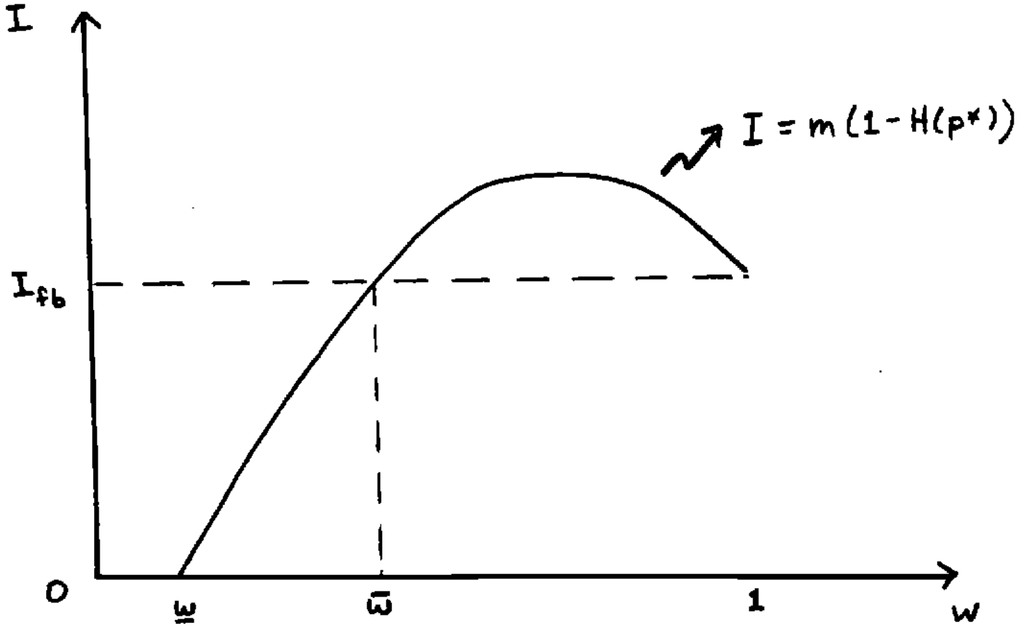

Figure 3.

5a. Variable endowments. The analysis of the last section is easily generalized to allow for an arbitrary distribution of initial endowments. The main modification is that intermediary contracts now depend on the borrower's endowment. For each w, the form of the optimal intermediary contract is precisely analogous to the contract described in Proposition (4.2). For example, for the interesting case where $p^* < r/R$, the contingent payoffs under the optimal contract are $C_u^w = 0$, $C_o^w = rw$, and $C_s^w = rw/p_w^*$, where the w superscripts and subscripts indicate dependence on w. Further, in analogy to (4.12), p_w^* is given by

$$[\hat{p}_w/p_w^*)(1 - H(p_w^*)) + H(p_w^*)]rw = V^w \tag{5.1}$$

where V^w is the reservation expected consumption level required by an entrepreneur with wealth w.

To calculate the general equilibrium, impose zero expected intermediary profits contract by contract. This implies

$$(1 - H(p_w^*))(\hat{p}_w R - r) + rw = V^w \tag{5.2}$$

Conditions (5.1) and (5.2) uniquely determine p_w^* and V^w.

Which entrepreneurs will borrow in this equilibrium? The evaluation cost of the marginal borrower is determined by

$$V^w - e(m_w) = rw \tag{5.3}$$

For any given endowment level w, individuals with evaluation costs less than or equal to $e(m_w)$ will borrow, others will not. In analogy to (4.21), the expected utility of an entrepreneur of type θ and with wealth w is given by

$$V^w - e(\theta) = rw + (1 - H(p_w^*))(\hat{p}_w R - r) - e(\theta) \tag{5.4}$$

which equals rw for $\theta = m_w$ and exceeds rw for $\theta < m_w$.

The basic features of the equilibrium with uniform endowments are replicated here. First, p_w^* and m_w are below the first-best levels for borrowers with $w < 1$. Second, p_w^* and m_w are increasing in w and attain the first-best for $w = 1$. Third, individuals whose endowments fall below a critical lower bound will be unable to undertake any investment (their credit will be "cut off").

The equilibrium with variable endowments also makes clear an important implication of asymmetric information in this setup: Unlike the first-best case, here the pattern of initial endowments -- in particular, the correlation of endowments with entrepreneurial skill -- is a determinant of the best feasible outcome. Two points are worth emphasizing: First, in the equilibrium with variable endowments, it is not necessarily the case that those evaluations which are done will be done by the most efficient entrepreneurs; rather, relatively inefficient entrepreneurs with high endowments may displace more efficient entrepreneurs with lower endowments. Second, pure redistributions of endowment which reduce the correlation of skill and endowment will tend to reduce output and investment efficiency.[21]

5b. Observable evaluation costs. If individual evaluation costs $e(\theta)$ are public knowledge, then intermediary contracts will be conditioned on the $e(\theta)$ of the individual borrower (as well as on the borrower's w, if that differs among individuals). It turns out that the intermediary's optimization problem in this case differs from the case with unobservable $e(\theta)$'s in only two respects: First, the intermediary's controls (p^*, $\bar{C}$, C_s, C_o, C_u) and the reservation consumption level (V) all become functions of θ. Second, since non-entrepreneurs can be directly excluded from signing contracts, constraint (4.7) in the intermediary's problem simplifies to

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21 Greenwald and Stiglitz (1986) make a related argument.

$$(5.5) \qquad \bar{C}^{\theta} - e(\theta) \geq C_o^{\theta}$$

(where the θ superscript signifies dependence on the borrower's type θ), instead of to (4.8) as before.

For the case $p^* < r/R$, the contingent payoffs under the optimal contract are now $C_u^{\theta} = 0$, $C_o^{\theta} = V^{\theta} - e(\theta)$ and $C_s^{\theta} = [V^{\theta} - e(\theta)]/p_{\theta}^*$, with p_{θ}^* determined by

$$(5.6) \qquad [(\hat{p}_{\theta}/p_{\theta}^*)(1 - H(p_{\theta}^*)) + H(p_{\theta}^*)][V^{\theta} - e(\theta)] = V^{\theta}$$

Zero expected intermediary profits, contract by contract, implies

$$(5.7) \qquad (1 - H(p_{\theta}^*))(\hat{p}_{\theta}R - r) + rw = V^{\theta}$$

For each θ, (5.6) and (5.7) determine the general equilibrium values of p_{θ}^* and V_{θ}.

V^{θ} is decreasing in θ. This implies that, for any given wealth level w, there exists some m such that

$$(5.8) \qquad V^m - e(m) = rw$$

Individuals with wealth w whose evaluation costs are equal to or less than the e(m) defined by (5.8) will borrow in equilibrium; others will not. The expected utility of an individual entrepreneur is given by an expression exactly analogous to (4.21) and (5.4).

If we compare the equilibrium with observable evaluation costs to the equilibrium with unobservable costs (but the same initial wealth distribution), some interesting results emerge.[22] First, the total number of project evaluations and the reservation success probability of the marginal entrepreneur are precisely the

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[22] These results are only summarized here. Detailed statements and proofs are available on request.

same in the two economies. Thus, the observability of evaluation costs is not in itself sufficient to take the decentralized economy to the first-best, or even to avoid investment collapse, if borrower wealth levels are sufficiently low. However, it <u>is</u> the case that <u>inframarginal</u> entrepreneurs are more efficient when their $e(\theta)$'s are observable than when they are not. This is because, with observable $e(\theta)$'s, it is easy for the intermediary to screen out high-$e(\theta)$ individuals who would have an incentive to pretend to evaluate and to collect C_o. Thus the constraint $C_o \leq rw$, which binds in the unobservable $e(\theta)$ case, can be relaxed here for inframarginal borrowers. The relaxation of this constraint allows p_θ^* to increase as θ falls, i.e., the moral hazard problem is reduced for more efficient entrepreneurs. Indeed, inframarginal borrowers (but not the marginal borrower) may attain the first-best reservation success probability ($p_\theta^* = r/R$) for w strictly less than one.

Thus, in general equilibrium, observable evaluation costs may ameliorate, but cannot eliminate, the inefficiencies arising from the combination of asymmetric information and imperfect collateralization.

<u>5c. Entrepreneurial coalitions</u>. We have assumed throughout that intermediaries deal with borrowers on an individual basis. However, if individuals can observe the evaluation costs of others, and if evaluation costs are sufficiently low, potential borrowers may find it profitable to form coalitions.[23]

To take a simple example, suppose that two individuals each have $w = \frac{1}{2}$. These individuals might agree to pool endowment and projects, to fund the project (of their two) with the highest success probability (or perhaps to store if neither project is good), and to share total returns. If the rule for sharing returns is independent of whose project is undertaken, then neither individual has an incentive to mis-report his success probability to the other. At one level at least, the moral hazard problem is eliminated.

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[23] We thank Barry Nalebuff for pointing this out to us.

Further elaboration of this example would be worthwhile (e.g., as part of an explanation of why intermediaries do not diversify away agency risk, as in Diamond (1984).) Indeed, we did something of this sort in Bernanke-Gertler (1986). However, we do not find it important to undertake this elaboration here, for two reasons.

First, the formation of coalitions is itself subject to an incentive problem: The coalition must ensure that each member has an incentive actually to evaluate his project, and not to "free ride" on the projects of others. The free rider problem worsens as the coalition size grows and when evaluation costs are high, and it is likely to become fatal to coalition formation when evaluation costs are unobservable (so that non-entrepreneurs are able to free-ride). Thus, as a formal matter, we can exclude coalition formation for many sets of parameter values when the $e(\theta)$'s are observable, and in almost all cases of interest when the $e(\theta)$'s are unobservable.

Second, since the coalition of two individuals might find that it has two good projects instead of just one, it will in general want to sign a contingent contract with an intermediary, in order to allow for possible additional financing. Formal analysis of this contract suggests that the same sorts of moral hazard problems will arise between the coalition and the intermediary as arise between individual borrowers and the intermediary in our basic analysis. Allowing for entrepreneurial coalitions thus would not seem to affect the qualitative nature of our results; at most, it changes the fundamental unit of observation from the individual entrepreneur to a coalition.

5d. Lotteries. A number of recent studies of models with asymmetric information have stressed the importance of allowing for random consumption allocations, or lotteries, in the analysis; see, e.g., Prescott and Townsend (1984). Because of our assumption of universal risk neutrality, consumption lotteries would have no effect on decisions or social welfare in our model. It turns out, however, that lotteries in endowment (done before evaluations are undertaken) are potentially quite helpful, at a theoretical level at least, in the present setting.

Consider the case in which endowments are variable and evaluation costs $e(\theta)$ are observable. For a given individual of type θ, expected utility as a function of his endowment w can be written as

$$(5.9) \qquad EU_{\theta}(w) = \begin{cases} rw & \text{for } \underline{w} > w \\ rw + \int_{p^*}^{1} (pR - r)dH(p) - e(\theta) & \text{for } \underline{w} \leq w \end{cases}$$

where $\underline{w}$ is the endowment below which the individual cannot invest, and the expected utility for the case $w \geq \underline{w}$ is analogous to the expression given in (5.4). Note that p^* depends on w, and that both p^* and $\underline{w}$ depend on θ. Assume for simplicity that $\int(pR - r)dH(p)$ is concave in w.[24] Then the individual's expected utility as a function of his endowment is given by the curve OAB in Figure 4. Note the kink in expected utility at A (where $w = \underline{w}$). Note also that the slope of the curve is r for $w < \underline{w}$, that it exceeds r but is declining in the region $w \geq \underline{w}$, and that it equals r again at point B, where w=1.[25]

Because the expected utility curve is not concave in w, individuals will want to take fair bets when $0 \leq w \leq w^*$, where w^* corresponds to the point where a ray from the origin is tangent to the expected utility curve (see Figure 4). By the usual arguments, the individual's preferred fair lottery is the one that pays w^* with probability w/w^* and zero with probability $1 - w/w^*$, where w is initial wealth. Further, it can be seen from the diagram (or shown algebraically) that:

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24 Similar results can be obtained for the non-concave case.

25 The derivative of expected utility with respect to w equals r at point B since the derivative of the integral term in (5.9) is zero when w = 1; at w=1, $p^* = r/R$ and the surplus from evaluating a project is maximum.

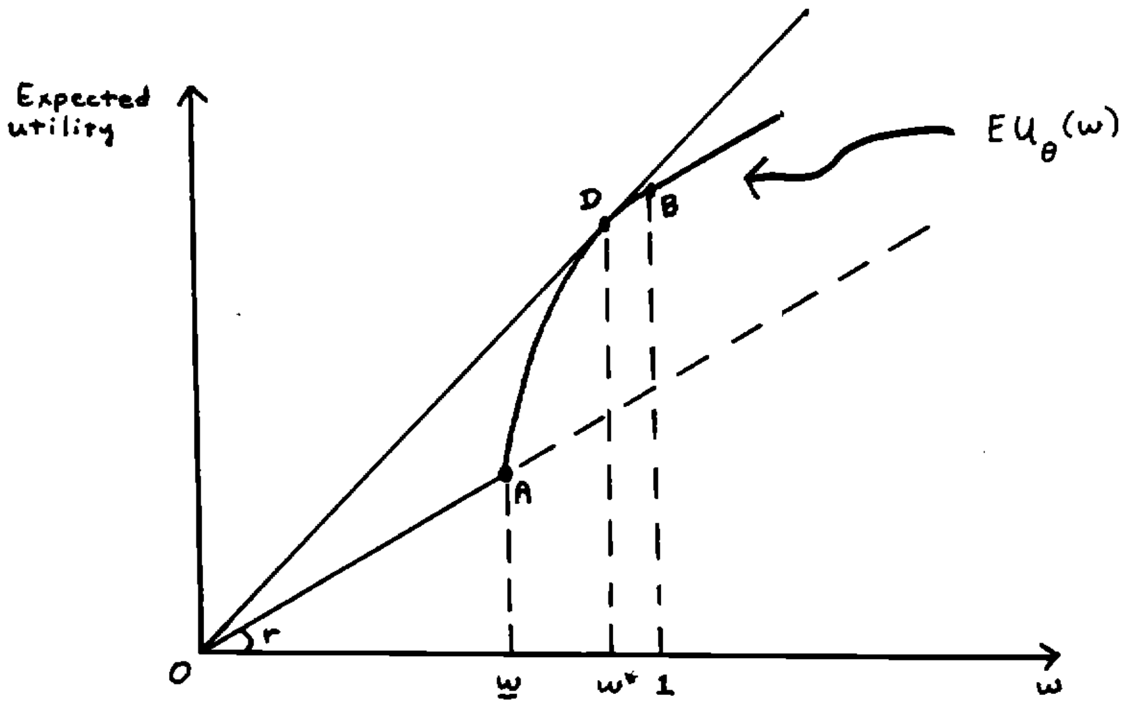

Figure 4.

(1) For a given skill level, w^* is independent of initial wealth w; i.e., all lottery winners of a given ability will have the same endowment when they sign contracts with intermediaries.

(2) $w^* > \underline{w}$; lottery winners will always have enough endowment to proceed with a project evaluation.

(3) $w^* < 1$; individuals will not attempt to fully collateralize themselves, so that borrowing from intermediaries will occur in final equilibrium.[26]

Finally, it can also be shown that

(4) w^* is increasing in $e(\theta)$; less able entrepreneurs will prefer riskier lotteries.[27]

The main way in which the introduction of a lottery modifies our previous results is that the investment collapse described in Proposition (4.4) is much less likely to occur; the collapse will be prevented by the "pooling" of endowment (via the lottery), except in the case where entrepreneurial net worth is zero. The other results of Section 4 remain qualitatively true: In particular, entrepreneurs will not be fully collateralized even after the lottery, so that the basic agency problem remains.[28]

Lotteries of the sort described here do not seem to occur in practice or to have obvious institutional counterparts. A possible explanation for this absence of lotteries is risk aversion, from which we have abstracted. Another possibility

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26 This is proved by noting that the ray OD must have a slope greater than r, while (as noted above) the slope of the expected utility curve at w=1 equals r.

27 To see this in the figure, note that an increase in $e(\theta)$ shifts the humpshaped part of the expected utility line down, which moves the tangency point D to the right.

28 As in Section 5a, it is also true in the lottery equilibrium that some projects will be undertaken by relatively less efficient entrepreneurs (who happen to win the lottery).

is that the willingness of an entrepreneur to enter lotteries may send an adverse signal (e.g., lack of prudence?) to potential lenders.[29]

The revelation of information by lotteries can also be beneficial, however. In the version of our model in which evaluation costs are unobserved, it is possible for the introduction of a lottery to induce a separating equilibrium (in which entrepreneurs credibly reveal their types by their choices of lotteries), which Pareto - dominates the equilibrium without a lottery. Like the analogous equilibrium with public evaluation costs, however, this equilibrium does not attain the first-best.

5e. Summary. This section has considered a variety of extensions of the basic model, including variable endowments, observable entrepreneurial skill, entrepreneurial coalitions, and lotteries in endowment. The only significant modification of the basic results is that, as a theoretical matter, the admission of endowment lotteries and entrepreneurial coalitions (the latter when the $e(\theta)$'s are observable) may eliminate the "investment collapse" equilibrium. However, the principal messages of sections 2 through 4 remain qualitatively unaffected: Under all of the extensions, it remains true that insufficient borrower wealth and the resulting necessity of external finance lead to too few evaluations and insufficient selectivity in equilibrium; and that these capital market inefficiencies disappear only as borrowers' endowments approach the level of full collateralization of projects.

6. The role of policy. An advantage of the sort of formal setup we have used here is that normative policy analysis can be done in a straightforward way, by comparison of the allocations arising in decentralized equilibria with those implied by the social planner's solution. An earlier version of this paper (available on request) develops this comparison explicitly. To conserve space, we

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29 Stiglitz and Weiss (1981) make a similar point in their discussion of the role of collateral.

here only describe our results. Fortunately, our principal policy conclusion is easy to demonstrate without formal apparatus.

An important preliminary point is that, for the classes of economies studied (e.g., in section 4, for the class in which entrepreneurial skill is unobservable, and lotteries and coalitions are excluded), the decentralized equilibria derived in sections 4 and 5 are Pareto optima.[30] Thus we will not be able to find a policy which alters the equilibrium outcome that would receive unanimous approval. However, policy <u>will</u> be able to increase social welfare, investment efficiency, and output (which, in this context, are all the same thing). Also, by definition, welfare-improving policies are policies that would be unanimously approved if people could vote before knowing their types (endowments and evaluation costs). Such policies seem worthy of study, even if they are not Pareto-improving.

The critical determinant of the potential effectiveness of policy, it turns out, is the degree of observability of individual entrepreneurial skills. If entrepreneurial ability is not observed at all, policy can do little. Perfect observability of skill levels implies, remarkably, that policy can drive the economy to the unconstrained social optimum. Intermediate levels of observability imply, in general, intermediate policy effectiveness.

<u>6a. Unobservable entrepreneurial skill.</u> Consider first the case analyzed in sections 3 and 4, in which entrepreneurial skill (as measured by evaluation costs) is unobserved. Endowments may be either identical or variable across individuals.[31] The welfare-maximizing policy may be obtained by solving the

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30 The equilibria of sections 4 and 5 can be reproduced as solutions to social planning problems, in which positive weights are assigned to the utilities of those who become entrepreneurs in equilibrium and zero weights are assigned to the utilities of non-entrepreneurs. The zero weight assigned to non-entrepreneurs implies that, in the planner's solution, the non-entrepreneurs' voluntary participation constraints will be binding; i.e., each non-entrepreneur will receive consumption equal to exactly r times his endowment, just as in the decentralized outcomes.

31 Throughout this section we exclude coalitions and lotteries, for simplicity; these extensions can be handled by similar methods, however, and would not affect the nature of the results.

social planner's problem as done in Section 3, but this time imposing all applicable information constraints. This procedure yields the following results, stated without proof:

(1) Unless the endowments of all individuals who would be borrowers in the first-best equilibrium happen to equal one, the first-best outcome is not attainable by the planner. Further, the social planner's choices of m and p* are both below their respective first-best levels, as occurred in the decentralized case.

(2) The solution to the planner's problem and the outcome of the decentralized competitive solution are, however, not identical. The formal analysis implies that the planner can improve social welfare (relative to the decentralized case) by imposing a tax on successful investment projects and using the proceeds to subsidize storage. The reason that the tax is helpful is that it permits a subsidy to non-entrepreneurs, which relaxes the constraint on what can be paid to entrepreneurs who decide not to proceed with their projects. Both the loosening of this constraint and the tax on investments itself tend to raise p*; at the same time, the tax on investments lowers m in equilibrium. Thus the planner is trading off a lower number of projects initiated against a higher quality of projects undertaken.

The policy suggested by this analysis is interesting in one respect, in that it shows that an investment subsidy (which would be the opposite of the optimal policy in this case) does not help when the economy is suffering from underinvestment. In the present case, an investment subsidy would raise the number of evaluations, which is desirable; but it would also reduce the selectivity of entrepreneurs (i.e., lower p*), leading on net to a decrease in social welfare.

Overall, though, we don't take the tax policy implied by this analysis very seriously, for several reasons. First, it is very much a "second-order" policy: If the fraction of the population who are entrepreneurs is small, then the average subsidy paid to non-entrepreneurs must also be small. Further, as was noted, the gains in p* achieved by the policy are offset to some degree by reductions in m.

The net welfare effect of this policy, starting from the decentralized solution, would likely be insignificant.

Second, and more importantly, this policy arises from a somewhat artificial constraint that we have imposed on the planner - specifically, that he has no information at all about which individuals (or firms, in reality) are potentially efficient investors. Because of the assumption that there is no information about entrepreneurs, the only available policy is one that works through the very indirect channel of trying to raise the opportunity cost of undertaking inefficient investments. If we assume (more realistically) that the planner has at least some information about individual skill, the scope for policy increases substantially.

6b. Observable entrepreneurial skill. Suppose now that the planner can perfectly observe individual evaluation costs. As was shown in Section 5b above, observability of evaluation costs does change the competitive equilibrium somewhat but is not sufficient to cure the agency problems created by external finance. However, observability of evaluation costs does have a very dramatic impact on the capability of the planner. Consider the following simple policy:[32] The planner calculates the value of m, m_{fb}, corresponding to the (unconstrained) first-best. Using lump-sum taxes, he then provides a net subsidy of $1-w_i$ to any individual i whose cost of evaluating projects is $e(m_{fb})$ or less. The planner's policy thus fully collateralizes borrowers, which sends the economy to the unconstrained first-best! This result cannot be achieved by the private economy alone, even by using lotteries, coalitions, or other devices. The policy works because it directly attacks the cause of financial fragility, low borrower net worth.

The transfer policy seems to retain at least a degree of efficacy even when entrepreneurial skills are only imperfectly observed. We have studied a number of cases. For example, suppose that the planner can tell only whether an individu-

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[32] This policy can be derived as the solution to the planner's problem, but it is transparent without the aid of formal apparatus.

al's evaluation cost is above or below the marginal evaluation cost in the first-best. Alternatively, suppose that individuals can pretend to be less skilled but not more skilled than they actually are (e.g., one can always intentionally fail a test but cannot do better than is given by one's ability). In either of these cases, it is elementary to show that the planner's "full collateralization policy" is still feasible and the economy attains the first-best. Not much is changed if individual evaluation costs are measured with a random error.

Another example we have analyzed assumes that there is no direct observability of entrepreneurial skill, but that there is a costly signal that individuals can emit about their abilities. (In practice, this might involve undertaking marginally unprofitable projects and incurring debt in order to build a "track record".) Our working paper proves two results: (1) If the economy is initially in an inefficient region ($p^* < r/R$), and the signalling costs are not too large, the planner will generally be able to increase welfare by subsidizing individuals who signal themselves to be entrepreneurs. (2) However, when there are signalling costs, it is never desirable to fully collateralize entrepreneurs (that is, to bring their endowments all the way up to one.)[33]

To reiterate, our main policy result is that if there is some observability of entrepreneurial skill (here, evaluation costs), transfers to entrepreneurs/ borrowers may increase financial market efficiency, output, and welfare (although these transfers will not induce Pareto improvements). Some implications of this and our other formal results are drawn out in the next and final section.

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33 The reason for this result is that, as m and p^* approach their first-best levels, the additional reductions in agency cost achieved by increasing the subsidy approach zero, while the marginal signalling costs rise (as entrepreneurs signal more intensely in order to compete for the increased subsidy). Thus with signalling it is never optimal to try to eliminate all agency costs by setting borrowers' wealth at one.

7. Conclusion. Most discussions of financial fragility have focused on what is often termed the "excessive" buildup of debt (Kaufman (1987)). Our approach suggests that fragility (or stability) is, at a deeper level, a product of the level and distribution of national wealth: The financial system is less efficient, and contributes to inferior macroeconomic equilibria, when potential borrowers have low levels of net worth. Debt is significant only if it indicates declining borrower net worth; or if, in the absence of complete indexing, the debt level creates a potential for large and systematic redistribution away from borrowers (e.g., if there is an unanticipated fall in prices). Indeed, because our analysis assumes contingent contracting and observable returns, our model economy may be interpreted as a pure equity economy; thus, all our results go through even in the complete absence of debt instruments.

To what extent is financial fragility important to real activity? It seems to have been at least a portion of the explanation of the Great Depression (Bernanke (1983)), a period during which debt-deflation greatly reduced the general level of credit-worthiness. Postwar examples of financially-based problems having real effects are harder to pinpoint, although casual empiricism suggests a number of candidates (such as in the agricultural credit crisis; see Calomiris, Hubbard, and Stock (1986)), as well as possible dangers (e.g., depletion of the net worth of banks and savings and loans). Although the empirical work needs to be done, it is possible that changes in borrower net worth play a role in the ordinary business cycle: Bernanke and Gertler (1986) show in a formal setting how real shocks to the economy can be amplified, as declining net worth during a downswing leads to higher agency costs and lower investment demand. Finally, this approach may be of empirical relevance in the study of the apparently close link between financial development and general economic development: It may be, for example, that an important cause of the primitive and fragmented state of LDC financial markets is the generally low wealth level of potential borrowers. Our approach may also explain why the emergence of a relatively wealthy mercantile class (from which spring credit-worthy entrepreneurs) has historically been an important pre-condition for the development process.

As was discussed in the previous section, the most distinctive result of our formal policy analysis is that, in a financially fragile situation, transfers to borrowers can improve welfare and increase output. We interpret this as supporting the view that, in the face of large and imperfectly provided for shocks to borrower net worth, debtor "bailouts" by the government are sometimes a useful alternative to letting the financial system collapse or operate at an inefficient level.

Conditions like those that prevailed in the U.S. in the 1930's are probably most conducive to a bailout policy: At that time, those in need of help were easily identified; the source of distress was clearly systemic rather than idiosyncratic to individuals; and it could credibly be argued that New Deal "debt re-adjustments" were a one-time-only policy. Transfers restored the financial system without excessive signalling costs and without greatly increasing subjective probabilities of future bailouts (a cost not captured in this one-period setting).

We emphasize, though, that we do not want to be interpreted as favoring a generalized and ongoing bailout policy, with the obvious costs that would entail. The government's decision to help borrowers must balance the short-run benefits to the financial system against the excessive risk-taking and other inefficiencies that the prospect of future bailouts creates. Thus, optimal bailouts will be rare and will be in response only to large, systematic shocks.

The policy of transfers to borrowers might be objected to on equity grounds, since (according to our analysis) they are not Pareto-improving and tend to help borrowers at the expense of the rest of the population. This objection is valid, but we offer two qualifications: First, it is not generally true that transfers to borrowers involve taking from the poor to give to the rich; the primary beneficiaries of the New Deal policies, for example, were small and deeply indebted businesses, farmers, and homeowners. Second, if there are increasing returns or aggregate demand externalities, then the benefits of a healthy investment sector may be conferred more broadly than is implied by our simple model.

Various extensions of the analysis of this paper are possible. For example, the implications of this approach for the way we think about standard policies such as banking regulation, monetary policy, and lender-of-last-resort policy are interesting, and remain to be more completely explored. An extension that we are currently pursuing is the multi-period analogue of the model of this paper (i.e., we allow entrepreneurs to invest more than once, and to maintain continuing relationships with intermediaries). The purpose of doing this is to see if long-term lender-borrower relationships would eliminate or reduce the agency problem. The basic messages of the present paper seem to be largely unchanged by this extension: Low borrower wealth reduces the efficiency of the investment process, and there is scope for government policy. The multi-period model does yield some interesting dynamics, however. For example, we can show that financial factors provide an independent source of output persistence; this arises because current economic conditions affect net worth, which in turn affects economic performance in subsequent periods.

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