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FINANCIAL FRAGILITY AND ECONOMIC PERFORMANCE*

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Financial stability is an important goal of policy, but the relation of financial stability to economic performance and even the meaning of the term itself are poorly understood. This paper explores these issues in a theoretical model. We argue that financial instability, or fragility, occurs when entrepreneurs who want to undertake investment projects have low net worth; the heavy reliance on external finance that this implies causes the agency costs of investment to be high. High agency costs in turn lead to low and inefficient investment. Standard policies for fighting financial fragility can be interpreted as transfers that maintain or increase the net worth of potential borrowers.

I. INTRODUCTION

Given tastes and productive technologies, is there some sense in which general financial conditions (e.g., the creditworthiness of borrowers or the "soundness" of banks) exert an independent effect on the macroeconomy? Policy makers appear to think so: concerns about financial stability—motivated in large part by the experiences of the Depression and earlier episodes of financial crisis—are a principal rationale for the regulation of banking and securities markets. Preservation of financial stability is also an important goal of monetary policy (as when the Penn Central crisis of 1970 or the stock market crash of 1987 induced the Federal Reserve to supply extra liquidity) and fiscal policy (as in the "bailouts" of Chrysler, Lockheed, and the savings and loans).

Despite the importance attached by policy makers to maintaining a sound financial system, there is controversy over the mechanisms by which financial factors are supposed to affect the real economy and, indeed, over how financial stability can be operationally defined. For example, there is an interesting ongoing debate about the significance of the large recent increases in corporate debt in the United States. Some economists, such as Henry Kaufman [1986] and Ben Friedman [1986], have decried the buildup of debt as posing significant dangers; their concern is that the next serious recession may lead either to an epidemic of financial distress (which would exacerbate the downturn by leading

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to cutbacks in investment and employment) or to inflation (if the Fed is forced by mounting insolvency to flood the system with liquidity). On the other side, Michael Jensen [1988] has promoted the view that increased leverage is necessary to improve managerial performance and the efficiency of U. S. corporations. Thus, Jensen would claim that the recent growth of corporate debt burdens represents an increase in financial stability.

In this paper we take a step toward an operational definition of financial stability. We argue that financial stability is best understood as depending on the net worth positions of potential borrowers. Our basic reasoning is as follows: generally, the less of his own wealth a borrower can contribute to the funding of his investment "project," the more his interests will diverge from those of the people who have lent to him. When the borrower has superior information about his project, or the ability to take unobserved actions that affect the distribution of project returns, a greater incompatibility of interests increases the agency costs associated with the investment process. We define a *financially fragile* situation to be one in which potential borrowers (those with the greatest access to productive investment projects, or with the greatest entrepreneurial skills) have low wealth relative to the sizes of their projects. Such a situation (which might occur, e.g., in the early stages of economic development, in a prolonged recession, or subsequent to a "debt-deflation"[1]) leads to high agency costs and thus to poor performance in the investment sector and the economy overall.

We illustrate this general point in the context of a specific model of the process of investment finance. In this model individual entrepreneurs perform costly evaluations of potential investment projects and then undertake those projects that seem sufficiently worthwhile. The evaluation process gives the entrepreneurs (who must borrow in order to finance projects) better information about the quality of their projects than is available to potential lenders. As in Myers and Majluf [1984] and others, this informational asymmetry creates an agency problem between lenders and the entrepreneurs-borrowers. This agency problem (which is more severe, the lower is borrower net worth) raises the prospective costs of investment 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

1. The term is due to Irving Fisher [1933]. See Bernanke and Gertler [1989] for an analysis.

expected return will be sensitive to the "creditworthiness" of borrowers (as reflected in their net worth positions). Indeed, if borrower net worth is low enough, there can be a complete collapse of investment.

The inverse relationship between net worth and the agency costs of investment finance has played a role in our previous work [Bernanke and Gertler, 1989].[2] The earlier paper employed Robert Townsend's [1979] "costly state verification" (CSV) model to motivate agency costs of investment. A principal virtue of Townsend's setup is its simplicity, which allowed us to model the financial sector in a minimal way and to concentrate on other issues. However, a problem with the CSV model is that the agency costs in the model are identified with monitoring costs, which empirically are too small to rationalize first-order effects for financial fragility.

The model of investment employed in the present paper has, for our purposes, several advantages over the CSV model. The model used here is more realistic, as it allows for asymmetric information about borrower types, borrower actions, and project qualities, rather than just about project outcomes (as in the CSV model). Further, the agency problem that emerges is that borrowers are insufficiently selective in undertaking investments, a problem that authors such as Jensen have emphasized as being important in practice. The model of this paper also makes it easier to motivate quantitatively significant real effects for financial factors, since the empirical counterpart of the agency costs in our model need not be confined literally to monitoring costs, as in the CSV model, but may encompass a much broader set of costs associated with financial distress.

This paper also contains some novel policy results, not discussed in our earlier work. The most striking of these is that, if "legitimate" entrepreneurs are to some degree identifiable, then a policy of transfers to these entrepreneurs will increase welfare. We show that a number of standard policies for fighting financial fragility can be interpreted along these lines.

The rest of the paper is organized as follows. Section II lays out our basic model of the process of investment finance. The social planner's optimum for the model, which is useful as a benchmark, is derived in Section III. Section IV derives the optimal financial contract between borrowers and lenders and then calculates the general equilibrium of the model; these results allow us to make our

2. See also Leland and Pyle [1977] and Calomiris and Hubbard [forthcoming].

main points about the relationship between borrower net worth, financial fragility, and the performance of the real economy. Section V discusses policy implications of the model. Section VI concludes the paper with some comments on how this type of formal analysis can help us think about the Kaufman-Friedman-Jensen debate about corporate debt and financial stability.

II. A Model of Investment Finance

We use a simple two-period general equilibrium model. The assumptions are intended to capture some basic features of investment and investment finance. Investment here is a lengthy (more than one-stage) process. The final success of investment projects depends on actions taken along the way by the firm's "insiders" (entrepreneurs, managers, directors); these actions cannot be perfectly observed by people outside the firm. In addition, as the process evolves, the insiders obtain superior information about the quality of the investment. To the extent any external finance is required, the informational asymmetries introduce an agency problem; namely, that the insiders have the incentive to invest the funds of the outside lenders in negative present value projects.

The specific assumptions are as follows:

There is a countable infinity of people. An individual drawn at random is an "entrepreneur" with probability μ and is a "nonentrepreneur" with probability $1 - \mu$.

There are two periods: a savings period and a consumption period. At the beginning of the first period, an endowment of a nonconsumable input good is distributed continuously over the population; each individual i receives the quantity w_i. During this period the endowment may either be "stored" or "invested." The output of either storage or investment is a consumption good, available in the second period. The gross return on any amount stored is r units of output per unit of input. The investment technology, in contrast, is indivisible, involves informational asymmetries, and yields a random payoff.

There are an infinite number of potential investment projects. All projects are identical ex ante. There are two stages in the investment process (both of which take place during the first period). In the first stage the project must be "evaluated." Only entrepreneurs know how to evaluate projects. Evaluation costs the entrepreneur e units of effort[3] and yields a probability p that the

3. It is unimportant that the evaluation costs involve effort rather than endowment; having the costs involve effort minimizes the algebra.

project, if undertaken, will succeed. The probability of success p can be thought of as a measure of the quality of the project; p is itself a random variable that is independent across projects and is drawn from a continuous cumulative distribution function $H(p)$. Evaluation also allows the entrepreneur to learn how to properly implement and manage the project; a successful outcome is not possible unless the project is evaluated.[4] Only one project can be evaluated by each entrepreneur.

In the second stage of the investment process, the entrepreneur decides whether or not to proceed with the project he evaluated in the first stage. Undertaking the project requires one unit of endowment; the entrepreneur must obtain external finance if his endowment is less than unity. If the project succeeds (which it does with probability p), it pays $R > r$ units of consumption goods. If it fails, it pays nothing. If the entrepreneur decides not to proceed, he may simply store his endowment or lend it to others; however, the effort expended in the evaluation stage is sunk and cannot be recouped if the project is abandoned. A nonentrepreneur could in principle undertake a project (this will never happen in equilibrium), but since nonentrepreneurs cannot evaluate, the project would fail with certainty.

We shall also assume (by choice of parameters) that a policy of undertaking *all* evaluated projects yields a negative expected project return, net of evaluation costs. This serves to guarantee that the optimal reservation success probability for accepting projects is always positive.

The model's information structure is as follows: whether a project succeeds or fails is publicly observable. Also, the c.d.f. that defines the project quality distribution, $H(p)$, is common knowledge. The evaluated project quality (the "p"), however, is the entrepreneur's private information. In addition, it cannot be publicly observed whether an individual who claims to have evaluated a project has in fact done so.[5] We assume that individual endowments are observable (there will be no incentive to hide endowment in this model). Finally, because our policy conclusions depend on whether

4. The evaluation stage can be interpreted broadly. The key features are that it is costly, involves acquisition of information, and is essential for a successful final outcome. It could be thought of as research and development or simply as setting up and, through time, becoming increasingly familiar with the project.

5. Without this "moral hazard" problem, a contract that gives the entrepreneur a fixed, noncontingent return would achieve the first-best. Thus, either the assumption that evaluation is costly and unobservable, or some alternative assumption that gives the entrepreneur the option to enjoy "on-the-job consumption" at the expense of lenders, is necessary to make the problem interesting. See subsection IVa.

a person's type (entrepreneur or nonentrepreneur) is observable, we consider both cases.

We assume that everyone is risk neutral. Entrepreneurs maximize expected second-period consumption less any effort expended on project evaluation. Nonentrepreneurs maximize expected second-period consumption; their only decision is whether to store or lend their endowment.

III. 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 $\overline{w}$ be per capita endowment; we assume that $\overline{w} > \mu$, so that it is feasible to fund all entrepreneurs' projects. 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 are 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,

$$\hat{p} = E(p \mid p \geq p^*) = \left[\int_{p^*}^{1} p \, dH \right] \Big/ [1 - H(p^*)].$$

Then $\hat{p}R$ 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

$$\max_{p^*,m} r[\overline{w} - m(1 - H(p^*))] + m[(1 - H(p^*))\hat{p}R - e], \tag{1}$$

subject to

$$m \leq \mu. \tag{2}$$

The first term in (1) is the expected per capita return from storage, and the second is the expected per capita return (net of evaluation costs) from investment. The constraint (2) says that there can be no more projects evaluated than there are entrepreneurs.

Let the subscript "*fb*" designate a "first-best" value. The solution to the planner's problem is

$$p^*_{fb} = r/R \tag{3}$$

$$m_{fb} = \begin{cases} \mu, & \text{if } (1 - H(p^*_{fb}))(\hat{p}_{fb}R - r) - e > 0 \\ 0, & \text{otherwise.} \end{cases} \tag{4}$$

This solution is easily interpreted. Rewritten as $p^*_{fb}R = r$, (3) says that the optimal reservation success probability is such that the expected return of going ahead with the project is just equal to the opportunity cost (i.e., the storage return r) of the required input. In (4) the expression $(1 - H(p^*_{fb}))(\hat{p}_{fb}R - r) - e$ gives the expected surplus, relative to storage, of evaluating an additional project. If this value is nonnegative, then it is socially profitable for all entrepreneurs to initiate projects ($m_{fb} = \mu$); otherwise, storage is preferred to investment ($m_{fb} = 0$). In what follows, we shall assume that the expression in (4) is nonnegative, so that it is always socially desirable for all entrepreneurs to evaluate projects.[6]

Welfare maximization has no implications for output 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 of the initial distribution of wealth (endowment). With private information, however, the distribution of wealth between entrepreneurs and nonentrepreneurs will in fact have an important effect on the constrained optimum, as we shall see.

IV. The Model with Asymmetric Information: A Decentralized Solution

We now reintroduce asymmetric information and consider a particular decentralized (competitive) equilibrium for our economy.

Suppose that for most individuals i it is the case that $w_i < 1$, so that individual endowments are less than the unit of input required

6. The "bang-bang" nature of the solution to the planner's problem is easily avoided, e.g., by letting the project success payoff R or evaluation costs vary continuously over the population of entrepreneurs. See the working paper version of this article.

to operate a project. Then entrepreneurs who decide to proceed with their projects must borrow endowment from lenders (i.e., nonentrepreneurs and entrepreneurs who do not proceed). It is convenient to think of this borrowing as being channeled through competitive financial intermediaries, which use no resources in the process of intermediation and earn no profits in equilibrium. The main function of these intermediaries is to diversify lending across entrepreneurs. Diversification here ensures that credit arrangements which are feasible in expected terms ex ante will also be feasible in realizations ex post.[7]

The key step in constructing the equilibrium is finding the optimal credit arrangement between the individual entrepreneur and intermediary. Without loss of generality, we may restrict attention to arrangements of the following form: the entrepreneur signs a contract with an intermediary at the beginning of the first period. He then evaluates his project,[8] learns the success probability, and decides whether to proceed. If the entrepreneur does choose to proceed, the intermediary lends him $1 - w$ of the input good which, together with his own endowment w, is sufficient to fund the project; if he does not proceed, he simply stores his endowment or lends it to the intermediary. The financial contract specifies the amount of consumption good that the entrepreneur must pay the intermediary in the second period, contingent on the three possible project outcomes (undertaken and successful, undertaken and not successful, not undertaken). The notation defining the state-contingent payoffs (which may be either positive or negative) is given in the following tabulation.

If:	The entrepreneur pays the intermediary:	And the entrepreneur's profit is:
A project is undertaken and is successful	Z_s	$R - Z_s$
A project is undertaken and is not successful	Z_u	$-Z_u$
No project is undertaken	Z_0	$rw - Z_0$

Note that the three contingencies on which the consumption payment is based are assumed to be distinguishable by the interme-

7. Diversification to guarantee the payoffs under an optimal incentive-compatible credit arrangement is also a feature of the intermediaries in Boyd and Prescott [1986].

8. Nothing essential depends on this assumed sequence; a similar analysis applies if evaluations can take place before contracts are signed.

diary. Importantly, missing from the contract is a contingency based on the project's quality; having this contingency is not possible since the intermediary cannot verify the success probability p. Also, for the contingency "no project is undertaken," the intermediary cannot tell whether the borrower evaluated a project but decided not to go ahead, or whether he simply did not evaluate in the first place.

We note here that the gross return on storage, r, will be the market-clearing riskless interest rate. This is true because our previous assumptions guarantee that the level of storage is always positive in equilibrium. We therefore take r to be the intermediary's opportunity cost of funds.

IVa. The Optimal Financial Contract When Borrower Type Is Unobservable

We now derive the optimal contract between an entrepreneur with endowment w and a competitive intermediary. For the time being, we assume *unobservable types*; that is, we assume that whether an individual is an entrepreneur or a nonentrepreneur is the individual's private information. The case of observable types is considered later in this section.

It is convenient to derive the contract under the assumption that evaluation is profitable; i.e., that there exist feasible contract parameters such that the objective (5) exceeds the entrepreneur's opportunity cost, rw. Should this premise not hold, then the entrepreneur will not evaluate, and the solution to the optimal contracting problem is irrelevant.

The optimal contract solves the following problem:

$$\max_{Z_s,Z_0,Z_u} [(1 - H(p^*))\hat{p}R + H(p^*)rw - e] - [(1 - H(p^*))(\hat{p}Z_s + (1 - \hat{p})Z_u) + H(p^*)Z_0] \tag{5}$$

subject to

$$(1 - H(p^*))(\hat{p}Z_s + (1 - \hat{p})Z_u) + H(p^*)Z_0 \geq (1 - H(p^*))r(1 - w) \tag{6}$$

$$p^*(Z_s,Z_0,Z_u) = \text{argmax}\,\{[(1 - H(p^*))\hat{p}R + H(p^*)\,rw - e] - [(1 - H(p^*))(\hat{p}Z_s + (1 - \hat{p})Z_u) + H(p^*)Z_0]\} \tag{7}$$

$$Z_0 \geq 0. \tag{8}$$

In addition there are constraints that ensure that the entrepreneur's consumption is nonnegative in every state; we return to these in a moment.

Expression (5) is the entrepreneur's expected utility, equal to his gross expected gain from evaluating the project less his expected obligation to the intermediary. This expected utility is to be maximized with respect to the state-contingent payments to the intermediary, Z_s, Z_0, and Z_u.

Expression (6) is the requirement that the intermediary make nonnegative profits. The left side of (6) is the expected payment from the entrepreneur, while the right side is the expected opportunity cost of the funds committed to the entrepreneur.

Because the intermediary cannot directly verify project quality, the contract must take into account the entrepreneur's decision rule for proceeding with an investment. The incentive compatibility condition (7) states that the reservation success probability p^* chosen by the entrepreneur is the one that maximizes his utility, given the terms of the financial contract. This value of p^* can be expressed explicitly: differentiation of the objective with respect to p^* yields the first-order condition:

$$rw = Z_0 = p^*(R - Z_s) - (1 - p^*)Z_u. \tag{9}$$

Expression (9) defines the entrepreneur's choice of p^* directly in terms of the contract payments and other parameters of the problem. According to (9), p^* is the success probability at which the entrepreneur is just indifferent between proceeding with the project (which has expected return $p^*(R - Z_s) - (1 - p^*)Z_u$) and not proceeding (which has a return of $rw - Z_0$).

The second-order condition for the entrepreneur's choice of p^* requires that

$$R - Z_s \geq -Z_u. \tag{10}$$

The inequality (10) is necessary to ensure that the entrepreneur will undertake projects with success probabilities above p^*, rather than those with success probabilities below p^*. Expression (10) never binds if expected profits are nonnegative (see the Appendix).

Since (9) and (10) define the entrepreneur's incentive-compatible choice of p^*, these two conditions can replace condition (7) in the entrepreneur's maximization problem.

Constraint (8) is another incentive-compatibility condition, needed to guarantee that any borrower entering a contract actually evaluates a project (since evaluation is unobservable). Constraint (8) follows from the assumption, maintained in this section, that intermediaries cannot distinguish entrepreneurs (people with access to legitimate projects) from nonentrepreneurs (people without access to projects). Constraint (8) requires that Z_0, the payment made by the entrepreneur if no project is undertaken, be nonnegative. If Z_0 were instead negative (i.e., a transfer is made to the entrepreneur when no project is undertaken), it would pay nonentrepreneurs to claim falsely that they are entrepreneurs in order to collect this transfer. Constraint (8) can be relaxed somewhat in the case where entrepreneurs and nonentrepreneurs can be distinguished; see below.

Finally, because entrepreneurs cannot have negative consumption, the payments made to the intermediary in each state must be no greater than the entrepreneur's resources in that state. The "limited liability" constraints are

$$0 \geq Z_u \tag{11}$$

$$rw \geq Z_0. \tag{12}$$

A separate restriction on Z_s is not necessary, since (10) and (11) together imply that Z_s is feasible (i.e., that $R \geq Z_s$). It also turns out that (12) never binds.[9]

The optimal contract, with some implications for the entrepreneur's investment decisions, is characterized by the following propositions. Proofs of Proposition 1–3 are in the Appendix.

PROPOSITION 1. If $w \geq 1$, then $p^* = r/R = p^*_{fb}$.

In this case the entrepreneur has enough endowment to completely self-finance his project. Having a 100 percent stake gives him the incentive to maximize expected project surplus; he thus sets p^* at r/R, the social optimum.

PROPOSITION 2. If $w < 1$, then

(i) the optimal contract sets $Z_s = r(1 - w)/\hat{p}$, $Z_0 = 0$, $Z_u = 0$;
(ii) $p^* < r/R$ under the optimal contract;
(iii) p^* is an increasing function of w, defined implicitly by

$$p^*R - r[w + (p^*/\hat{p})(1 - w)] = 0. \tag{13}$$

When $w < 1$, the entrepreneur must borrow from the intermediary. An agency problem emerges; this problem takes the form

9. If (12) were binding, then by (9)–(11) p^* would have to equal zero. This implies that the entrepreneur's expected profits would be negative, which is clearly suboptimal in this case.

suggested by Jensen [1988]; i.e., the entrepreneur has the incentive to undertake negative present value projects ($p^* < r/R$). The financial contract is structured to minimize this inefficiency to the extent possible; this is accomplished by rewarding entrepreneurs who are selective in undertaking an investment (making $rw - Z_0$ large) and punishing those who are not (making Z_u large). However, the moral hazard constraint (8) and the limited liability condition (11) restrict what can be done. The optimal contract goes as far as is feasible by fixing Z_0 at zero (so that (8) is binding) and fixing Z_u at zero (so that (11) is binding). This contract could be interpreted as a credit line, in which the entrepreneur draws funds as needed and repays if successful. However, as discussed below, this interpretation does not generalize.

Substituting the results that $Z_0 = 0$ and $Z_u = 0$ into (9) and (6), and then using (9) to eliminate Z_s from (6) yields equation (13), which defines p^*. Implicit differentiation of (13) shows that p^* is increasing in w. Intuitively, the rise in w increases the entrepreneur's opportunity cost of proceeding with his project (equal to rw since $Z_0 = 0$), which makes him more selective. Expected project surplus thus also rises,[10] lowering agency costs. Thus, our model exhibits an inverse relationship of borrower net worth and agency costs, as emphasized in the introduction.

It is important to realize that, since in this model there is a safe alternative asset for lenders, the entrepreneur completely bears the agency costs of financing his investment. The intermediary recognizes that the average quality of accepted projects declines when w falls; it therefore requires a bigger share of the return of successful projects (Z_s) in order to keep its expected return equal to the riskless rate.

The deadweight losses from external finance imply that there is a premium on "internal funds" (the entrepreneur's own endowment). To see this, note that the entrepreneur's (maximized) expected utility V, after substitution of (6) into (5), is given by

$$V = (1 - H(p^*))(\hat{p}R - r) + rw - e. \tag{14}$$

Differentiation of V with respect to w, taking into account the dependence of p^* on w, yields

$$\frac{\partial V}{\partial w} = (r - p^*R) \cdot \frac{\partial p^*}{\partial w} + r. \tag{15}$$

10. Expected project surplus, $(1 - H(p^*))(\hat{p}R - r) - e$, is increasing in p^* for $p^* < r/R$.

When $w < 1$, then $r > p^*R$, and $\partial p^*/\partial w > 0$, so that the right side of (15) exceeds r. Because internal finance reduces agency costs, the expected return to internal funds, $\partial V/\partial w$, exceeds the expected return to external funds, which is r.

PROPOSITION 3. There exists some value of endowment $w_l > 0$ such that, if $w < w_l$, then it is not profitable for the entrepreneur to evaluate his project. w_l and p_l^*(the associated value of p^*) are determined jointly by

$$p_l^*R - r\,[w_l + (p_l^*/\hat{p}_l)(1 - w_l)] = 0 \tag{16}$$

$$(1 - H(p_l^*))(\hat{p}_lR - r) - e = 0. \tag{17}$$

If borrower net worth is low enough, agency costs become overwhelming, and there is no contract for which evaluation of investment projects is profitable. The observation made above that there is a premium on internal funds does not apply when $w < w_l$; below the threshold endowment level a marginal unit of internal finance does not reduce agency costs.

In order to gain some further intuition on the source of inefficiencies in this setting, it is worth noting that the first-best could be attained if it were feasible for the entrepreneur to issue either a pure *riskless* debt contract or a pure equity contract. Under the riskless debt contract the intermediary is repaid $r(1 - w)$ under any project outcome, implying that $Z_s = Z_u = r(1 - w)$ and $Z_0 = 0$. Substituting these values for the contingent payments into the incentive condition (9) implies that $p^* = r/R$, the first-best outcome. The efficient outcome arises because, with a fixed obligation across states, the entrepreneur internalizes all the gains from his choice of p^*. What makes the riskless debt contract infeasible, of course, is the limited liability condition.

Under the pure equity contract the entrepreneur receives fixed compensation across all states (i.e., $R - Z_s = -Z_u = rw - Z_0$), and the intermediary bears all the residual risk. Because the entrepreneur's compensation is independent of the actions he takes, he no longer has an incentive to choose a nonoptimal value of p^*. (Formally, (9) does not restrict the choice of p^* under the equity contract, implying that p^* can be freely adjusted to the social optimum.) The moral hazard constraint (8), however, rules out the pure equity contract, since it restricts Z_0 from being negative; intuitively, when the entrepreneur's return is independent of his actions, he has no incentive to make an effort to evaluate the project.

IVb. General Equilibrium When Types Are Unobservable

The general equilibrium of this economy is easy to compute. The market riskless interest rate is r, since there is positive storage in equilibrium. All entrepreneurs with endowments greater than or equal to w_l evaluate their projects while the rest become lenders. Nonentrepreneurs and entrepreneurs whose evaluated projects have success probabilities below the reservation level also lend (or store) their endowments.

The key result is that total welfare and output depend on the distribution as well as the level of endowment, despite the assumption of universal risk neutrality. The reason is that the distribution of entrepreneurs' endowments affects agency costs and investment. Let $F(w)$ and $f(w)$ be the c.d.f. and p.d.f., respectively, of initial endowments for entrepreneurs, and let $\overline{w}$ be the per capita mean endowment (of both entrepreneurs and nonentrepreneurs). Then per capita welfare v and per capita total output (from both storage and investment) q are given by

$$(18) \qquad v = q - me$$
$$< v_{fb} = q_{fb} - \mu e$$

$$(19) \qquad q = r\overline{w} + \mu \int_{w_l}^{1} [1 - H(p^*(w))](\hat{p}(w)R - r)f(w)\,dw$$
$$+ \mu(1 - F(1))(1 - H(p^*_{fb}))(\hat{p}_{fb}R - r)$$
$$< q_{fb} = r\overline{w} + \mu(1 - H(p^*))(\hat{p}_{fb}R - r),$$

where v_{fb} and q_{fb} are per capita welfare and output in the unconstrained optimum. m, the number of projects evaluated in the decentralized equilibrium, is given by

$$(20) \qquad m = \mu(1 - F(w_l)) < \mu.$$

The second term in the expression for q in (19) is the per capita surplus from projects owned by "middle-class" entrepreneurs, those with endowments between w_l and unity; the third term is the per capita surplus from "rich" entrepreneurs, those with endowments exceeding unity. v lies below v_{fb} and q lies below q_{fb} for two reasons: first, not all entrepreneurs evaluate their projects in the informationally constrained equilibrium (i.e., $m < \mu$); "poor" entrepreneurs, those with endowments less than w_l, drop out of the market. Second, middle-class entrepreneurs produce expected surplus below the first-best, since they set too low a "hurdle rate" (p^*) for projects they undertake.

We characterize a situation in which many entrepreneurs have low wealth (relative to the sizes of their various investment projects) as *financially fragile*. In this situation many potential borrowers need funds but are not "creditworthy"; that is, the agency costs of lending to them are high, possibly too high to permit them to operate at all. As a consequence, even though the "fundamentals" of investment may be good, both the number of investments evaluated and the average realized return of investments undertaken are low. Indeed, a complete investment *collapse* is possible: if all entrepreneurs have endowments below w_l, no investment projects will be evaluated, and thus none will be undertaken in equilibrium.[11]

While insufficient entrepreneurial net worth induces lower per capita output and welfare, the net impact on investment (here, the quantity of endowment used as project input) is unclear. There are two offsetting forces: fewer projects are evaluated, but the acceptance rate among evaluated projects is higher. It is possible to show, however, that as entrepreneurial net worth declines, the former effect dominates, leading to underinvestment overall.[12] The limit is the complete investment collapse, arising when entrepreneurial endowments are all below w_l.

IVc. The Case of Observable Types

We now briefly consider how the analysis is modified when the intermediary can directly verify whether the borrower is a legitimate entrepreneur. Generally speaking, giving the intermediary more knowledge about potential borrowers permits the use of more individually customized financial arrangements, thereby reducing agency costs. In particular, if intermediaries can distinguish entrepreneurs, then the moral hazard constraint (8) is loosened. The intermediary can now make a payment to entrepreneurs who evaluate but do not proceed with their projects without being concerned that nonentrepreneurs will (by pretending to be in this

11. The possibility of an investment "collapse" due to financial factors has previously been shown by Mankiw [1986]. Mankiw restricts his attention to debt contracts, while our result applies when general contingent claims contracts are used.

12. Using a model similar to ours, deMeza and Webb [1987] obtain an "overinvestment" result. This 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 their projects. The difference in results is explained by the fact that deMeza and Webb implicitly treat the number of evaluations (m) as exogenous. When the investment process includes a costly evaluation stage, entrepreneurs internalize the cost of insufficient selectivity, so that underinvestment can occur. DeMeza and Webb also implicitly rule out the flat managerial compensation contract discussed at the end of our subsection IVa; this contract would eliminate the agency problem in their setting.

class of entrepreneurs) also claim the payment; that is, Z_0 can be negative. The financial arrangement can thus be structured to encourage greater project selectivity (a higher p^*) than before, which reduces the severity of the incentive problem.

The financial contracting problem is the same as before, except that (8) is replaced by the following constraint:

$$(21)\quad [(1-H(p^*))\hat{p}R + H(p^*)rw - e] - [(1-H(p^*))(\hat{p}Z_s + (1-\hat{p})Z_u) + H(p^*)Z_0] \geq rw - Z_0.$$

In analogy to (8), (21) is needed to eliminate the borrower's incentive to claim falsely to have evaluated a project. Expression (21) requires that the entrepreneur's expected gain from evaluating be greater than or equal to the payoff he would receive from not evaluating and claiming that the project is not worth undertaking. Since the outside return constraint (6) always binds, we can add (6) to (21) to obtain

$$(22)\quad (1-H(p^*))(\hat{p}R - r) - e \geq -Z_0.$$

Expression (22) shows that it is incentive-compatible for the intermediary to make a payment to the entrepreneur if he does not proceed (i.e., Z_0 can be negative), but this transfer cannot exceed the expected surplus from evaluating a project.

As before (when the incentive constraints bind), the optimal contract minimizes agency costs by fixing Z_u at its maximum feasible value and by fixing Z_0 at its minimum feasible value. Thus, Z_u is set again at zero; but unlike before, Z_0 is given by

$$(23)\quad Z_0 = -[(1-H(p^*))(\hat{p}R - r) - e] < 0.$$

An expression for the optimal p^* follows by combining (23) with (6) and (9) and imposing $Z_u = 0$:

$$(24)\quad p^*R - r[w + (p^*/\hat{p})(1-w)] = \phi(p^*),$$

where

$$\phi(p^*) \equiv \left[1 + \frac{p^*H(p^*)}{\hat{p}(1-H(p^*))}\right][(1-H(p^*))(\hat{p}R - r) - e] \geq 0.$$

If multiple values of p^* satisfy (24), the optimum is the *largest* value.

The optimal contract emerging here is a variant of the simple "credit line" contract arising in the previous case. It allows for some compensation to the entrepreneur (interpretable as salary) in the event he evaluates but does not proceed with his project, in return for which the intermediary receives a higher payment in the event of a successful project outcome. The improved efficiency of this contract can be seen by comparing (24) with (13), the expression for p^* in the previous case; p^* is larger than before, except in the knife-edge situation where expected project surplus is zero (in which case p^* is the same). Intuitively, the new contract induces more prudent project selection by shifting some of the entrepreneur's payoff from the successful investment state to the "no-investment" state.

Some characteristics of the optimal contract when types are observable and the borrower has wealth w are summarized in Proposition 4.

PROPOSITION 4. When borrower types are observable,

(i) there exists some $w_u < 1$ such that, if $w > w_u$, then $p^* = r/R$; w_u is the value of w satisfying (24) when $p^* = r/R$;

(ii) if $w < w_u$, then $p^* < r/R$, and p^* is an increasing function of w given by (24);[13]

(iii) there may or may not exist some $w > 0$ below which it is not profitable to evaluate projects; if this minimum w does exist, it is less than or equal to w_l, the minimum w at which it is profitable to evaluate in the case of unobservable types.[14]

The proof of Proposition 4 is analogous to the proofs of Proposition 1–3.

Because the contract here is more efficient than when types are unobservable, it is possible to achieve the first-best outcome even when borrower net worth is less than one, so that there is some external finance (see part (i) of Proposition 4). Similarly, the level of borrower wealth at which investment "collapses," if it exists, may be lower than in the unobservable types case (see part (iii) of the proposition).

A key message of Proposition 4, however, is that the qualitative nature of the outcome when types are observed is not much different from the unobservable types case. Unless the amount of

13. The second-order conditions require that $(1 - H(p^*))(\hat{p}R - r) + rw - e \geq p^*(1 - p^*/\hat{p})(r - p^*R)h(p^*)$. This restriction guarantees that p^* is increasing in w.

14. As before, the minimum is found by calculating the lowest value of w at which expected project surplus is nonnegative. In this case, however, expected project surplus may be positive when $w = 0$; whereas in the case with unobservable types it was necessarily negative.

external finance is relatively small (i.e., $w > w_u$), there will still be agency costs of investment in equilibrium; and these costs will increase the greater the share of external finance (part (ii) of the proposition). Allowing borrower types to be observable thus does not eliminate the possibility of financial fragility in market equilibrium.

Although the market outcomes for the observable and unobservable cases are similar, the two cases provide very different scope for policy intervention, as will be discussed in Section V.

IVd. Lotteries

Before turning to policy implications, we digress briefly on a technical issue—the potential to improve the allocations in our model by the use of 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 helpful in the present setting.

The reason these lotteries may be beneficial is that the entrepreneur's expected utility may be locally convex in wealth, due to the value of wealth in reducing agency costs. (See equation (15) and the discussion thereafter.) For reasons of space, we do not discuss lotteries in detail here. (See Bernanke and Gertler [1989] or the working paper version of this paper.) The main modification to our results is that, with lotteries, a complete investment collapse is much less likely. The collapse will be prevented by a pooling of entrepreneurial endowment (via the lottery). Our other results are not substantially affected. Underinvestment remains possible since "lottery-losers" must abandon their projects. Further, since optimal lotteries will not raise the wealth of winning entrepreneurs high enough to eliminate the need for external finance,[15] the financial contracting problem of our basic analysis is still relevant.

V. POLICY IMPLICATIONS

So far, we have considered the positive questions of the determinants of financial fragility and its effects on the economy. In

15. It can be shown that our entrepreneur's expected utility is concave in wealth when w is below but near the level of wealth that makes agency costs zero. For this reason, the optimal lottery pays winners a value of w less than unity.

this section we turn to the normative question of what government policy can do about financial fragility.

An advantage of the formal setup we have used here is that normative analysis can be done in a straightforward way, by comparison of the allocations arising in market equilibrium with those implied by the information- and incentive-constrained planning solution. Since our model is overly simple—one important omission is the lack of dynamics—our results require qualification, as we shall discuss. Nevertheless, the analysis does provide some useful insights into the nature of alternative policies for dealing with financial fragility. To conserve space, here we shall emphasize results and omit details of the calculations.

An important preliminary point is that, for the class of economy studied here (in particular, excluding lotteries), the market equilibria we have derived are Pareto optima. Thus, even in a situation of financial fragility so severe that no investment is possible, there will be no policy action available that would be unanimously approved. However, policy *will* be able to increase total social welfare, the return to saving, 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 and endowments. Such policies seem worthy of study, even if they are not Pareto-improving.

The critical determinant of the effectiveness of policy, it turns out, is the observability of individual types (entrepreneur or nonentrepreneur).

If types are not observable, then the optimal policy for fighting financial fragility is to *tax* successful investment projects, distributing the proceeds to those who claim to be nonentrepreneurs. This somewhat surprising result is due to the particular nature of the agency problem, which is that entrepreneurs accept too many evaluated projects; by reducing the expected return to proceeding with an investment, the tax on successful projects makes entrepreneurs more selective.[16]

We do not take this policy implication of our model entirely seriously. While it can be shown that the optimal tax is positive, the net effect on welfare of introducing a tax will in most cases be limited. The problem is that, although a tax on successful projects

16. A tax on corporate cash flow would also seem to be an implication of Jensen's [1988] "free cash flow" theory (see Section VI). So far advocates of this theory have not made this recommendation.

helps on the selectivity margin (i.e., it raises p^*), it also reduces the expected return to evaluation. Thus, the tax is likely to reduce the number of evaluations (m),[17] which is already inefficiently low in the competitive equilibrium; this offsets the benefits of increased selectivity. A more general qualification is that this policy implication is not robust to alternative specifications of the agency problem.

The alternative case is the one in which individual types are public information. As was shown above, observability of types does change the competitive equilibrium somewhat but in general is not sufficient to cure the agency problems created by external finance. However, observability of types does have a dramatic impact on the capability of the planner. *The planner can always achieve a first-best allocation in this case,* simply by redistributing endowment (via lump sum taxes) from nonentrepreneurs to entrepreneurs, up to the point where there are no agency costs of investment. (I.e., the transfer must bring every entrepreneur's wealth up to w_u; see Proposition 4.) If we think of the economy as starting from a financially fragile state, with low borrower net worth and low investment, this transfer policy may be interpreted as a *debtor bailout.*[18] The "bailout" policy works because it directly attacks the cause of financial fragility, which is low borrower net worth. Further, unlike the tax policy in the unobservable types case, the transfer policy is likely to be beneficial for a wide variety of specifications of the agency problem; this is because the proposition that increased borrower net worth reduces agency costs, although not true in literally every case, is quite general.

Governments have often used debtor bailout policies, and while these may to some degree have reflected a desire to make pure transfers to politically favored groups, a desire to improve overall economic performance seems also to have been a motive. The classic example is Roosevelt's policy of financial rehabilitation during the New Deal; by reducing the debt burdens of farmers, homeowners, businesses, and banks, this policy helped normalize credit markets,

17. The precise effect of the tax on the number of evaluations depends on the distribution of entrepreneurial wealth; specifically, on the proportion of entrepreneurs whose net worth is such that their before-tax expected surplus from evaluation is positive and their after-tax surplus from evaluation is negative.

18. Strictly speaking, in our one-shot economy, the policy is not a bailout of debtors but a bailout of people who prospectively need to borrow, in order to finance investment projects. Presumably, in the real economy, people who have borrowed in order to finance projects in the past are the ones most likely to want to borrow again today. In this case, the terminology "debtor bailout" is appropriate.

leading to increased output and investment.[19] Similarly, the current agitation for LDC debt relief is not based purely on redistributionist grounds (else, why not aid the poorest countries, independent of debt burdens?) but on the belief that making LDC borrowers creditworthy again will lead to better economic performance overall.

Transfers to borrowers need not be direct in order to reduce financial fragility. For example, much Federal credit activity (loan subsidies and guarantees) is channeled through financial intermediaries, presumably in order to take advantage of intermediaries' information capital. It is interesting to note that, in our model, the government can achieve the first best without itself having to identify "legitimate" borrowers, as long as (1) intermediaries can tell which borrowers are legitimate and (2) the government can observe the number of successful projects; the way the government can do this is by subsidizing the intermediary according to the number of financial contracts it signs. (Since intermediaries are competitive, these subsidies are effectively transferred to borrowers.) To see whether the intermediary is in fact signing contracts with legitimate borrowers, in our model the government only needs to check whether the appropriate fraction of signed contracts culminate in successful projects (the ex post and ex ante success rates will be the same, by the law of large numbers). In reality, the tradeoff between the costs of monitoring intermediaries and the costs of determining directly who are the legitimate borrowers will affect the government's decision about whether to make transfers to borrowers directly or via intermediaries.

Another type of policy for fighting financial fragility that can be interpreted in terms of transfers to borrowers has been recently discussed by Brimmer [1989]. Brimmer discusses how the Federal Reserve has broadened the concept of lender of last resort to include protection of financial institutions and markets from systemic shocks. In this case, the "borrowers" receiving transfers are financial firms such as banks, brokers, and clearinghouses.[20] Like the entrepreneurs in our model, financial institutions need net worth (capital) to be able to borrow and to perform their functions

19. Another way of transferring wealth to debtors is through unexpected inflation. Roosevelt's "reflation" and abandonment of the gold standard may be interpreted in this light.

20. In the Penn Central crisis of 1970, the Federal Reserve apparently extended its policy of borrower subsidization (indirectly, through banks) to nonfinancial firms that were having difficulty borrowing in the commercial paper market.

with manageable levels of agency costs [Bernanke and Gertler, 1987; Bernanke, forthcoming]. On occasions such as the Silver Bubble of 1980 and the stock market crash of 1987, when the Federal Reserve perceived the capital of important institutions as being threatened, it has taken steps to protect that capital (see Brimmer for details). The Fed's measures must be viewed as having a transfer component; if they were not concessionary in some way, they could have been performed by private lenders.

Thus far, we have focused on the benefits of transfer policies; our model suggests that they can be used to improve borrower creditworthiness and thus reduce the adverse effects of financial fragility. However, our model, not being dynamic, does not incorporate every economist's first and most strongly held objection to bailouts: the moral hazard issue. The problem is, of course, that expectations of being bailed out in the future will lead to excessive risk-taking and other inefficient behavior by borrowers.

One response to this is to recommend that bailouts be used only in response to large aggregate or systemic shocks, over which individual borrowers could have no control; individual institutions that have made bad decisions should not be bailed out. In principle, this approach should avoid the moral hazard problem. This recommendation does presuppose that private contracts have not been optimally indexed to aggregate risk—probably a reasonable presumption for rare or unforeseen types of disturbances, such as the rise and fall of the silver bubble in 1980 or the events of October 1987. Under this interpretation the government's role is to use transfers to provide a sort of "ex post indexing" of borrowers' net worth against the effects of large, unanticipated disturbances. The Roosevelt debt-relief policy, which offset the effects of a large unanticipated deflation on the value of debt contracts, can be interpreted in this way.

It must be admitted though that, in practice, it is not always so easy to distinguish "systemic" from "idiosyncratic" shocks. The most difficult type of situation is when the shock is the result of a large borrower (Chrysler, Continental Illinois) getting into trouble, with uncertain implications for the stability of the entire financial system. Ex post, in these cases, a bailout of the large borrower usually appears preferable to no bailout; but the failure of the government to make an ex ante commitment against bailouts may create an inferior time-consistent equilibrium in which financial crises are more, rather than less, likely. We can think of two ways to address the time consistency problem in this case: one is to follow the dictum of "bail out the institution but not the (top) management"; this preserves much of the intangible capital of the institution without rewarding bad or risky strategic decisions. The second approach is not to bail out the large troubled institution at all, but to take steps to protect the capital of borrowers in the rest of the financial system; this was the strategy the Federal Reserve used in the Penn Central case.

VI. A Perspective on the Corporate Debt Debate

In lieu of a summary of our results, we end the paper with some implications of our analysis for the debate about the recent buildup of corporate debt, alluded to in the introduction.

As mentioned in the introduction, there are two views on the significance of this increase in corporate debt. The more conventional view is that high levels of debt greatly increase the risks of an economic downturn. The alternative, espoused by Jensen [1988], is that higher leverage is good for the economy. Jensen claims that many U. S. corporations are suffering from excessive "free cash flow,"[21] which managers (whose perquisites depend on the size of their domain) have incentives to use for inefficient expansion, rather than for increasing payments to shareholders. Issuing debt for the purpose of repurchasing equity reduces the free cash flow problem, according to Jensen, by (1) removing the free cash flow from the firm, (2) imposing on managers the discipline of meeting high fixed interest charges, and (3) improving managers' incentives by increasing the sensitivity of their compensation to firm profits. (The latter is particularly likely to be true when the proceeds of debt issuance are used to take the firm private.)

There is an interesting similarity between Jensen's free cash flow model and the model used in this paper: in both cases a misalignment of incentives induces managers to be insufficiently selective in choosing projects (p^* is too low). Yet the suggested solutions to the agency problem are quite different. Jensen proposes the use of a financial contract (debt) that is noncontingent,

21. Free cash flow is defined to be the excess of the corporation's cash flow over the quantity of funds that can be invested profitably within the firm.

except in bankruptcy states. Our approach suggests the use of state-contingent contracts to motivate managers.[22]

Loosely speaking, the difference in the recommendations is that we propose a second-best solution to the agency problem, while Jensen advocates a third- or fourth-best (in a technical sense) solution. Our solution is second-best in that we allow for information and incentive constraints (which would not bind in the first-best) but assume no barriers to contingent contracting. In contrast, Jensen is implicitly assuming that only a very limited set of financial contracts is available in practice; hence some theoretically preferable contracts are ruled out.

While it is easy enough to say that we do not see anything approaching complete contingent contracting in practice, the restrictions on contracting being assumed by Jensen are nevertheless severe. Indeed, even if we accept Jensen's view that a good approximate solution to the agency problems created by free cash flow is to make managers "residual claimants," there would seem to be practical means of accomplishing this that do not involve leveraging the company. Examples are a fixed-dividend policy on equity, with sanctions on the management if they fail to meet the dividend, and managerial contracts that tie compensation closely to profits. Thus, the buildup of debt probably has more to do with factors such as the tax treatment of debt, legal restrictions on highly profit-sensitive managerial contracts (see Shleifer and Vishny [1988]), portfolio restrictions on banks and other investors, and financial market innovations (such as the development of the junk bond market), rather than on the inherent superiority of debt contracts as a way of reducing agency costs.

Putting aside the reasons for the increase in leverage, it still may be asked whether the higher level of debt implies greater financial fragility. Our answer is, "It depends." We believe that the focus on debt versus equity ignores the primary determinant of

22. While it is true that one could interpret the particular contract derived in our paper as a credit line, straightforward and realistic extensions of our model show that it is the state contingency, not the credit line features of the contract, that are robust. For example, suppose that we were to modify our model so that when the entrepreneur evaluates the project, he finds out both a success probability and what the payoff will be if successful (that is, projects have different R's ex ante as well as different p's). It can be shown in this case that the lender's payoff will depend on the ex post return of the project, not just on whether the project succeeds or fails. The intuition is that, subject to an overall constraint that the intermediary must earn its required expected return, the parameters of the optimal contract will be varied in order to equate the expected marginal reductions in agency costs across states; this will generally imply sharing rules between the entrepreneur and the intermediary that depend on the project's return.

financial stability—the net worth of borrowers, or, as we may call it for the purposes of this discussion, the "insiders' stake."[23] If the insiders' stake is high, debt need not be harmful. For example, as has been frequently pointed out, Japanese corporations have traditionally relied much more on debt than have U. S. firms. This has not posed a problem for the Japanese, however, because managerial decisions are tightly monitored by financial backers—banks or parent corporations. Effectively, insider stakes in Japan are high; among other things, this means that firms' finances can efficiently be restructured when circumstances change. Thus, whether the U. S. economy is in a financially fragile condition depends fundamentally more on the magnitude of insiders' stakes in the United States than on the composition of firms' external liabilities.

There have been factors pushing insiders' stakes in both directions in the United States during this decade. For example, to the extent that the wave of takeovers and buyouts has represented the seizure of corporate control by well-financed management teams, there may have been an effective increase in insiders' stakes; likewise, increased monitoring of management by takeover specialists and investment banks may have had a salutary effect. Working in the other direction, increasing securitization (for example, the greater reliance on junk bond financing at the expense of commercial bank loans[24]) has typically reduced the overlap between the providers of financial capital and the insiders in the corporation; greater use of "arm's length" financing trends to increase financial fragility. Measurement of the effects of these countervailing forces on the stability of the U. S. financial system is a difficult, but not impossible, empirical challenge.

APPENDIX: THE OPTIMAL CONTRACT WHEN TYPES ARE UNOBSERVED

The entrepreneur's contracting and investment problem is to choose Z_s, Z_0, and Z_u to solve (5), subject to (6), (8), (9), (10), and

23. Operationally, the insiders' stake can be defined narrowly as the amount of personal wealth that insiders (managers, directors, activist shareholders, and others with inside knowledge about the firm) have at risk in the firm. A broader definition is personal wealth at risk plus that part of the corporate wealth that is not committed to the payment of interest, dividends, salaries, etc., to outsiders. Note that insider stake is not the same as cash flow; thus, there is no inconsistency between arguing that increased insider stake improves efficiency, as we do, and arguing that increased cash flow reduces efficiency, as Jensen does.

24. Perry and Taggart [forthcoming] document this shift. They also document that the preponderance of junk bonds is owned by institutional investors, who are much more likely to function as outsiders than as insiders.

(11). The optimal reservation success probability p^* is a function of Z_s, Z_0, and Z_u; however, it is algebraically convenient to treat p^* as an additional control variable, imposing its relationship to the other control variables (equation (9)) as a constraint on the problem. It is also convenient to replace Z_s with $Z_s - Z_u$.

Let μ, α, γ, θ, and ψ be the multipliers associated with (6), (8), (9), (10), and (11), respectively. Then the first-order necessary conditions with respect to p^*, $(Z_s - Z_u)$, Z_0, and Z_u are given by

(A1) $$\mu(r - p^*R)h(p^*) - \gamma(R - (Z_s - Z_u)) = 0$$

(A2) $$(\mu - 1)(1 - H(p^*))\hat{p} + \gamma p^* - \theta = 0$$

(A3) $$(\mu - 1)H(p^*) - \gamma + \alpha = 0$$

(A4) $$(\mu - 1)(1 - H(p^*)) + \gamma - \psi = 0,$$

where h is the p.d.f. associated with H. μ, α, θ, and ψ are nonnegative.

LEMMA 1 If it is profitable ex ante for the entrepreneur to evaluate his project, then (i) $\theta = 0$ ((10) is relaxed), and (ii) $0 < \mu \leq 1$ ((6) is binding).

Proof. Part (i): We show that $R > Z_s - Z_u$ which implies that $\theta = 0$. Suppose that $R = Z_s - Z_u$. Then (9) implies that $rw - Z_0 = -Z_u$. The objective (5) must then equal $-Z_u - e$. However, $-Z_u - e < rw$ since $rw - Z_0 = -Z_u$ and $Z_0 \geq 0$ (by (8)). Because the objective is less than rw, the entrepreneur is better off lending his wealth than evaluating his project—a contradiction. Thus, $\theta = 0$. Part (ii): Suppose that $\mu = 0$. Since $R > Z_s - Z_u$, (A1) implies that γ must equal zero, which contradicts (A2). Thus, $\mu > 0$. To see that $\mu \leq 1$, divide (A2) by p^*, then add (A3) to obtain $(\mu - 1)(1 - H(p^*))(\hat{p}/p^* + 1) + \alpha = 0$. Since $\alpha \geq 0$, $\mu \leq 1$. Thus, $0 < \mu \leq 1$.

Q.E.D.

Proof of Proposition 1. If $w \geq 1$, then the entrepreneur has enough wealth to fully fund his project. Thus, constraints (8)–(11) do not bind. Substituting (6) into the objective implies that the maximand becomes $(1 - H(p^*))(\hat{p}R - r) - e + r(w - 1)$. (We know from Lemma 1 that (A6) is binding.) Maximizing with respect to p^* yields $r - p^*R = 0$, or equivalently, $p^* = r/R$.

Proof of Proposition 2. Using (9) to eliminate $(Z_s - Z_u)$ in (6) yields

$$\text{(A5)}\quad p^*R - r\left[w + \left(\frac{p^*}{\hat{p}}\right)(1 - w)\right] = -\left[1 + \frac{p^*H(p^*)}{\hat{p}(1 - H(p^*))}\right]Z_0 + \left(1 - \left(\frac{p^*}{\hat{p}}\right)\right)Z_u.$$

Expressions (8) and (11) imply that the right side of (A5) is ≤ 0. Thus, if $w < 1$, p^* must be less than r/R. It follows from Lemma 1 and (A1)–(A4) that $\alpha > 0$ and $\psi > 0$, implying that $Z_0 = 0$ and $Z_u = 0$. Then, from (A12), p^* must satisfy

$$p^*R - r[w + (p^*/\hat{p})(1 - w)] = 0.$$

Differentiating yields $dp^*/dw > 0$.

Q.E.D.

Proof of Proposition 3. Proposition 3 follows directly from proposition 2 and the assumption that entrepreneurs may choose whether to evaluate. To see that $w_l > 0$, note that if $w = 0$, then (13) implies that $\hat{p} = r/R$ and expected utility from evaluation (14) is strictly less than rw. By continuity, $w_l > 0$.

Q.E.D.

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