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SALMAN SHAH and ANJAN V. THAKOR*

ABSTRACT

Examined in this paper is the choice between private and public incorporation of an asset for an entrepreneur (asset owner) who hires a manager with superior information about the asset's return distribution. Public sale of equity is shown to be the preferred alternative when (a) capital market issue costs are low or (b) the asset's idiosyncratic risk is high *and* the owner is either sufficiently risk averse or sufficiently "optimistic" about the asset's expected return. Thus, those assets deemed most valuable by their owners will tend to be publicly incorporated. The paper also explores the impact of incorporation mode—private versus public—and information structure on the firm's investment policy and ownership distribution.

THE DETERMINANTS OF CORPORATE ownership structure have attracted much attention. (See, for example, Demsetz and Lehn [7].) The recent spate of leveraged buyouts (LBO's) and other activities designed to consolidate ownership structure—and often to take it out of the public domain—have raised questions about the optimality of public ownership of corporations.

A related issue is the link between real output and the mode of incorporation in firms with a separation of ownership and control. Do privately incorporated firms have systematically different investment policies from publicly incorporated firms? If so, aggregate output must be a function of the cross-sectional distribution of incorporation modes in the economy. There is also considerable interest in the impact of insider information, a topic that concerns us in this paper.[1]

We have two principal objectives. The first is to explore the conditions that determine an asset owner's choice of incorporation for the asset. That is, when would the owner prefer to keep asset ownership private as opposed to having a portion of that ownership publicly traded? In particular, what is the role of the owner's perception of the value of the asset in this determination? Are the assets being taken privately more or less valuable than those that are publicly traded? Insights on this score should help in understanding corporate ownership structure evolution. Our second objective is to examine the impact of information structure—symmetric versus asymmetric information—and the firm's incorporation

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[1] Numerous papers have looked at this problem. See, for example, Bhattacharya and Pfleiderer [2], Heckerman [8], and Trueman [18].

mode—private versus public—on the firm's investment policy and the distribution of ownership among the founding owner, the manager, and (possibly) outside investors.

While these are ambitious goals, our achievement in this paper may be considered a modest first step. We consider an asset owner who has the option to invest in an asset and who must hire a manager to "activate" the asset. The manager knows the asset's return distribution, but the owner possibly does not. For tractability, we assume away moral hazard by letting the asset return distribution be completely exogenous. The choices for the asset owner are (a) to incorporate the firm privately or publicly or (b) to give the manager a compensation package that depends on the report of his or her private information that he or she submits to the owner. This compensation package includes a nonrandom payment up front and also gives the manager some shares of stock that cannot be traded. The decision of whether the asset should be "activated" is delegated to the manager. When the owner opts to sell equity in the capital market, we assume that outside investors are ex ante uninformed about the asset's return distribution. Thus, relative to the first-best value, the market value of the asset is reduced by an amount equal to screening/certification costs (see Campbell and Kracaw [5], Stiglitz [17], and Viscusi [19]) that the outside investors buying the stock must bear.

What emerges from our analysis is a set of predictions about the types of firms that will tend to be publicly incorporated, the differences in managerial ownership across publicly held and privately held firms, and differences in investment criteria based on whether ownership is private or public. Our purpose is to develop a theory driven mostly by informational considerations, one that focuses on the tradeoffs produced by the risk sharing provided by the capital market, the issuing (screening) costs that accompany public equity issues, and the (strategic) gaming behavior of privately informed managers. Explicit treatment of some other institutional realities and aspects of corporate decision making—particularly the rich, interactive effects of product and financial markets' institutional constraints on corporate behavior—is sacrificed for the sake of tractability.

Our most important findings are summarized below. These findings appear in Sections III, IV, and V, where the intuition for each is discussed in detail. Broadly speaking, the intuition driving these results is that public ownership allows both the manager and the owner to transfer risk to the market, reducing their respective optimal ownership shares and stochastically increasing the firm's risky investment. This transfer is achieved at the expense of a dissipation in firm value caused by screening/certification costs. More significantly, however, public incorporation permits the owner to limit informationally induced surplus extraction by the manager who strategically exploits his or her private knowledge of the asset's return distribution.

1. Under symmetric information between the founding owner and the manager, aggregate investment in public firms is stochastically greater than that in private firms.
2. In private firms, asymmetric information between the founding owner and the manager causes a stochastic decline in investment. Also, the higher the

founding owner's risk aversion, the greater is the stochastic decline in investment.

3. In public firms, too, asymmetric information between the founding owner and the manager causes a stochastic decline in investment. This decline, however, is unaffected by the founding owner's risk preference.
4. Ceteris paribus, the manager of a public firm holds a smaller fraction of his or her firm's equity than the manager of a private firm.
5. The founding owner in a public firm owns a smaller fraction of his or her firm than the owner of a private firm.
6. In both privately and public held firms, the manager's superior information results in his or her owning a smaller fraction of the firm's equity. In a private firm, this increases the owner's equity share, but, in a public firm, outside investors end up owning a larger fraction of the firm (relative to first best) and the owner's equity share is unaffected.
7. Public ownership of a firm with sufficiently high idiosyncratic risk becomes more desirable as the risk aversion of the (founding) owner increases relative to capital market certification costs.
8. For the (founding) owner of an initially privately held firm with sufficiently high idiosyncratic risk, going public becomes more desirable (under asymmetric information between the owner and the manager) as his or her prior about the profitability of his or her investment opportunity becomes more favorable. For the advocates of public ownership, this should be consoling. It suggests that *the most productive assets in the economy will tend to be publicly owned and traded.*

The analysis is in six sections. Section I contains the model development and derivation of the optimal solutions for private firms. Section II has the analysis for public firms. The analysis in Sections I and II provides the groundwork for studying various effects, which we do in subsequent sections. In Section III, we examine the impact of incorporation mode and information structure on investment policy. In Section IV, we study the impact of incorporation mode and investment policy on ownership distribution. The owner's choice between private and public incorporation is analyzed in Section V. Section VI concludes. No formal proofs are included; these are in an Appendix available upon request from Thakor.

I. The Model and the Choice Problem in Private Firms

We shall first develop the model and derive the allocations under symmetric information, i.e., when the owner knows as much about the investment opportunity as the manager. Asymmetric information is considered next.

In our examination of different wage policies, we use the following notation. A wage policy is labeled ij, where $i = S$ means there is symmetric information between the owner and the manager, $i = A$ means there is asymmetric information between them, $j = N$ means there is no equity trading (firm is private), and $j = T$ means there is equity trading (firm is public). Policies SN and AN are examined in this section, and policies ST and AT in the next section.

A. The Model under Symmetric Information (SN Policy)

The economy lasts for one period. Consider the owner of an asset who requires the services of a manager to harvest a return from the asset.[2] This return is generated by a "bounded-variance" linear process of the form:

$$\tilde{R} = \theta + \beta\tilde{R}_m + \tilde{\varepsilon}, \tag{1}$$

where tildes denote random variables, $\tilde{R}$ is the return on the asset, θ and β are known real-valued constants, $\tilde{R}_m$ is the return on the market or a well-diversified (zero-residual-risk) portfolio, and $\tilde{\varepsilon}$ is the asset's idiosyncratic return. Recasting (1), we obtain (with r_f defined as the riskless rate or the return on a "zero-beta" security)

$$\tilde{R} = \gamma + r_f + \beta[\mathrm{E}(\tilde{R}_m) - r_f] + \beta\tilde{\varepsilon}_m + \tilde{\varepsilon}, \tag{2}$$

where

$$\gamma \equiv \theta - [1 - \beta]r_f, \tag{3}$$

$$\tilde{R}_m \equiv \mathrm{E}(\tilde{R}_m) + \tilde{\varepsilon}_m, \tag{4}$$

and

$$\mathrm{E}(\tilde{\varepsilon}_m) = \mathrm{E}(\tilde{\varepsilon}) = \mathrm{cov}(\tilde{\varepsilon}, \tilde{R}_m) = 0, \tag{5}$$

with $\mathrm{E}(\cdot)$ and $\mathrm{cov}(\cdot, \cdot)$ denoting the statistical expectation and covariance operators, respectively. For later use, let $R_f \equiv 1 + r_f$. Following Heckerman [8], we call γ the asset's index of "excess return". Although currently all payoff-relevant parameters are assumed common knowledge, we later assume that the manager has private information about γ.

The owner's initial wealth endowment is W. His or her investment opportunity set consists of the asset (which we currently assume is not traded), the market portfolio, and the riskless security. The asset is indivisible and requires an investment I fixed at some value in $(0, W)$. This specification—as opposed to permitting an endogenous choice from a set of feasible investment levels—makes sense in light of our assumption of stochastic constant returns to scale. We have avoided assuming declining returns to scale because it would introduce monopolistic elements in investment policy. Let K be the fixed wage paid by the owner to the manager for the latter's services. Denote Ψ as the fraction of the total investment in the asset made by the manager and $1 - \Psi$ as the fraction provided

[2] This means that, if the manager is not hired to manage the asset, the return it could potentially generate will be unavailable. Note, however, that, if the manager is hired, the action he or she can take is assumed to be exogenously fixed, so that there is no choice of managerial action that can affect the asset's return. Further, we assume a relatively large economy in which the exclusion of a single asset from the market has a negligible impact on the return distribution of the market portfolio. Thus, we use the same market return distribution regardless of whether the asset under consideration is managed. Note that the assumption of a large economy is also essential to avoid Roll's [14] criticism of using security-market-line-based measures of superior performance. As Connor [6] has shown, if one operates in a very large economy, one trivializes the problem of the informed and the uninformed having different "betas" for the same asset due to differences in their perceptions of excess returns. This issue is of relevance when we consider publicly traded firms. Note that we assume here observability of the market portfolio and the associated return distribution, thereby abstracting from some of the problems discussed in Shanken [16].

by the owner. Then the owner's end-of-period wealth will be

$$\tilde{W}_1 = [W - K - \{1 - \Psi\}I][I + \tilde{R}_p] + I[1 + \tilde{R}][1 - \Psi], \tag{6}$$

where the portfolio return is

$$\tilde{R}_p = x_f r_f + x_m \tilde{R}_m, \tag{7}$$

x_f is the fraction of the owner's available wealth $[W - K - I\{1 - \Psi\}]$ invested in the riskless security, and x_m is the fraction invested in the market. The budget constraint is

$$\textstyle\sum_{i \in \{f,m\}} x_i = 1. \tag{8}$$

Upon substitution for $\tilde{R}_m$ from (4), we can express (7) as

$$\tilde{R}_p = r_f + x_m \bar{r}_m + x_m \tilde{\varepsilon}_m, \tag{9}$$

where $\bar{r}_m \equiv \mathrm{E}(\tilde{R}_m) - r_f$.

The owner will employ the manager only if it increases his or her expected utility above the level possible by investing optimally only in the market portfolio and the riskless security. Likewise, the manager will accept employment only if it yields him or her at least as great an expected utility as he or she can attain investing optimally in the market portfolio and the riskless security an amount equal to his or her initial wealth endowment and the wage, S, offered by his or her best alternative occupation. We assume that the manager cannot invest in the asset unless he or she manages it.

The owner has a mean-variance utility function given by

$$U(\tilde{W}_1) = \mathrm{E}(\tilde{W}_1) - [\tau/2]v(\tilde{W}_1), \tag{10}$$

where $\tau > 0$ is a risk-aversion parameter, $\mathrm{E}(\cdot)$ is the expectation operator, and $v(\cdot)$ is the finite-variance operator.

Now, if the owner does not invest in the asset (and thus does not contract with the manager for his or her services), then his or her expected utility is

$$U(\tilde{W}_1) = WR_f + Wx_m\bar{r}_m - [\tau/2][Wx_m]^2 v(\tilde{\varepsilon}_m),$$

where x_m is the fraction of W invested in the market portfolio and $1 - x_m$ is the fraction of W invested in the riskless asset. Using standard techniques, we obtain the optimal investment in the market portfolio, x_m^*, as

$$x_m^* = \bar{r}_m[W\tau v(\tilde{\varepsilon}_m)]^{-1},$$

and substituting this in the owner's expected utility gives the maximized value of that expected utility as

$$U^*(\tilde{W}_1) = WR_f + [\bar{r}_m]^2[2\tau v(\tilde{\varepsilon}_m)]^{-1}. \tag{10'}$$

The manager's initial endowment is Z. His or her end-of-period wealth is

$$\tilde{Z}_1 = [Z + K][1 + \tilde{T}_p], \tag{11}$$

where $\tilde{T}_p$ is the return on the manager's portfolio and is given by

$$\begin{aligned}\tilde{T}_p &= y_f r_f + y_m \tilde{R}_m + y_a \tilde{R} \\ &= r_f + y_m[\tilde{R}_m - r_f] + y_a[\tilde{R} - r_f],\end{aligned} \tag{12}$$

where y_f, y_m, and y_a are the fractions of the manager's wealth invested in the riskless security, the market, and the asset, respectively. We can write

$$\mathrm{E}(\tilde{Z}_1) = [Z + K]R_f + [Z + K][y_m + \beta y_a]\bar{r}_m + [Z + K]y_a\gamma \tag{13}$$

and

$$v(\tilde{Z}_1) = [Z + K]^2[y_m + \beta y_a]^2 v(\tilde{\varepsilon}_m) + [Z + K]^2 y_a^2 v(\tilde{\varepsilon}). \tag{14}$$

Like the owner, the manager has a mean-variance utility function given by

$$V(\tilde{Z}_1) = \mathrm{E}(\tilde{Z}_1) - [\eta/2]v(\tilde{Z}_1), \tag{15}$$

where $\eta > 0$ is a risk-aversion parameter. Using standard techniques, we obtain the manager's optimal portfolio weight as

$$y_m^* + \beta y_a^* = \{[Z + K]\eta v(\tilde{\varepsilon}_m)\}^{-1}[\bar{r}_m], \tag{16}$$

and substituting this in (15) gives the manager's maximized expected utility:

$$V^*(\tilde{Z}_1) = [Z + K]R_f + [\bar{r}_m]^2[2\eta v(\tilde{\varepsilon}_m)]^{-1} + [Z + K]y_a\gamma - [\eta/2][Z + K]^2 y_a^2 v(\tilde{\varepsilon}). \tag{17}$$

The manager's maximized expected utility without the asset is

$$V(\tilde{Z}_1) = [Z + S]R_f + [\bar{r}_m]^2[2\eta v(\tilde{\varepsilon}_m)]^{-1}. \tag{18}$$

Note now that $\Psi I \equiv y_a[Z + K]$ is the manager's dollar investment in the asset and $[1 - \Psi]I$ is the owner's dollar investment in the asset. Moreover, since the manager's investment participation will yield him or her a positive expected utility, his or her fixed wage, K, can generally be set lower than S. To see how K is determined, use (17) and (18) to write the manager's incremental expected utility from managing the asset as

$$\Delta V^*(\tilde{Z}_1) = KR_f + \Psi I\gamma - SR_f - [\eta/2]\Psi^2 I^2 v(\tilde{\varepsilon}). \tag{19}$$

Under symmetric information, the owner makes the manager's incremental expected utility exactly zero. Thus, K is obtained by setting (19) equal to zero:

$$KR_f = SR_f - \Psi I\gamma + [\eta/2]\Psi^2 I^2 v(\tilde{\varepsilon}). \tag{20}$$

Now, using (6), (10), and (20), we obtain[3]

$$U(\tilde{W}_1) = [W - S]R_f + \Psi I\gamma - [\eta/2]\Psi^2 I^2 v(\tilde{\varepsilon}) + [\bar{r}_m]^2[2\tau v(\tilde{\varepsilon}_m)]^{-1} + [1 - \Psi]I\gamma - [\tau/2][1 - \Psi]^2 I^2 v(\tilde{\varepsilon}). \tag{21}$$

For this case, we denote Ψ_S^* as the manager's optimal fractional asset investment, $\bar{\gamma}_S$ as the critical "hurdle rate" such that the asset is activated (or the project is accepted) if $\gamma \geq \bar{\gamma}_S$ and rejected otherwise, and $\Delta U_S^*(\tilde{W}_1)$ as the owner's *incremental* expected utility, i.e., over and above that attainable by investing only

[3] To obtain (21), one first substitutes for $\tilde{R}_p$ from (9) into (6) and for K from (20) into (6), and then one substitutes (6) into (10). Simplification thereafter yields (21).

in the riskless asset and the market portfolio.[4]

LEMMA 1 (*Analysis of the optimal solution for the SN policy*):

(i) $\Psi_S^* = \tau[\eta + \tau]^{-1}$,

(ii) $\bar{\gamma}_S = \{SR_f + \eta\tau[2\{\eta + \tau\}]^{-1}I^2 v(\tilde{\varepsilon})\}I^{-1}$,

(iii) $\Delta U_S^*(\tilde{W}_1) = \begin{cases} 0 & \text{if } \gamma \leq \bar{\gamma}_S, \\ I\gamma - I\bar{\gamma}_S & \text{if } \gamma > \bar{\gamma}_S. \end{cases}$

The manager's first-best ownership share is equal to the ratio of the owner's risk aversion to the total risk aversion of the owner and the manager. Further, the owner's incremental expected utility is nondecreasing everywhere in the asset's excess return, γ, and strictly increasing in γ for γ's exceeding the hurdle rate. Both results are intuitive.

B. The Model under Asymmetric Information (AN Policy)

Suppose that the manager knows the asset's γ but the owner does not. We are implicitly assuming that the manager has costless access to information about γ. One may object to the assumption that the owner does not have the same access. However, our assumption permits exclusive focus on a pre-contracting informational asymmetry between the owner and the manager; essentially the same results will obtain if the manager can acquire his or her information at a sufficiently lower cost than the owner. Moreover, we also assume, realistically, that the manager's (privately made) portfolio choices are unobservable to the owner. We let the owner have some belief about γ. Imprecise as this belief may be, we can view the owner as having a prior probability-density function over γ in the Bayesian framework. Let $h(\gamma)$ denote this density function. We assume that $h(\gamma)$ is strictly positive over its compact support, $[\gamma^-, \gamma^+]$, and zero elsewhere. The associated cumulative distribution function is $H(\cdot)$. It is assumed that $1 - H(\cdot)$ is a Pölya frequency function of order 2 (PF_2).[5] For simplicity, we let $\gamma^- \geq 0$.

Following the revelation principle (see, for example, Myerson [12]), the owner can be viewed as instructing the manager to report γ directly and truthfully to the owner. In response to the report, the owner gives the manager a participatory wage package that is a triplet: a probability, $\pi(\cdot)$, that the asset will be activated, a nonrandom wage up front of $K(\gamma)$, and a fractional ownership in the asset of

[4] Thus, $\bar{\gamma}_S$ is the value of γ that makes $\Delta U_S^*(\tilde{W}_1) = 0$. Henceforth, whenever we refer to the "incremental expected utility" with a given policy, we mean the difference between the expected utility with that policy and the expected utility obtained by investing only in the market portfolio and the riskless asset.

[5] This implies that the function $\phi(\gamma) \equiv \{1 - H(\gamma)\}\{h(\gamma)\}^{-1}$ is nonincreasing in γ. (See Barlow, Marshall, and Proschan [1].) This class of distribution functions is wide and satisfies many useful properties such as variation diminishing, closure under convolution, unimodality, etc. Among the probability distributions included in this class are the Uniform, members of the Beta family with means greater than or equal to ½, the Exponential, the Truncated Exponential, the Standard Normal, and the Truncated Standard Normal.

$\Psi(\gamma)$. The schedule $\{\pi(\gamma), K(\gamma), \Psi(\gamma) \mid \gamma \in [\gamma^-, \gamma^+]\}$ is known to the manager at the time of submission of the report. This policy is in the spirit of participative management control systems in the sense that both the owner and the manager participate in managerial incentive contract design.[6] Note, however, that we have restricted the strategy space to an asset-activation probability, nonrandom wages, and a fixed ownership fraction as a function of the outcome, without claiming that such a restricted strategy space is necessarily optimal. By using the revelation principle in conjunction with the owner's optimization program, we ensure that the owner attains the highest expected utility, *given* this strategy space. The adoption of nonrandom wages is not particularly restrictive since the asset activation probability is unrestricted. If a random wage policy were truly optimal, it would be likely to show up in the optimal $\pi(\cdot)$ lying between zero and one. We will find, however, that such randomization is not optimal. The assumption of an ownership fraction that depends only on the manager's report (and not on the outcome) *may* be restrictive. Although such a restriction may well emerge as a consequence of the model's risk-aversion structure, the superior information-elicitation capability of more complex (nonlinear) schemes has been noted elsewhere.[7]

For *any* reported γ, the owner's incremental expected utility is

$$\pi(\gamma)\{[1 - \Psi(\gamma)]I\gamma - K(\gamma)R_f - [\tau/2][1 - \Psi(\gamma)]^2 I^2 v(\tilde{\varepsilon})\}. \tag{22}$$

Note that, in writing (22), we have used the fact that the owner computes his or her optimal portfolio weights *after* he or she receives the manager's report of γ. Hence, the owner's investment portfolio is ex post efficient for all γ's for which $\pi(\gamma) = 1$; i.e., for every such γ, the owner chooses the same portfolio weights that would be chosen under symmetric information. *Prior* to the manager's report, the owner computes his or her expected incremental utility as

$$\Delta U(\tilde{W}_1) = \int_{\gamma^-}^{\gamma^+} \pi(\gamma)\{[1 - \Psi(\gamma)]I\gamma - K(\gamma)R_f - [\tau/2][1 - \Psi(\gamma)]^2 I^2 v(\tilde{\varepsilon})\}h(\gamma)\, d\gamma. \tag{23}$$

[6] Although details are not presented here, we have also formally examined other wage packages for the manager. Under symmetric information, we have also analyzed a fixed wage policy under which the manager gets a predetermined fixed wage and is not allowed to invest anything in the asset. We find that such a policy is strictly Pareto-dominated by the *SN* policy we considered earlier, in the sense that it leads to stochastically lower investment and lower incremental expected utility for the owner. Under asymmetric information, we have analyzed two additional wage policies with details not given in the paper. One is a fixed-wage policy with no managerial investment in the asset, and the other is a policy that sets managerial investment in the asset at first best, regardless of the manager's report. In a comparison of these two policies, we find, somewhat surprisingly, that managerial investment participation per se does not enhance investment, unlike the symmetric information case. Moreover, even if investment is enhanced by managerial investment participation in the asset, there is *not* an unambiguous rise in owner welfare. Hence, the risk-sharing benefits to the owner from inviting the manager to invest in the asset may be completely offset by the owner's informational disadvantage. We find, however, that the reporting policy that we consider below strictly dominates the fixed-wage policy from the owner's standpoint; it leads to stochastically higher investment and higher incremental expected utility from the owner.

The conclusion to be drawn from this discussion is that the managerial wage policy can significantly affect the firm's investment policy. We have chosen to focus on the best policies within each information structure.

[7] See, for example, Bhattacharya and Pfleiderer [2].

The expectation in (23) is with respect to two probability measures. One is the measure describing the asset's random return. This expectation is implicitly impounded in the term within the braces in (23) because of our use of a mean-variance utility function. The second measure refers to the owner's priors, and this expectation is over the unknown parameter γ.

Define $Q(\hat{\gamma} \mid \gamma)$ as the manager's expected incremental utility when he or she knows the asset's excess return is γ but reports that it is $\hat{\gamma}$. With a modification of (19), we can write

$$Q(\hat{\gamma} \mid \gamma) = \pi(\hat{\gamma})\{K(\hat{\gamma})R_f + \Psi(\hat{\gamma})I\gamma - [\eta/2][\Psi(\hat{\gamma})]^2 I^2 v(\tilde{\varepsilon}) - SR_f\}. \tag{24}$$

The owner must, therefore, design $\{\pi(\gamma), K(\gamma), \Psi(\gamma)\}$ to maximize (23) subject to

$$\begin{aligned} Q(\gamma \mid \gamma) &\equiv Q(\gamma) \\ &\equiv \pi(\gamma)\{K(\gamma)R_f + \Psi(\gamma)I\gamma - [\eta/2][\Psi(\gamma)]^2 I^2 v(\tilde{\varepsilon}) - SR_f\}, && (25) \\ Q(\gamma) &\geq Q(\hat{\gamma} \mid \gamma), && (26) \\ Q(\gamma) &\geq 0, && (27) \\ \pi(\gamma) &\in [0, 1]. && (28) \end{aligned}$$

This is a routine optimization program. Equation (25) is a definitional constraint, (26) is the usual incentive-compatibility constraint, (27) is the individual-rationality constraint, and (28) states that $\pi(\cdot)$ is a probability. Any contracting policy satisfying (25) through (28) is called *feasible.* Lemma 2 simplifies our analysis of the optimal policy.

LEMMA 2: *Any feasible AN contracting policy satisfies*

$$\int_{\gamma^-}^{\gamma^+} Q(\gamma)h(\gamma)\, d\gamma = Q(\gamma^-) + \int_{\gamma^-}^{\gamma^+} \pi(\gamma)\Psi(\gamma)I\phi(\gamma)h(\gamma)\, d\gamma, \tag{29}$$

$$Q''(\gamma) \geq 0 \quad \textit{for almost every} \quad \gamma \in [\gamma^-, \gamma^+], \tag{30}$$

and (25), (27), *and* (28), *where primes denote derivatives.*[8]

Before analyzing the optimal solution in this case, we define Ψ_A^* as the optimal fractional investment in the asset by the manager, $\bar{\gamma}_A$ as the hurdle rate, π_A^* as the optimal contracting probability, and $\Delta U_A^*(\tilde{W}_1)$ as the incremental expected utility of the owner.

[8] The basic idea in Lemma 2 is to establish a monotonicity for the manager's expected utility with respect to the private information parameter, γ. Given such a monotonicity, we can represent the global incentive-compatibility inequalities with calculus conditions. In our model, the expected utility of a manager is nondecreasing and (weakly) convex in γ. Lemma 2 is very useful in deriving the optimal solution in Lemma 3 because it enables standard optimal control theory to be used.

LEMMA 3 (*Analysis of the optimal solution for the AN policy*):

(i) $\Psi_A^*(\gamma) = \tau[\eta+\tau]^{-1} - \phi(\gamma)\{[\eta+\tau]Iv(\tilde{\varepsilon})\}^{-1}$,

$$\text{where} \quad \phi(\gamma) \equiv [1-H(\gamma)][h(\gamma)]^{-1},$$

(ii) $$\bar{\gamma}_A = \phi(\bar{\gamma}_A)\tau[\eta+\tau]^{-1} - [\phi(\bar{\gamma}_A)]^2[2\{\eta+\tau\}Iv(\tilde{\varepsilon})]^{-1} + SR_f I^{-1} + \eta\tau I\tilde{v}(\varepsilon)[2\{\eta+\tau\}]^{-1},$$

(iii) $$\pi_A^*(\gamma) = \begin{cases} 0 & \text{if} \quad \gamma < \bar{\gamma}_A, \\ 1 & \text{if} \quad \gamma \geq \bar{\gamma}_A, \end{cases}$$

(iv) $$\Delta U_A^*(W_1) = \begin{cases} 0 & \text{if} \quad \gamma \leq \bar{\gamma}_A, \\ I\gamma - I\bar{\gamma}_A & \text{if} \quad \gamma > \bar{\gamma}_A. \end{cases}$$

A comparison of this optimal solution with that for the *SN* policy is made in Section III, and it provides some interesting insights into the impact of asymmetric information. For now, it is useful to note that the manager's informational advantage allows him or her to capture a surplus. In the optimal solution identified above, the manager earns more than his or her reservation expected utility.

II. The Choice Problem in Publicly Traded Firms

Suppose now that the owner also sells some fraction $\alpha \in [0, 1]$ of the asset to outside investors and that the equity held by outsiders is publicly traded. For simplicity, we assume throughout that the firm is all-equity financed, so that owning a fraction α of equity implies a claim to a fraction α of the asset's total cash flow. Outsiders are assumed to be uninformed about the asset's γ, but all other payoff-pertinent attributes of the asset are common knowledge. In the spirit of screening models (Stiglitz [17], for example), we let $J(\alpha \mid d)$ represent the cost incurred by outside investors in learning γ, where d is the "extent" of the informational asymmetry that exists between the (informed) manager and the outside investors. For any $d_1 > d_2$, we have $J(\alpha \mid d_1) > J(\alpha \mid d_2)$. That is, we assume the monotonicity property that greater ignorance entails a higher cost for being informed.[9] Further, we let $J(\alpha \mid d) = \alpha j(d)$, with $j(d) > 0$ for any d.

One can think of J as an equity flotation cost that subsumes the costs of capital market certification as well as transactions costs. In equilibrium, J must be borne by the asset owner (firm). Henceforth, J will simply be referred to as "issue costs". We denote by V_0 the current market value of the asset. There are now two principal cases to consider: (a) the asset owner and the manager know γ but outsiders do not and (b) the manager knows γ but neither the asset owner nor the outsiders do. As in our previous analysis, we shall continue to assume that the owner, when incompletely informed, resorts to a revelation game for information extraction. For the cases relating to traded firms, optimal values will

[9] To think of this concretely, suppose that the investor's priors about an asset's γ are described by the probability distribution $\Omega(\gamma \mid d_1)$ and that for another asset they are described by $\Omega(\gamma \mid d_2)$. Then, if $d_1 > d_2$, we may, for example, view $\Omega(\gamma \mid d_1)$ as a mean-preserving spread of $\Omega(\gamma \mid d_2)$.

be denoted in the same manner as for private firms, except that the asterisk will be replaced by "t". That is, the subscripts S and N will once again denote symmetric and asymmetric information, respectively. The hurdle rates for the symmetric and asymmetric information cases will be denoted by $\bar{\gamma}_S$ and $\bar{\gamma}_A$, respectively.

A. Owner and Manager Symmetrically Informed but Outsiders Uninformed (Policy ST)

The (founding) asset owner's terminal wealth is

$$\tilde{W}_1 = [W - K - I\{1 - \Psi\} - J(\alpha \mid d) + \alpha V_0][1 + \tilde{R}_p] + [1 - \alpha - \Psi]I[1 + \tilde{R}],$$

and his or her expected utility is

$$\begin{aligned} U(\tilde{W}_1) = {} & [W - K - I\{1 - \Psi\} - J(\alpha \mid d) + \alpha V_0][1 + \mathrm{E}(\tilde{R}_p)] \\ & + [1 - \alpha - \Psi][1 + \mathrm{E}(\tilde{R})] \\ & - [\tau/2][W - K - I\{1 - \Psi\} - J(\alpha \mid d) + \alpha V_0]^2 x_m^2 v(\tilde{\varepsilon}_m) \\ & - [\tau/2][1 - \alpha - \Psi]^2 I^2 [\beta^2 v(\tilde{\varepsilon}_m) + v(\tilde{\varepsilon})]. \end{aligned} \tag{31}$$

The owner's optimal portfolio investment in the market portfolio can be routinely found to be

$$Ax_m^t + B\beta = \bar{r}_m[\tau v(\tilde{\varepsilon}_m)]^{-1}, \tag{32}$$

where

$$A \equiv W - K - I\{1 - \Psi\} - J(\alpha \mid d) + \alpha V_0, \tag{33}$$

$$B \equiv [1 - \alpha - \Psi]I. \tag{34}$$

We shall take V_0 to be given by the single-factor Arbitrage Pricing Theory (APT) of Ross [15] as

$$\begin{aligned} V_0 R_f &= \mathrm{E}(V_1) - I\beta\bar{r}_m \\ &= I\{1 + \mathrm{E}(\tilde{R})\} - I\beta\bar{r}_m \\ &= I\{1 + \gamma + r_f\} + I\beta\bar{r}_m - I\beta\bar{r}_m \\ &= I[R_f + \gamma]. \end{aligned} \tag{35}$$

The manager's expected utility is

$$V(\tilde{Z}_1) = [Z + K]R_f + [\bar{r}_m]^2[2\eta v(\tilde{\varepsilon}_m)]^{-1} + \Psi I\gamma - [\eta/2]\Psi^2 I^2 v(\tilde{\varepsilon}), \tag{36}$$

recalling that $\Psi I \equiv y_a[Z + K]$. The manager's expected utility without the asset is given by (18). To find K, we equate (18) and (36) to obtain

$$KR_f = SR_f - \Psi I\gamma + [\eta/2]\Psi^2 I^2 v(\tilde{\varepsilon}). \tag{37}$$

Using (35) and (37) in conjunction with (31) and employing a little algebra, we obtain

$$U(\tilde{W}_1) = WR_f - SR_f + I\gamma - [\eta/2]\Psi^2 I^2 v(\tilde{\varepsilon}) - J(\alpha \mid d)R_f + [\bar{r}_m]^2[2\tau v(\tilde{\varepsilon}_m)]^{-1} - [\tau/2][1 - \alpha - \Psi]^2 I^2 v(\tilde{\varepsilon}). \quad (38)$$

LEMMA 4 (*Analysis of the optimal solution for the ST policy*):

(i) $\Psi_S^t = j(d)R_f[\eta I^2 v(\tilde{\varepsilon})]^{-1}$,

(ii) $1 - \alpha_S^t - \Psi_A^t = j(d)R_f[\tau I^2 v(\tilde{\varepsilon})]^{-1}$,

(iii) $\bar{\bar{\gamma}}_S = SR_f I^{-1} + J(\alpha_S^t)R_f I^{-1} + [j(d)R_f]^2[2I^3 v(\tilde{\varepsilon})]^{-1}[\tau^{-1} + \eta^{-1}]$,

(iv) $\Delta U_S^t(\tilde{W}_1) = \begin{cases} 0 & \text{if } \gamma \le \bar{\bar{\gamma}}_S, \\ I\gamma - I\bar{\bar{\gamma}}_S & \text{if } \gamma > \bar{\bar{\gamma}}_S. \end{cases}$

We see that asset-specific capital contributions by both the owner and the manager decline as the asset's idiosyncratic risk increases. Moreover, the owner's incremental expected utility is strictly increasing in the asset's excess return for all values of this return exceeding the hurdle rate.

B. Only Manager Knows Excess Return; Owner and Outside Investors Do Not (Policy AT)

All the technical details related to this case are omitted (and available in an Appendix upon request) since the analysis is quite similar to that of policy *AN*. We go directly to the characterization of the optimal solution.

LEMMA 5 (*Analysis of the optimal solution for the AT policy*):

(i) $\Psi_A^t = j(d)R_f[\eta I^2 v(\tilde{\varepsilon})]^{-1} - \phi(\gamma)[\eta I v(\tilde{\varepsilon})]^{-1}$,

(ii) $1 - \alpha_A^t - \Psi_A^t = j(d)R_f[\tau I^2 v(\tilde{\varepsilon})]^{-1}$,

(iii) $\bar{\bar{\gamma}}_A = J(\alpha_A^t)R_f I^{-1} + [j(d)R_f]^2[2I^3 v(\tilde{\varepsilon})]^{-1}[\tau^{-1} + \eta^{-1}] + SR_f I^{-1} - [\phi(\bar{\bar{\gamma}}_A)]^2[2\eta I v(\tilde{\varepsilon})]^{-1}$,

(iv) $\pi_A^t = \begin{cases} 0 & \text{if } \gamma < \bar{\bar{\gamma}}_A, \\ 1 & \text{if } \gamma \ge \bar{\bar{\gamma}}_A, \end{cases}$

(v) $\Delta U_A^t(\tilde{W}_1) = \begin{cases} 0 & \text{if } \gamma \le \bar{\bar{\gamma}}_A, \\ I\gamma - I\bar{\bar{\gamma}}_A & \text{if } \gamma > \bar{\bar{\gamma}}_A. \end{cases}$

Note that, in this case, too, the manager is optimally allowed to earn more than his or her reservation expected utility. This completes our analysis of the four policies and provides us with sufficient structure to begin comparisons aimed at discovering the impact of incorporation mode and information structure.

III. Impact of Incorporation Mode and Information Structure on Investment Policy

In this section, we wish to examine the manner in which a firm's investment policy is influenced by its incorporation mode—private versus public—and by the information structure within which contracting takes place.

PROPOSITION 1 (*Impact of incorporation mode on investment policy*): *Under symmetric information between the founding owner and the manager, the hurdle rate for project acceptance is lower with public incorporation than with private incorporation.*

This is a strong result that is derived from a comparison of policies *SN* and *ST*. It suggests that public incorporation of firms will facilitate an enhancement of aggregate investment. The intuition is that public sale of equity enables ownership to be shared with well-diversified investors who ignore idiosyncratic risk in pricing the asset. Thus, although both the (founding) owner and the manager "care" about idiosyncratic risk in private as well as public firms, the introduction of outside investors in a public firm makes such a firm attach lesser overall importance to idiosyncratic risk than a private firm. Consequently, projects with relatively high idiosyncratic risk may be rejected by the private firm but accepted by the public firm. In this proposition, we assumed that information between the (founding) owner and the manager was symmetric. This was done to *isolate* the effect of incorporation mode from that of asymmetric information; the impact of asymmetric information is influenced by the incorporation mode. We now examine the effect of information structure on investment policy separately for private and public firms.

PROPOSITION 2 (*Impact of information structure on investment policy in private firms*): *In private firms, asymmetric information between the founding owner and the manager causes the project acceptance hurdle rate to rise, thus causing more projects to be rejected. Moreover, the higher the owner's risk aversion, the greater the distortion created by asymmetric information.*

The observation that asymmetric information stochastically depresses investment is not surprising. In a very different model setting, this result also appears in Holmström and Weiss [9]. More interesting, however, is the finding that the investment policy distortion introduced by asymmetric information is *magnified* by the owner's risk aversion. That is, the greater the owner's risk aversion, the larger the difference between the asymmetric-information and symmetric-information hurdle rates. The intuition is as follows. The fractional asset ownership the owner would like to give to the manager is an increasing function of the owner's risk aversion, holding fixed the manager's risk preference and the information structure. This follows from optimal risk-sharing considerations. Moreover, the informational surplus that the manager can extract—the excess over his or her reservation expected utility that the manager can earn—due to his or her informational advantage increases in the asset ownership given to him or her. For example, the informational surplus could be totally eliminated by giving the manager some fixed wage that is independent of the manager's report since such a policy would be trivially incentive compatible. However, then the owner would bear all of the asset's risk. Thus, the owner trades off "informational exploitation" by the manager against the gains from improved risk sharing when he or she decides how much of the asset to let the manager own as a function of his or her report. The more risk averse the owner, the more important the risk-sharing gains to him or her and the greater the asset ownership by the manager—consequently, the greater the informationally induced distortion in investment policy as manifested in a larger difference in the asymmetric-information and symmetric-information hurdle rates.

PROPOSITION 3 (*Impact of information structure on investment policy in public firms*): *In public firms, asymmetric information between the owner and the manager causes the project acceptance hurdle rate to rise, thus causing more projects to be rejected. However, the (founding) owner's risk aversion has no effect on the distortion in investment policy induced by asymmetric information.*

This proposition points out an important difference between private and public firms, insofar as the impact of asymmetric information is concerned. Although the (founding) owner's informational disadvantage results in a distortion in investment policy, the owner's risk aversion does *not* magnify this distortion. This suggests that highly risk-averse owners—who are particularly vulnerable to "informational exploitation" by the manager—may be able to improve their expected utilities by going public; this will be verified later. The intuition behind this result lies in the fact that the owner can now share risk with both the outside investors and the manager. A highly risk-averse owner, therefore, does not necessarily have to tolerate a greater informational surplus extraction by the manager in his or her quest for lesser risk exposure; he or she can lower his or her risk by sharing it with outside investors. Thus, the tradeoff for the owner is now between surplus extraction by the manager and the issue costs associated with selling equity to outsiders. This means that the owner's risk aversion does not dictate the extent of distortion in investment policy resulting from asymmetric information.

IV. Impact of Incorporation Mode and Information Structure on Ownership Distribution

We will now examine how the distribution of ownership in a firm among the founding owner, the manager, and possibly outside investors is affected by how the firm is organized and the contracting information structure.

PROPOSITION 4 (*Impact of incorporation mode on ownership distribution*): *Under symmetric information between the owner and the manager, the manager's asset ownership is smaller in publicly held firms than in privately held firms. Moreover, the founding owner also chooses to hold a smaller fraction of the asset ownership in a publicly held firm than in a privately held firm. Both observations are also valid under asymmetric information.*

Both predictions of this proposition seem consistent with practice. Managers in public firms—even when these firms are no bigger than privately held firms—do seem to hold smaller ownership shares of their firms than their counterparts in private firms. Further, the founding owners in public firms also seem to hold smaller fractions of their firms' equity than those in private firms. The reason for the managerial ownership result under symmetric information is that outside investors offer the owner better risk sharing than the manager does. Interestingly, this effect is further reinforced under asymmetric information as the owner reduces informational surplus extraction by the manager by displacing managerial ownership with ownership by outside investors. The intuition behind lower asset ownership by the owner in publicly held firms relative to that in privately held firms is that the introduction of (value-maximizing) outside investors expands the set of risk-sharing opportunities available to the owners. Whereas in a private firm the owner's ability to shift the risk associated with asset ownership away from himself or herself was limited by the "desire" of the risk-averse manager to absorb such risk, in a public firm the owner is not so constrained.

We now take up the issue of how information structure impacts ownership distribution.

PROPOSITION 5 (*Impact of information structure on ownership distribution in private firms*): *In a private firm, the effect of asymmetric information is to reduce the manager's ownership share.*

The intuition is clear. Under symmetric information, the owner transfers from himself or herself to the manager all of the risk of asset ownership consistent with Pareto-optimal risk sharing. However, asymmetric information retards this transfer. The owner must now trade off the risk-sharing gains from managerial ownership against the cost imposed on him or her due to informational surplus extraction by the manager. Thus, asymmetric information has two detrimental effects on the owner: it results in suboptimal risk sharing, and it allows the manager to capture an informational rent.

PROPOSITION 6 (*Impact of information structure on ownership distribution in public firms*): *In a public firm, the impact of asymmetric information between the (founding) owner and the manager is to reduce the manager's ownership share and increase the ownership share of outside investors. The owner's share is unchanged.*

We have already discussed the intuition behind the decline in the manager's ownership share when there is managerial private information. The reason why the owner's share remains unchanged is that there is no longer any reason for the owner to sacrifice risk sharing in order to limit informational surplus extraction by the manager. The owner can retain his or her optimal investments in the asset, the market portfolio, and the riskless asset and can utilize increased asset ownership by outside investors as a means to limit the rent earned by the manager due to his or her private information.

V. Choice of Incorporation Mode

Given a choice between private and public incorporation, what will the owner do? This is the question we seek to answer in this section. We identify the conditions under which private and public firms will arise.

Before getting to that identification, however, we need some preliminaries. Suppose that $H(\gamma)$ is confined to a class $\mathscr{H}$ of probability-distribution functions. This class has the property that, for any $H_i(\gamma)$, $H_j(\gamma) \in \mathscr{H}$ such that $H_i(\gamma)$ strictly stochastically dominates $H_j(\gamma)$ in the first-order sense, we have $\phi_i(\gamma) \geq \phi_j(\gamma)$ for all γ, with strict inequality for at least some γ.[10] Then, when the owner's priors about γ are described by $H_i(\gamma) \in \mathscr{H}$, we shall say that he or she has "more favorable" beliefs (is more optimistic) about γ than when his or her priors are described by $H_j(\gamma) \in \mathscr{H}$.[11]

PROPOSITION 7 (*Founding owner's incorporation choice*):

(i) *For the owner, the desirability of public ownership declines as d increases, ceteris paribus.*

(ii) *Public incorporation may be strictly preferred by the owner under both symmetric and asymmetric information between the owner and the maanger or just under either.*

(iii) *For a sufficiently high* $v(\tilde{\varepsilon})$, *the gains to the owner from going public increase as* (a) *the owner's risk aversion increases,* (b) *the owner's priors about* γ *become more favorable, or both.*

(iv) *Whenever the owner is better off with public ownership than with private ownership, there is stochastically greater investment in the public firm than in the private firm.*

In view of the observed coexistence of private and public firms, it makes sense that neither mode of incorporation—private or public—dominates the other under all circumstances. The advantage of public incorporation is that it provides capital market risk-sharing opportunities that are inherently superior to the risk sharing with a partially diverisified manager available in a private firm. The disadvantage, of course, is the incidence of issue costs that are not encountered by private firms. Public incorporation will be preferred whenever the owner is sufficiently risk averse—so that the risk-sharing inefficiencies introduced by private incorporation create a nontrivial distortion—and capital market issue costs are not prohibitive. A more interesting finding is that, as the owner's priors

[10] The set $\mathscr{H}$ is quite large. An example of an element of the set is when $H_i(\gamma)$ is a uniform distribution on $[0, \gamma_i]$ and $H_j(\gamma)$ is a uniform distribution on $[0, \gamma_j]$ with $\gamma_i > \gamma_j > 0$. Then, $H_i(\gamma) = \gamma\gamma_i^{-1} < H_j(\gamma) = \gamma\gamma_j^{-1}$, implying first-order stochastic dominance. Also, $\phi_i(\gamma) = \gamma_i - \gamma > \phi_j(\gamma) = \gamma_j - \gamma$, implying the ordering on ϕ.

More generally, instead of the PF_2 restriction on the distribution function, we could have assumed that $h(\gamma)$ is a monotone likelihood-ratio density. We know then from Barlow, Marshall, and Proschan [1] that, given this assumption on h, ϕ is monotone nonincreasing. We also know (see, for example, Rogerson [13]) that the monotone likelihood-ratio property (MLRP) implies (first-order) stochastic dominance. Thus, assuming MLRP for h would give us both stochastic dominance as well as the desired ordering property on ϕ.

[11] Our development of this notion of "greater optimism" is close to the development in Milgrom [11].

about γ become more favorable, he or she will gravitate toward public sale of equity. The implication, of some importance for understanding *one* aspect of the relationship between asset productivity and corporate ownership structure, is that those assets deemed most valuable by their initial owners will tend to be publicly owned. This is a significant result.[12] It seems particularly surprising in view of the Leland and Pyle [10] observation that the value of the firm increases with the share of the firm held by the entrepreneur. In our model, the owner holds a smaller fraction of the firm when it is public than when it is private. (See Proposition 4.) Thus, in contrast to Leland and Pyle, the founding owners of more valuable assets hold smaller ownership shares. The intuition underlying our result is as follows. Under asymmetric information, the manager extracts a surplus from the owner by way of an expected utility higher than his or her reservation utility. Moreover, the owner's evaluation of the surplus extracted is an increasing function of the owner's perception of γ. To limit this surplus extraction, the owner must reduce the asset ownership share of the manager. With private incorporation, however, such an action causes the owner's share of asset ownership to increase. The risk-averse owner finds this unappealing. With public incorporation, on the other hand, the founding owner can reduce the manager's ownership share by selling asset ownership to the public. This way, managerial surplus extraction can be limited without an increase in the owner's risk exposure. Since surplus extraction is an increasing function of the perceived γ, public ownership is most beneficial for the assets perceived to be the most valuable.

It is interesting that the positive relationship between the gains from public incorporation and the owner's risk aversion, as well as optimism about γ, depends on $\upsilon(\tilde{\varepsilon})$ being sufficiently high. Clearly, the owner's risk aversion comes into play only if there is some nontrivial risk that he or she faces. Further, the owner's priors about γ matter only when the manager's report about γ is of sufficient gravity for the owner. Recall that such reporting is of value only when the manager is awarded some ownership of the asset, and managerial asset ownership is significant when the owner wants to share a nontrivial portion of the risk embodied in $\upsilon(\tilde{\varepsilon})$. Finally, it is not surprising that greater "ignorance" on the part of investors will make it more attractive for the owner to take this firm private. It does suggest, however, that the recent surge in LBO's resulting in private ownership of corporate assets may be due to deepening informational gaps about asset productivities between managers and investors.

VI. Concluding Thoughts

Using as the focal point of our analysis the assumption that managers have better information about the return distributions of the assets they manage than do either existing or prospective owners, we have developed a model that has produced some preliminary findings regarding the choice of public versus private ownership in corporations. We have shown that the choice rests on the (nonlin-

[12] Note that, in deriving our result, we do not assume that the public has the same prior belief about γ as the owner.

ear) tradeoff between capital market certification costs and the improved risk sharing facilitated by the capital market. The choice will also be influenced by the owner's assessment of the asset's value. More valuable assets will be publicly incorporated. Moreover, our reseach has explored the impact of incorporation mode and information structure on investment activity and the distribution of ownership. Managerial private information stochastically lowers investment in both private and public firms, whereas investment in a public firm is stochastically greater than in a private firm, even under symmetric information. Moreover, both managers and founding owners hold smaller ownership fractions in public firms than in private firms.

The scope for future work on this subject becomes substantial. Paying careful attention to production decisions and injecting moral hazard into the model in conjunction with managerial private information could possibly go a long way in enriching the model's predictions.[13] At the very least, one could learn how far such models can be taken before their predictive strength is so diluted as to make the increased realism not worthwhile.

[13] Another important extension would be to allow the owners and managers of private firms to have information that they want to keep confidential for strategic reasons. (See, for example, Bhattacharya and Ritter [3] and Campbell [4].) This would provide an added stimulus for private incorporation that we have not examined.

REFERENCES

1. Richard E. Barlow, Albert W. Marshall, and Frank Proschan. "Properties of Probability Distributions with Monotone Hazard Rate." *Annals of Mathematical Statistics* 34 (1963), 375–89.
2. Sudipto Bhattacharya and Paul Pfleiderer. "Delegated Portfolio Management." *Journal of Economic Theory* 36 (June 1985), 1–25.
3. Sudipto Bhattacharya and Jay R. Ritter. "Innovation and Communication: Signalling with Partial Disclosure." *Review of Economic Studies* 50 (April 1983), 331–46.
4. Tim Campbell. "Optimal Investment-Financing Decisions and the Value of Confidentiality." *Journal of Financial and Quantitative Analysis* 14 (December 1979), 913–24.
5. ——— and William Kracaw. "Information Production, Market Signalling and the Theory of Financial Intermediation." *Journal of Finance* 35 (September 1980), 863–82.
6. Gregory Connor. "Performance Measurement with a Beta Pricing Model." Unpublished manuscript, Northwestern University, September 1983.
7. Harold Demsetz and Kenneth Lehn. "The Structure of Corporate Ownership: Causes and Consequence." *Journal of Political Economy* 93 (December 1985), 1155–77.
8. Donald G. Heckerman. "Motivating Managers to Make Investment Decisions." *Journal of Financial Economics* 2 (September 1975), 273–96.
9. Bengt Holmström and Lawrence Weiss. "Managerial Incentives, Investment and Aggregate Implications: Scale Effects." *Review of Economic Studies* 52 (July 1985), 403–26.
10. Hayne E. Leland and David H. Pyle. "Informational Asymmetries, Financial Structure and Financial Intermediation." *Journal of Finance* 32 (May 1977), 371–412.
11. Paul Milgrom. "Good News and Bad News: Representation Theorems and Applications." *Bell Journal of Economics* 12 (Autumn 1981), 380–91.
12. Roger B. Myerson. "Optimal Auction Design." *Mathematics of Operations Research* 6 (February 1981), 58–73.
13. William Rogerson. "Repeated Moral Hazard." *Econometrica* 53 (January 1985), 69–76.
14. Richard Roll. "Ambiguity When Performance is Measured by the Securities Market Line." *Journal of Finance* 33 (September 1978), 1031–69.
15. Stephen A. Ross. "The Arbitrage Theory of Capital Asset Pricing." *Journal of Economic Theory* 13 (December 1976), 341–60.

16. Jay Shanken. "The Arbitrage Pricing Theory: Is It Testable?" *Journal of Finance* 37 (December 1982), 1129–40.
17. Joseph E. Stiglitz. "A Theory of 'Screening', Education and the Distribution of Income." *American Economic Review* 65 (June 1975), 283–300.
18. Brett Trueman. "Optimality of the Disclosure of Private Information in the Production-Exchange Economy." *Journal of Finance* 38 (June 1983), 913–24.
19. Kip Viscusi. "A Note on 'Lemons' Markets with Quality Certification." *Bell Journal of Economics* 9 (Spring 1978), 277–80.