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Source: *The Journal of Political Economy*, Vol. 101, No. 4 (Aug., 1993), pp. 678–709
Published by: The University of Chicago Press
Stable URL: http://www.jstor.org/stable/2138744
Accessed: 27/08/2008 20:11

Market Liquidity and Performance Monitoring

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This paper studies the value of the stock market as a monitor of managerial performance. It shows that the stock price incorporates performance information that cannot be extracted from the firm's current or future profit data. The additional information is useful for structuring managerial incentives. The amount of information contained in the stock price depends on the liquidity of the market. Concentrated ownership, by reducing market liquidity, reduces the benefits of market monitoring. Integration is associated with weakened managerial incentives and less market monitoring. This may explain why shares of divisions of a firm are rarely traded. The model offers a reason why market liquidity and monitoring have both a private and a social value, a feature missing in standard finance models. This is used to study the equilibrium size of the stock market as a function of investor preferences and the available amounts of long- and short-term capital.

I. Introduction

It is widely believed that stock markets can play an important role in monitoring management. Public trading of a firm's stock can influ-

ence managerial incentives in two major ways. First, a poorly performing firm may become a target for a takeover. If it is assumed that managers will be fired if a takeover succeeds, this threat will help curb managerial misbehavior (though it may also have less desirable effects, such as managerial myopia). Less dramatically, public trading allows managerial incentives to be provided according to the continuing performance of the firm's share price. The recent boom in takeovers has focused most of the attention on the corporate control dimension of market monitoring, but in a historical perspective, incentive contracts, whether explicit or implicit, have arguably played an equally, if not more, significant role in influencing managerial incentives.

The literature on managerial incentives includes models of both takeovers (Laffont and Tirole 1988; Scharfstein 1988; Stein 1988) and compensation contracts (Diamond and Verrecchia 1982; Jensen and Murphy 1990). Nevertheless, the role of stock markets as monitors of management remains imperfectly understood. One of the missing elements in the study of market incentives is the cost of market monitoring. If monitoring is valuable, why are not all firms publicly traded? To push the logic one step further, would it not be better to trade shares of individual divisions of a firm, since information about divisional performance could thereby be obtained?[1] The answer must be that public trading is costly. The purpose of this paper is to investigate a model in which the costs as well as the benefits of market monitoring are carefully articulated and analyzed.

Our main thesis is that a firm's ownership structure influences the value of market monitoring through its effect on market liquidity.[2] The basic idea is easy to explain. Consider an insider who holds some fraction of the firm as a long-term investment. If he decides to decrease his ownership, there will be more shares actively traded and the liquidity of the market will go up. We model this by assuming that the number of liquidity traders (i.e., those traders that for extraneous

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[1] In Holmström and Tirole (1989), we touch on this topic briefly, asking why a publicly traded company so often is delisted when it is acquired. We suggest as a reason the manipulability of share prices and the consequent need to protect minority shareholders via covenants. However, even if management is in a position to dilute the value of a subsidiary's operations, such dilution need not imply less efficient performance measurement. What matters for performance information is the source of variation in the stock price. Suppose, quite hypothetically, that the subsidiary's shares are worth precisely 1 percent of the original subsidiary's shares at all times in the future—a 99 percent dilution. For measuring performance and constructing incentives, this would be inconsequential.

[2] In our model, ownership structure is measured along a single dimension, namely, the fraction of shares held for long-term investment. We postulate that increased concentration of ownership reduces market liquidity, an assumption that seems empirically valid (Bhushan 1989).

reasons decide to buy or sell shares) will increase. With more liquidity traders, it becomes easier for an informed party (a speculator) to disguise his private information and make money on it (Kyle 1984). We show that the marginal value of information also goes up. Hence the speculator will spend more time on monitoring. The increased information flow into the market improves the information content of the stock price. This enables the firm to design a more efficient managerial contract. It is notable that an improvement is achieved even though we let the manager's contract be contingent on the firm's present and future return streams. The reason is that in our formulation the speculator's forecast cannot be recovered from realized returns (a natural feature of any forecasting model). Thus price contains unique information about performance.

The logic above would seem to suggest that firms should always be publicly traded and be widely held to maximize the market liquidity and the informativeness of stock prices. However, market monitoring is not costless. Somebody has to pay the speculator for his monitoring service. Directly, the speculator gets reimbursed by the liquidity traders, who lose money when they must sell their shares for liquidity reasons. This ex post loss is compensated by a decrease in the initial share price, sufficient to assure that liquidity traders do not lose money overall (else they would invest in bonds). Indirectly, then, the cost of market monitoring is borne by the initial owners. Since the cost of monitoring equals the speculator's expected profits, maintaining a more liquid market is also more expensive. Thus some degree of ownership concentration is desirable, even when one considers market monitoring in isolation.

We do not mean to suggest that ownership decisions are made on the basis of a marginal calculus of the kind described above. But we do believe that monitoring effects are economically significant when large shifts in ownership concentration are contemplated. For instance, a decision to buy up a publicly traded firm must recognize the net loss in market monitoring, even if the main reason for buying is to gain control of the firm's assets.[3] Reversely, spinoffs can be rationalized by improvements in performance measurement. In fact, 94 percent of equity carve-outs lead to the adoption of incentive compensation plans based on the subsidiary's stock (Schipper and Smith 1986). The value of market information has been noted before (see, e.g., Schipper and Smith 1983; Aron 1988). But ours is a model in which the value is established without assuming that the shares of a

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[3] Williamson (1985) and Grossman and Hart (1986) have argued that ownership structure can best be understood in terms of the control rights that ownership confers. Control benefits can easily be incorporated into our framework, as we show by an example.

subsidiary cannot be publicly traded. Indeed, our model suggests a reason why they are not: monitoring benefits become insignificant when ownership concentration leads to an illiquid market.

Three features of our analysis deserve emphasis. First, a change in ownership is inevitably tied to a change in information flow and incentives, since the firm cannot contract with the speculator on the amount of information to be acquired.[4] Thus our analysis proves wrong the argument that an integrated firm and a nonintegrated firm have access to identical performance measures.

Second, unlike the earlier literature on the incentive effects of capital structure, in which the same changes in incentives could be provided by incentive schemes unrelated to capital structure (see Holmström and Tirole [1989] for references), our model has the feature that a redistribution of shareholdings has no perfect substitute. One could not provide the same incentives merely by altering the manager's contract. In fact, in our model a change in the manager's contract will have no effect on market monitoring.

Third, and most important, in our model market liquidity and monitoring have both a private and a social value. There is a vast literature in finance devoted to the analysis of information flows in stock markets, including how completely and how fast information is incorporated into prices. But in almost no model is information collection socially useful.[5] Nor do these models assign any cost, private or social, to public trading. Thus they cannot address how large a stock market should be from a social point of view, or how large it will become when private interests rule.[6]

In our framework these questions have answers. We illustrate this by setting up a simple equilibrium model in which the size of the market is endogenously determined by the firms' (entrepreneurs') decisions to go public or not. The model has long-term traders and short-term traders. Both have a choice of investing in newly issued shares or safe bonds. Long-term traders have no need to trade shares in the short run, whereas short-term (liquidity) traders must with some probability liquidate their shares prematurely. For this reason,

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[4] In a companion paper (Holmström and Tirole 1991) we discuss another important form of third-party monitoring: monitoring of quality by the product market.

[5] Exceptions are the models of Danthine (1978) and Kyle (1984), in which information about the future supply of a commodity is signaled by prices in the futures market. This improves the allocation of consumption over time. In independent work, Paul (1989) studies an agency model similar to ours and concludes that stock markets do not aggregate information efficiently for the purpose of performance evaluation. In his model, speculators will collect the wrong kind of information.

[6] We are not saying that these questions could not be analyzed in extended versions of the basic models. But to the best of our knowledge, the models have not been used for this purpose.

long-term traders value shares more highly than short-term traders do. However, if the amount of long-term capital is limited, as we shall assume, short-term traders will also wish to hold shares. This brings speculators into the stock market and makes it desirable for a fraction of the firms to go public. We show that the fraction of firms going public increases with the amount of long-term capital. However, the size of the stock market is not in general socially optimal, because the scarcity of long-term capital leads to rents.

Our vision of performance monitoring is, of course, one-sided. Managers could be monitored by other means as well. It has often been argued that large shareholders have a strong incentive to keep an eye on management because, unlike small shareholders, they can appropriate a significant fraction of the returns (see Demsetz and Lehn 1985; Huddart 1989). We do not deny this, but note that this view of monitoring is equally one-sided. Our analysis is intended to balance the account.

The market for corporate control also invites monitoring. This type of monitoring may be discouraged by a diversified ownership because of free-rider problems (Grossman and Hart 1980; Shleifer and Vishny 1986). Only shareholders who are sufficiently large may want to invest in information about the potential value of the firm under new management. There is then a trade-off between employing the takeover mechanism as an incentive device and employing incentive contracts based on more informative price signals.

An interesting aspect of this trade-off is that the two mechanisms elicit rather different monitoring responses. A person contemplating a takeover is primarily interested in how the firm would perform if the firm's strategy were changed, whereas a person interested in trading profits tries to forecast the consequences of past managerial actions. Put differently, the potential raider is interested in *strategic information,* whereas the regular market analyst is interested in *speculative information.* The value of liquidity then depends in part on what kind of monitoring information, strategic or speculative, the firm wants to acquire. The two types of monitoring are not substitute incentive instruments, but rather influence management in different ways.

The paper is organized as follows. Section II describes the model. Section III analyzes market equilibrium with a fixed managerial contract and a fixed ownership share. Section IV describes the optimal design of the manager's contract. Section V brings the analyses of the two previous sections together for a discussion of how the benefits and costs of monitoring influence the choice of insider shares. Sections VI and VII consider external factors influencing the insiders'

control fraction: the benefits of control and the value of large share-holders. Section VIII analyzes the equilibrium size of the stock market and discusses liquidity and bid-ask spreads in more general terms than the rest of the paper. Conclusions are offered in Section IX.

II. The Model

Agents

We consider a publicly traded firm, run by a manager and owned by several different categories of investors. The categories are (i) *inside owners,* who with management hold a constant fraction of shares in each period; (ii) *liquidity traders,* who buy shares for investment purposes but will have to sell shares when unexpected events occur (more on this shortly); and (iii) *speculators* (a single one in our model), who can collect information about the future value of the firm and make money by trading on that information.

All investors are assumed risk neutral. The manager is the only risk-averse agent in the model. For simplicity we assume that there is no discounting and that agents care only about their lifetime income. Thus the timing of payments is immaterial.

The fraction of shares held by insiders, denoted δ, will be strategically chosen. We postpone a fuller discussion of the objective behind the choice of δ. One central consideration is that δ will affect the liquidity of the market. We model this by assuming that the number of liquidity traders is reduced when δ is increased. The implication is that the variance in the random amount of shares that the liquidity traders are forced to liquidate because of unexpected events will go down with δ.

Timing and Technology

The model has three periods, indexed $t = 0, 1, 2$. In the initial period $t = 0$, the firm is established. At this time, the insiders decide on selling a fraction $(1 - \delta)$ of the shares to the market at a price p_0 that is determined so that liquidity traders earn zero expected profits. Also, the insiders hire a manager to run the firm, signing a management contract that will be in effect throughout the three periods (no renegotiations are allowed).

In period $t = 1$, the firm produces earnings (gross of payments to the manager) in the amount

$$\pi_1 = e_1 + \epsilon_1. \tag{1}$$

Here e_1 is the component of earnings determined by managerial actions, and ϵ_1 is a noise term, representing factors outside the manager's control. We assume that ϵ_1 is distributed normally with mean zero and variance σ_1^2. As a matter of convention, the firm pays out its first-period earnings, net of management fees, as dividends.

In the second period, the firm is liquidated. The resulting liquidation proceeds (gross of payments to management) are

$$\pi_2 = e_2 + \theta + \epsilon_2. \tag{2}$$

The random variables θ and ϵ_2 represent fluctuations in the value of the firm that are beyond the manager's control; both are assumed normally distributed with mean zero and respective variances σ_θ^2 and σ_2^2. We have divided the random component of the liquidation value into two parts in order to have a convenient parameterization of uncertainty relative to what the speculator knows (see eq. [3] below). The liquidation proceeds are distributed to the shareholders net of managerial fees.

We assume that the manager chooses e_1 and e_2 simultaneously; that is, both actions are taken in the first period. The interpretation we have in mind is that the manager allocates his time between enhancing short-term earnings and improving the long-term value of the firm. We may view $e_2 + \theta$ as representing the (unobserved) fundamental value of the firm after the first period, and ϵ_2 is the unpredicted change in value occurring during the second period.

Information

In period 1, the speculator[7] observes a signal

$$s = e_2 + \theta + \eta, \tag{3}$$

which provides information about the fundamental value of the firm at time 1 and hence about the liquidation value at time 2. The observation error η is assumed normally distributed with mean zero and variance σ_η^2. We emphasize that in our specification the speculator does *not* observe the true liquidation value π_2 with an independent error term (unless $\epsilon_2 \equiv 0$). Were this the case, the speculator's signal would be of no use in assessing the manager's performance given π_2.

All primitive random variables are assumed independent. Note, however, that the speculator's signal s is correlated with the liquidation value π_2.

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[7] We assume that the speculator holds no initial shares at date 0. Alternatively, the speculator could be an insider who adjusts his position at date 1 on the basis of the signal he receives. The analysis in this case would be only slightly altered.

A key feature of the model is that the speculator can affect the precision with which he can observe the value of the firm. We assume that he can choose σ_η^2 at a cost $g(1/\sigma_\eta^2)$, where g is increasing and convex and $g(0) = 0$.[8] The market cannot observe the choice of σ_η^2 or the signal s.

Managerial Contract

There are three sources of performance information in this model: first-period earnings, π_1; the firm's liquidation value, π_2; and the share price, p_1 (which, as we shall see, will depend linearly on the signal s observed by the speculator). We shall consider only contracts that are linear in these three measures.[9]

Rather than write the manager's contract as a general linear function of the three performance measures, we shall describe it in terms of the instruments in which the manager gets paid. The same reduced-form contract can be implemented with different combinations of instruments, and hence it is essential for accounting purposes to fix the interpretation we have in mind.

We assume that the manager's contract takes the following general form. In the first period the manager is paid a fixed *salary* W with a *bonus* $B\pi_1$ added as a reward for short-term performance; the manager holds no shares of the firm in this period, and his payments come out of the firm's account. In the second period the contract specifies that S *shares* be transferred from the inside owners to the manager; they entitle the manager to a fraction S of the liquidation value of the firm.[10] In addition, the manager is given A *stock apprecia-*

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[8] One natural information structure satisfying these assumptions is the following. Assume that the speculator can buy any number n of signals $s_i = e_2 + \theta + \omega_i$, where ω_i are independent, normally distributed variables with zero mean and unit variance. The cost of buying n signals is $g(n)$, where n is increasing and convex. Let $\eta = \Sigma\omega_i/n$. Then $s \equiv e_2 + \theta + \eta$ is a sufficient statistic for the speculator's sample; i.e., we can equivalently imagine the speculator observing s. Since the variance of η is $\sigma_\eta^2 = 1/n$, the cost of choosing σ_η^2 is $g(1/\sigma_\eta^2)$.

[9] A linear incentive scheme is optimal in a dynamic model that has the reduced form we are describing, assuming that the manager chooses his actions contingent on performance information that is at least as accurate as the information provided by the processes π_1, π_2, and p_1 (see Holmström and Milgrom 1987). However, such an assumption is not realistic in our model since the final liquidation value is hardly known by the manager in period 1.

[10] The reason we assume that the manager's shares are transferred rather than newly issued is that we do not want the managerial contract to affect the fraction of shares traded $(1 - \delta)$. This way there is no interaction between the managerial contract and the equilibrium price, which allows a separate treatment of the two. The payoffs to the parties are not affected by this accounting convention.

tion rights, for which the firm pays him Ap_1 out of the liquidation proceeds in period 2.[11]

Since the timing of payments is immaterial, the manager cares only about the total income I provided by the contract (B, W, S, A):

$$I = B\pi_1 + W + Ap_1 + S(\pi_2 - Ap_1). \tag{4}$$

It should be clear from (4) that an arbitrary linear contract in the three performance measures (π_1, π_2, p_1) can be implemented by the four instruments we have made available.[12]

We assume that the manager's performance over income I can be represented by an exponential utility function. We denote by $c(e_1, e_2)$ his private cost of choosing inputs. We measure this cost in money and assume that it is independent of the manager's wealth. The manager's evaluation of the normally distributed (in equilibrium) income lottery I, given his choice of inputs e_1 and e_2, can then be represented by the certain equivalent measure

$$U(I, e_1, e_2) = E(I) - \frac{r}{2}\text{var}(I) - c(e_1, e_2),$$

where r is the manager's coefficient of absolute risk aversion.

Sequence of Events

The events in the three-period model can be summarized as follows. *Period 0:* (i) Insiders and the manager publicly agree on the incentive contract (B, S, A, W) and the fraction of inside shares, δ. (ii) Insiders publicly sell the remaining $(1 - \delta)$ shares to liquidity traders. *Period 1:* (i) The manager chooses effort e_1 and e_2. (ii) First-period earnings π_1 are realized and reported. (iii) The manager is paid $B\pi_1 + W$ in cash. Independent of the outcome, the manager is given A stock appreciation rights and S shares (out of the δ shares held by insiders). (iv) The remaining cash in the firm is paid out as dividends: $(1 - B)\pi_1 - W$. (v) The speculator privately chooses information level σ_η^2 and makes observation s. (vi) Liquidity traders, the speculator, and arbitrageurs trade shares at the market-clearing price p_1. *Period 2:* (i) The firm is liquidated for gross proceeds of π_2. (ii) The

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[11] A stock appreciation right is a promise of a cash payment as a function of an increase in the share price. It is immaterial which initial price is taken as a point of reference, since we can always absorb the implied change in the constant term into the fixed salary. Our appreciation rights have zero as the point of reference.

[12] A number of alternative instruments could have been used, of course. For instance, the manager could have been provided shares rather than a bonus in the first period, with no real effects.

manager is paid Ap_1 for stock appreciation rights and the shareholders are paid the residual value of the firm: $p_2 = \pi_2 - Ap_1$.

III. Determination of Equilibrium Share Prices

The prices of shares in the three periods are denoted p_0, p_1, and p_2. The second-period price is simply the net liquidation value of the firm, $p_2 = \pi_2 - Ap_1$. The price in the initial period, p_0, is what the insiders receive from the public offering. This price is easy to determine once we determine the first-period price p_1. To this end, we first calculate the equilibrium price p_1 by keeping fixed the insiders' share, the manager's contract, and his equilibrium actions. Subsequently, we consider the endogenous determination of these variables and their effect on p_1.

We adopt Kyle's (1985) model for determining prices in a market with informed traders.[13] In this model, market participants first submit their demands, and then prices are set in such a way that expected trading profits are zero conditional on aggregate demand. In other words, one envisions that aggregate demand by speculators and liquidity traders is public information on which arbitrageurs can act (indeed, the equilibrium price fully reveals aggregate demand). As usual, liquidity traders serve the purpose of disguising the trades of the informed; else prices would fully reveal the speculator's information and there would be no returns to collecting information.

Denote the demand of the liquidity traders by y. This variable is assumed normally distributed with mean zero and variance σ_y^2. We may interpret y as a deviation from the expected number of shares that liquidity traders will have to sell for exogenous reasons; taking the mean of y to be zero is inconsequential. We use as our measure of market liquidity the variance in liquidity trade, σ_y^2. Since the number of liquidity traders is proportional to $1 - \delta$, an increase in δ by this measure will reduce market liquidity. However, at this stage the connection between δ and σ_y need not be stressed. The results in this section apply for any exogenous change in market liquidity.[14]

[13] Other notable papers on information aggregation include Grossman and Stiglitz (1980), Hellwig (1980), and Admati and Pfleiderer (1987). We could alternatively have employed these models for our purposes.

[14] Obviously, factors other than δ may influence market liquidity. If arbitrageurs were risk averse, the degree of risk aversion would be a factor to consider. The amount of public information about the firm determines how much the speculator wants to invest, which, in a more detailed model of trading, would also influence liquidity (see Kyle 1984). We do not consider the role of public information, though this could be an important instrument for the firm in regulating market monitoring, as Mark Wolfson has pointed out to us. Finally, the size of the firm affects liquidity for the same reason that δ does. It is a common perception that larger firms are more liquid; more on this shortly. Alternative factors are also discussed in remark 4 in Sec. VIII.

Equilibrium price will depend on the strategy followed by the informed speculator. Conversely, the optimal strategy of the speculator will depend on how his trading affects price. We are looking for a rational expectations equilibrium in which the market's beliefs about the speculator's behavior will coincide with actual behavior. To this end, let $\overline{\sigma}_\eta^2$ be the hypothesized level of information chosen by the speculator and let $\overline{x}(s)$ be his hypothesized demand as a function of his observed signal s. (Hypothesized equilibrium choices or values will be identified by bars throughout.) We posit that this demand strategy takes the linear form

$$\overline{x}(s) = \overline{\alpha} + \overline{\beta} s. \tag{5}$$

Total demand is given by $q = y + x$. To preclude arbitrageurs from making expected profits, the price must satisfy the condition

$$p_1 = E[\pi_2 - Ap_1 | y + x(s) = q]. \tag{6}$$

The expectation in (6) is taken with respect to y and s, conditional on q and the assumption that the speculator behaves as posited in (5).

The speculator submits his demand x, knowing s but unaware of total demand q. His optimal x is determined by

$$\overline{x}(s) = \underset{x}{\operatorname{argmax}} \, x\{E[\pi_2 - Ap_1 | x, s] - E[p_1 | x]\}. \tag{7}$$

The expectation in (7) is taken over y, θ, and ϵ_2. In choosing his order x, the speculator takes into account that p_1 is a function of x and y.

Market equilibrium is determined by the linearity restriction (5), the pricing condition (6), and the rationality condition (7). The determination of this equilibrium is standard and can be found in Holmström and Tirole (1990). The results are summarized in the following proposition.

PROPOSITION 1. Fix the fraction of inside shares, δ, and the manager's contract (B, W, A, S). Let $(\overline{e}_1, \overline{e}_2)$ be the manager's equilibrium action. Then there exists a unique (linear) equilibrium satisfying conditions (5)–(7). In this equilibrium, (i) the *speculator's linear demand* is characterized by the coefficients

$$\overline{\alpha} = -\frac{\overline{e}_2 \sigma_y}{(\sigma_\theta^2 + \overline{\sigma}_\eta^2)^{1/2}}, \tag{8}$$

$$\overline{\beta} = \frac{\sigma_y}{(\sigma_\theta^2 + \overline{\sigma}_\eta^2)^{1/2}}; \tag{9}$$

(ii) the *speculator's information choice*, $\overline{\sigma}_\eta$, is determined by

$$\sigma_y \sigma_\theta^2 \frac{\overline{\sigma}_\eta^4}{2(\sigma_\theta^2 + \overline{\sigma}_\eta^2)^{3/2}} = g'\left(\frac{1}{\overline{\sigma}_\eta^2}\right); \tag{10}$$

(iii) the *equilibrium price* p_1 is such that

$$(1 + A)p_1 = \overline{e}_2 + \frac{\sigma_\theta^2(\theta + \eta)}{2(\sigma_\theta^2 + \overline{\sigma}_\eta^2)} + \left[\frac{\sigma_\theta^2}{2(\sigma_\theta^2 + \overline{\sigma}_\eta^2)^{1/2}}\right]\frac{y}{\sigma_y}; \tag{11}$$

and (iv) the *speculator's expected* (ex ante) *revenue* is

$$ER = \frac{\sigma_y \sigma_\theta^2}{2(\sigma_\theta^2 + \overline{\sigma}_\eta^2)^{1/2}}. \tag{12}$$

This characterization calls for several comments. Consider first the determination of an equilibrium. The right-hand side of (10) is decreasing in $\overline{\sigma}_\eta$ by convexity of g, and the left-hand side is increasing in $\overline{\sigma}_\eta$. Consequently, given the exogenous parameters σ_y and σ_θ, there is a unique value $\overline{\sigma}_\eta$ satisfying (10). This value in turn fixes the parameters $\overline{\alpha}$ and $\overline{\beta}$ as provided by (8) and (9). Thus there is exactly one equilibrium with a linear demand strategy.

Equations (8) and (9) imply that $\overline{\alpha} = -\overline{e}_2\overline{\beta}$ and hence that $\overline{x}(s) = \overline{\beta}(s - \overline{e}_2)$. In equilibrium, therefore,

$$\overline{x} = \overline{\beta}(\theta + \eta), \tag{13}$$

which tells that the speculator's net position is normally distributed around zero.

It follows from (10), (12), and (13) that neither the speculator's behavior nor his expected revenue depends on the manager's contract or equilibrium actions $(\overline{e}_1, \overline{e}_2)$.

We are particularly interested in how the equilibrium responds to a change in σ_y, that is, a change in market liquidity. Since the left-hand side of (10) increases in σ_y, the speculator will acquire more information (lower $\overline{\sigma}_\eta$) in response to increased market liquidity. Also, from (9) we see that the speculator will trade more aggressively on his information ($\overline{\beta}$ increases) when σ_y goes up; the direct effect of σ_y is positive, and it is reinforced by a decrease in $\overline{\sigma}_\eta^2$. The logic is simple. Increased liquidity provides a better disguise for the speculator, as price becomes less sensitive to his trade. Since the speculator can use his private information more effectively, its marginal return increases, causing him to acquire more. Both the direct and indirect effects of higher liquidity are positive in (12).

A peculiar feature of the speculator's optimal trading strategy is that $x(s)$ will adjust in response to changes in σ_y precisely so that the distribution of price is independent of the level of liquidity trading

(with $\overline{\sigma}_\eta$ fixed). This can be seen from (11) by noting that y enters as a standardized variable or by calculating the price variance,

$$\text{var}(p_1) = \frac{\sigma_\theta^4}{2(1 + A)^2(\sigma_\theta^2 + \overline{\sigma}_\eta^2)}, \tag{14}$$

which is independent of σ_y.

From (14) we see that price volatility will increase with the speculator's information level $1/\overline{\sigma}_\eta$; in particular, the price is constant when the speculator knows nothing ($\overline{\sigma}_\eta = \infty$). Since a more liquid market will induce the speculator to become better informed, an increase in σ_y will indirectly increase price variability. As the next section shows, a more volatile price will also be more informative about the manager's contribution to the long-term value of the firm (his choice of e_2). Consequently, a reduction in δ will improve market monitoring.

Change in the Scale of the Firm

Let K be a scale factor, and assume that $\pi_2 = K(e_2 + \theta + \epsilon_2)$ and $s = K(e_2 + \theta + \eta)$. Evidently, K will not affect the information content of the signal s directly, since s/K does not depend on K as long as the speculator chooses the same level of information. But there will be an indirect effect. From (10) and (12) it follows that the speculator invests more in information ($\overline{\sigma}_\eta$ goes down) and earns a higher expected revenue ER when K increases. Consequently, the market will provide more accurate performance information with increased scale.

We summarize the preceding discussion in the following corollary.

COROLLARY. The equilibrium in proposition 1 has the following features:

i)   The speculator's equilibrium strategy and his ex ante expected profits from trading are independent of the manager's equilibrium action ($\overline{e}_1$, $\overline{e}_2$) as well as the manager's contract.

ii) An increase in market liquidity (σ_y) will lead the speculator to invest more in information ($\overline{\sigma}_\eta$ goes down), will improve the information content of the price, and will increase the speculator's expected revenue (ER).

iii) An increase in the scale of the firm (K) will have the same consequences as described in part ii.

iv) When the information level of the speculator ($\overline{\sigma}_\eta$) is kept fixed, the price variance is unaffected by market liquidity. In equilibrium, increased liquidity increases price volatility.

We conclude this section by considering the equilibrium price p_0

in the initial period 0. This price is set so that liquidity traders break even in expectation, considering the fact that some of them will be forced to trade against the informed speculator but others will hold on to their shares to the end. To calculate this price, we can reason as follows. The total expected return from operating the firm is $E[\pi_1 + \pi_2]$. The speculator will receive ER in expectation (as specified in [12]). Since liquidity traders make no money on average, the net aggregate return to the insiders and the manager must therefore be

$$\Pi \equiv E[\pi_1 + \pi_2] - ER. \tag{15}$$

Alternatively, we can express Π as the expected value of the aggregate payouts to the insiders and the manager. Setting this aggregate equal to (15), we find that, to break even, liquidity traders must pay the insiders a total of

$$(1 - \delta)p_0 = (1 - \delta)E[(\pi_1 - B\pi_1 - W) + (\pi_2 - Ap_1)] - ER \tag{16}$$

for their fraction of shares. Both (15) and (16) underscore the fact that, while the speculator makes his money on liquidity trade, the insiders in equilibrium end up paying for his returns.

IV. The Manager's Contract

The fact that the manager's contract and actions have no effect on the behavior of the speculator (see the corollary above) is a convenient feature. It makes it possible to separate the analysis of market equilibrium from the analysis of optimal contracting. The two parts come together only when one considers the choice of δ.

The stock price, as a function of the speculator's signal s, provides additional information about the manager's choice e_2 (as long as $\sigma_2 > 0$). Rather than deal with p_1 directly, the analysis of contracting becomes easier if we transform p_1 to the following equivalent *normalized* performance measure:[15]

$$z \equiv \frac{(1 + A)p_1 - (1 - \mu)\bar{e}_2}{\mu}$$

$$= e_2 + \frac{y}{\sigma_y}(\sigma_\theta^2 + \sigma_\eta^2)^{1/2} + \theta + \eta, \tag{17}$$

where $\mu = \sigma_\theta^2/2(\sigma_\theta^2 + \sigma_\eta^2)$.

[15] From this point onward, we shall drop bars on variables related to the speculator's behavior. We shall keep using bars to distinguish between the manager's actual and hypothesized behavior.

Note that z can be constructed from public information; it is a transformation based on hypothesized equilibrium values. One benefit of dealing with z rather than p_1 is that z is independent of the parameters of the manager's contract as well as the manager's hypothesized actions (obviously z depends on actual actions). Also, the effects of parameter changes on the information content of the price signal become transparent this way. The variance of z is

$$\text{var}(z) = 2(\sigma_\theta^2 + \sigma_\eta^2). \tag{18}$$

This variance represents the noise-to-signal ratio of price (since the marginal return on effort is unity in [17]) and is the relevant measure of performance noise in the price signal. It is twice the noise-to-signal ratio of the speculator's observation s; in equilibrium, the speculator disguises half of his information. The most notable feature of (18) is that a change in liquidity (σ_y) does not have any *direct* effect on the value of price as a performance measure; the speculator will choose $x(s)$ so that the measurement error of performance (as measured by [18]) stays constant. However, there will be an *indirect* effect on price. By proposition 1, an increase in liquidity will induce the speculator to invest more in information collection. Lowering σ_η^2 improves the information content of price, as is evident from (18).

Expressed in terms of z, the manager's compensation scheme can be written in the reduced form

$$I = a_1\pi_1 + a_2\pi_2 + bz + d. \tag{19}$$

The coefficients of the original scheme (B, W, A, S) can be recovered from the following relationships:

$$B = a_1, \quad W = d - \frac{b(1 - \mu)\bar{e}_2}{\mu},$$

$$S = a_2, \quad A = \frac{b}{(1 - a_2)\mu - b}. \tag{20}$$

Since the manager's contract does not affect the information content of z, we can take z as exogenous in looking for an optimal design. An efficient design will offer the manager a contract that maximizes the expected joint profit Π in (15) less the manager's cost of choosing e_1 and e_2 and the cost of risk:

$$\max\left\{E[\pi_1 + \pi_2] - ER - \frac{r}{2}\text{var}(I) - c(e_1, e_2)\right\} \tag{21a}$$

subject to

$$(e_1, e_2): \max\{a_1e_1 + a_2e_2 + be_2 - c(e_1, e_2)\}. \tag{21b}$$

According to the corollary, the term ER does not depend on the manager's contract or actions and can therefore be ignored in the objective (21a). Constraint (21b) represents only the part of the manager's objective that depends on his actions. Note that the constant d does not appear in the program since it merely determines the division of surplus between the manager and the owners.

Using (18) and (19), we can rewrite program (21) as

$$\max \left\{ e_1 + e_2 - c(e_1, e_2) \right.$$

$$\left. - \frac{r}{2} [a_1^2 \sigma_1^2 + a_2^2(\sigma_2^2 + \sigma_\theta^2) + 2b^2(\sigma_\theta^2 + \sigma_\eta^2) + 2a_2 b \sigma_\theta^2] \right\} \qquad (22a)$$

subject to

$$a_1 = c_1, \qquad (22b)$$

$$a_2 + b = c_2, \qquad (22c)$$

where c_1 and c_2 denote the partial derivatives of the cost function, and (22b) and (22c) represent the first-order conditions for the manager's choice of e_1 and e_2. These conditions are necessary as well as sufficient since the manager's program is concave.

From (22c) we see that the same incentives for action can be provided with different weights on π_2 and z. The best combination (a_2, b) will simply minimize risk:

$$\min \{ a_1^2 \sigma_1^2 + a_2^2(\sigma_2^2 + \sigma_\theta^2) + 2b^2(\sigma_\theta^2 + \sigma_\eta^2) + 2a_2 b \sigma_\theta^2 \} \qquad (23a)$$

subject to

$$a_2 + b = \text{constant.} \qquad (23b)$$

At an optimum we must therefore have

$$\frac{b}{a_2} = \frac{\sigma_2^2}{\sigma_\theta^2 + 2\sigma_\eta^2}. \qquad (24)$$

From (24) we can make several observations. First, $a_2 > 0$: the manager will always receive a positive amount of stock ($S > 0$). This holds true even if $\sigma_\eta = 0$, that is, even if the speculator did observe e_2 without error, because liquidity traders prevent the market price from fully revealing the speculator's information. Therefore, the additional information provided by π_2 will be valuable.

Second, $b > 0$, unless $\sigma_2 = 0$: the market price will provide additional information about the manager's performance except in the special (and unrealistic) case in which the speculator's signal s equals

the true liquidation value plus an independent noise term. Therefore, stock appreciation rights will be offered in addition to stock ($A > 0$).

As the unpredictable component of the firm's future value increases (σ_2 gets larger), the liquidation value provides less accurate information about investment performance. In response, we would expect the optimal contract to place a relatively larger weight on the market price (which is unaffected by σ_2). This intuition is confirmed by (24). Conversely, if the speculator invests less in information (increases σ_η), b will become smaller since price is less informative.

From our earlier discussion, we know that an increase in the scale of the firm (K) will induce the speculator to become better informed. Since K does not directly affect (24), the net effect of an increase in scale is a contract with relatively more weight on the market price.

We summarize our discussion in the following proposition.

PROPOSITION 2. The manager's optimal incentive scheme will always include stock. If σ_2 is positive, the optimal incentive scheme will also include stock appreciation rights. The optimal scheme will put increased weight on price information relative to the liquidation value (b/a_2 will increase) as the liquidation value of the firm becomes less predictable (σ_2 increases), the scale of the firm (K) increases, or market liquidity (σ_y) increases.

Condition (24) says nothing about the sum $a_2 + b$, which determines the overall incentive for the long-term action e_2. To identify aggregate effects, define

$$\hat{a}_2 \equiv a_2 + b,$$

$$\nu \equiv \frac{\sigma_\theta^2 + 2\sigma_\eta^2}{\sigma_2^2 + \sigma_\theta^2 + 2\sigma_\eta^2}. \tag{25}$$

We can write the solution of (23) in terms of $\hat{a}_2$ and ν:

$$b = \hat{a}_2(1 - \nu), \tag{26}$$

$$a_2 = \hat{a}_2\nu. \tag{27}$$

The original program (22) can then be reexpressed as

$$V \equiv \max\{e_1 + e_2 - c(e_1, e_2) - k_1 a_1^2 - k_2 \hat{a}_2^2\} \tag{28a}$$

subject to

$$a_1 = c_1, \tag{28b}$$

$$\hat{a}_2 = c_2, \tag{28c}$$

where we have made use of the definitions

$$k_1 \equiv \frac{r}{2}\sigma_1^2, \tag{29}$$

$$k_2 \equiv \frac{r}{2} [\nu^2(\sigma_2^2 + \sigma_\theta^2) + 2(1 - \nu)^2(\sigma_\theta^2 + \sigma_\eta^2) + 2\nu(1 - \nu)\sigma_\theta^2]$$

$$= \frac{r}{2}(\sigma_\theta^2 + \nu\sigma_2^2). \tag{30}$$

The coefficients k_1 and k_2 measure the risk costs associated with the incentive coefficients for short-term and long-term performance, a_1 and $\hat{a}_2$. The virtue of (28) is that these coefficients are "orthogonal" in the sense that the risk costs k_1 and k_2 do not interact in the objective function. This makes it easy to identify how various factors affect the solution.

It is readily checked that k_2 is increasing in σ_θ, σ_η, and σ_2. Therefore, by revealed preference, $\hat{a}_2$ is decreasing in all three variances. We can combine this with the comparative statics implications of (24), to conclude that (i) a_2 will be reduced in response to an increase in σ_2 and (ii) b will be reduced in response to an increase in either σ_θ or σ_η (viewed as independent parameters).

Revealed preference also implies that a_1 will decrease with an increase in σ_1. More interesting is the question of what happens to a_1 in response to increases in k_2. Williamson (1985) has argued that when firms integrate, they are forced to offer low-powered incentives (on short-term results) lest management will devote too little time to build the long-term value of the firm. In accordance with this logic, one would expect that when long-term performance measurement becomes more costly (k_2 goes up), the power of short-term incentives (measured by a_1) would go down.

PROPOSITION 3. Assume that the manager's cost function is quadratic and that c_{12} is positive (i.e., the manager's activities are substitutes). Then the incentives for short-term and long-term performance (a_1 and $\hat{a}_2$) will covary positively with changes in the exogenous parameters underlying k_1 and k_2. In particular, both incentive coefficients will decrease with (i) an increase in σ_1 or σ_2, (ii) an (exogenous) increase in σ_η, and (iii) a decrease in σ_y. In all three cases, agency costs will go up.[16]

Proof. The first-order conditions for program (28) are

$$1 - a_1 c_{11} k_1 - \hat{a}_2 c_{12} k_2 - a_1 = 0 \tag{31}$$

and

$$1 - a_1 c_{12} k_1 - \hat{a}_2 c_{22} k_2 - \hat{a}_2 = 0. \tag{32}$$

Since these equations are symmetric with respect to k_1 and k_2,

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[16] The statement in part iii takes into account the speculator's choice of information level.

we need to consider only the effect of a change in one of them, say k_2. Simple algebra shows that $da_1/dk_2 < 0$ if and only if $(1 + c_{11}k_1)$ $\times (1 + c_{22}k_2) - c_{12}^2 k_1 k_2 > 0$. This latter condition is implied by the second-order condition of an optimum and the fact that c is convex. Since $d\hat{a}_2/dk_2 < 0$ by revealed preference, the two incentive coefficients will covary positively. The rest of proposition 3 follows from the definition of k_1 and k_2 and the corollary. Q.E.D.

Proposition 3 confirms the intuition that short-term and long-term incentives should move up and down together, to maintain a proper allocation of management attention between the two activities.[17] The underlying logic can also be understood as follows. There are two ways in which the manager can be induced to invest more for the long term: he can be paid a higher reward for long-term performance, or his opportunity cost for long-term investment can be reduced. The first alternative corresponds to raising $\hat{a}_2$, and the second alternative corresponds to lowering a_1. When the cost of rewarding the manager for long-term performance goes up, lost incentives are partly replaced by reducing the opportunity cost.

We should note, however, that other exogenous parameters, not included in this model, could result in a negative correlation between the two incentive coefficients. In particular, if the productivity of either of the manager's effort variables were to vary (alone), this would result in a negative correlation between short- and long-term incentives. The logic is the same as that used above. Suppose, for instance, that short-term effort becomes more productive. Then incentives for short-term effort should be strengthened. This is accomplished by raising a_1 *and* lowering a_2.

V. The Cost of Liquidity and the Choice of δ

The major conclusion from our preceding analysis is that market liquidity improves performance evaluation: the maximal value V of the objective function in (28) is increasing in σ_y. Should we therefore set δ as small as possible (i.e., equal to the manager's incentive share) in order to maximize market liquidity (recall that liquidity trade varies inversely with the insiders' fraction δ)? Certainly not. The speculator's monitoring service is not offered for free. The speculator's profit is the liquidity traders' loss, and, as we observed in (16), this loss is ultimately borne by the insiders in the form of a reduced initial share price p_0. Therefore, the expected revenue ER equals the fee the insiders have to pay for market monitoring. According to part ii of the

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[17] For a related discussion, see Holmström and Milgrom (1991) and Laffont and Tirole (1991).

corollary, ER decreases with δ. An optimal level of monitoring is found by choosing δ so that it maximizes $V(\delta) - ER(\delta)$.

Relationships between the exogenous measurement errors and δ are quite complicated. The only case in which we can make an unambiguous prediction is the following.

PROPOSITION 4. Assume that the manager's cost function is quadratic. Then an increase in the measurement error of short-term results (σ_1) will reduce the marginal benefits of market monitoring.

Proof. Available on request.

A more fruitful line of study is to identify factors that influence the optimal choice of δ without directly affecting measurement errors or managerial incentives. Then we can view changes in δ as exogenous and invoke the comparative static results of Sections III and IV. We shall give some examples of this below. But first let us consider the situation on a more abstract level.

Let $G(\delta, \tau)$ be a function measuring the net benefits from δ that are independent of market monitoring. Here, τ is an exogenous parameter, which drives variations in the observed level of δ.

PROPOSITION 5. Assume that we can express the joint surplus, as a function of the insiders' share δ, as $V(\delta) - ER(\delta) + G(\delta, \tau)$. Further, assume that

$$G(\delta, \tau) - G(\delta', \tau) \geq G(\delta, \tau') - G(\delta', \tau') \quad \text{for every } \delta > \delta', \tau > \tau'.$$

Then the optimal insiders' share under τ is at least as large as the optimal share under τ'. The variance of the stock price will be lower under τ'. If the manager's cost function is quadratic, the manager will be offered weaker incentives (both market and nonmarket) under τ than under τ'.

Proof. The first part follows from revealed preference (see, e.g., Milgrom and Roberts 1990). The second part follows from propositions 2 and 3. Q.E.D.

The proposition provides sufficient conditions for viewing observed changes in δ as driven by factors exogenous to our monitoring model.

VI. Control Rights and δ

There are often direct benefits from being able to control the decisions of the firm, for instance to avoid problems of holdup as discussed in Klein, Crawford, and Alchian (1978), Williamson (1985), and Grossman and Hart (1986). To illustrate how such benefits can be introduced in a way that satisfies the exogeneity conditions required for proposition 5, consider the following simple example.

Suppose that the firm in question, called firm S, can sell one unit

of a good to another firm, firm B. Firm S has first- and second-period profits $\pi_1 = e_1 + \epsilon_1$ and $\pi_2 = e_2 + \theta + \epsilon_2 + t$, where t is the price paid by B to S for the good produced by S. The cost of production is zero. Assume that the transaction price t cannot be agreed on beforehand, say because it is impossible to specify requisite quality. The buyer makes a (private) reliance investment ex ante in the amount $x^2/2$, which yields a benefit τx if the good is delivered. Under separate ownership, t is determined through bargaining, after the buyer has made the investment. If ex post gains are split evenly, the agreed-on price will be $t = \tau x - t = \tau x/2$. In a Nash equilibrium, the buyer will choose $x = \tau/2$, resulting in a price $t = \tau^2/4$ and a total surplus $3\tau^2/8$. By contrast, if B controls S, it can order S to supply. This leads to an optimal investment level $x = \tau$ and a total surplus of $\tau^2/2 > 3\tau^2/8$.

Now, while t depends on the control structure, it does so deterministically. Therefore, *for a given* δ (including B's share in S), the optimal incentive scheme and the amount of market monitoring in S are identical under separate ownership and under B control.[18] In other words, the market monitoring implications of δ are independent of the control implications of δ. An optimal δ is determined by maximizing the sum $V(\delta) - ER(\delta) + G(\delta, \tau)$, where $G(\delta, \tau) = 0$ if $\delta < \frac{1}{2}$ and $G(\delta, \tau) = \tau^2/8$ if $\delta \geq \frac{1}{2}$. The function G satisfies the conditions in proposition 5.[19]

Control considerations may lead to vertical integration or just a larger inside share. If the stock is still traded, we would expect it to exhibit lower liquidity, provide weaker performance information, and lead management to have lower-powered incentive schemes. While Grossman and Hart (1986) identify the cost of integration with the subordinate's reluctance to undertake relationship-specific investments, we have demonstrated that monitoring problems can be an alternative cost of vertical integration.

One question that this discussion leaves open is why the firm could not have the best of both worlds: efficient market monitoring as well as the benefits of control. One way in which this might be accom-

[18] We assume here that B is not publicly traded. If it is publicly traded, its stock price contains some information about S's performance, and the analysis must be amended slightly: B's manager's incentive scheme is then contingent on the two stock prices. But, typically, S's stock price is a very garbled measure of B's performance, and the same qualitative results obtain.

[19] This formulation assumes that B receives no investment benefits from owning less than half of A's shares ($\delta < \frac{1}{2}$), but it receives full investment benefits from owning more than half of the shares. While extreme, this assumption can in fact be rationalized using an alternating offers bargaining model. For different bargaining processes, we would expect that an increase in δ would raise the buyer's incentive to invest even if $\delta < \frac{1}{2}$. Yet, a discontinuity at $\delta = \frac{1}{2}$ will remain, if a majority shareholder can impose trade at a price equal to marginal cost.

plished is to issue two classes of shares. The subordinate class (with few votes) would be widely distributed in order to encourage monitoring of performance, and the regular shares would be closely held for control. Grossman and Hart (1988) and Harris and Raviv (1988) have reasoned against dual shares on grounds that it imperils the efficient transfer of control. Another possible drawback is that investors will show less interest in subordinated shares, reducing their liquidity. Nevertheless, dual shares in some circumstances may be desirable for the reasons described here.

VII. Large Shareholders, Inside Monitoring, and Takeovers

Giving managers stock and encouraging market monitoring of the firm's value is only one of three complementary methods to affect managerial incentives. The second method, also analyzed in this paper, is to base rewards on accounting data. The third method is to have shareholders intervene more directly in the operation of the firm, either as board members or as potential raiders. In this section we briefly discuss these alternative modes of incentive control, which have received much attention in the recent literature.[20]

In our model the speculator's private information is simply a prediction of the future value of the firm. Such *speculative* information is useful only for trading purposes. Alternatively, we could imagine that the information collected by the speculator is *strategic*. We define strategic information as information that indicates a better course of action for the firm but is useless unless acted on. For instance, information about the value of a merger would typically be strategic. Even though information rarely is purely speculative or purely strategic, it is useful to distinguish between the two, since the returns from investing in either type appear to be related to δ in opposite ways. We have shown that investment in speculative information is encouraged by a low δ. Here we shall review reasons why a high δ is conducive to investment in strategic information.

First consider takeovers. Grossman and Hart (1980) pointed out that there may be free-rider problems associated with taking over a firm in order to implement an improvement in its operations or to take advantage of synergies between firms. By hanging on to their shares, small investors can receive the same benefits as the raider.[21]

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[20] Since π_2 is exogenous except for the manager's choice of e_2, there are no returns from direct intervention in our model.

[21] This, of course, is not true if bids can be two-tiered. Grossman and Hart (1980) discuss optimal dilution rights. It should also be noted that free-riding cuts two ways. Minority shareholders must organize to seek redress. The Grossman-Hart argument is more relevant in the United States than in the United Kingdom.

If the raider is small too, there is no incentive to collect information. A resolution, suggested by Shleifer and Vishny (1986), is to have a large (inside) shareholder, who will gain from the takeover by making money on the initial fraction of his shares. If we think of the large shareholder as an insider, then this would be an argument in favor of a high δ.

We give a simple example to show how large insiders' concerns may be incorporated into our model. Consider a firm with first- and second-period profits:

$$\pi_1 = e_1 + \epsilon_1,$$

$$\pi_2 = e_2 + \theta + \epsilon_2 + \tau.$$

The difference from our previous specification is the additive increment τ to the liquidation value of the firm. This increment can be thought of as an improvement. Assume that the improvement is brought about if and only if some party invests a noncontractible amount $I < \tau$ in information relevant for identifying how the benefit τ can be achieved. If no one invests at least I, assume that there is no improvement. For simplicity, allow small shareholders the benefit of complete free-riding so that the only way to induce anybody to invest I is to have this party own at least $\delta_0 \equiv I/\tau$ shares.

Suppose now that the optimal insiders' share δ^* in the absence of potential improvements (i.e., $\tau < I$) is less than δ_0. The firm then faces a trade-off between forgoing the improvement (set $\delta = \delta^*$) and reducing market liquidity (set $\delta = \delta_0$). The choice of having a big insider or not depends on the value of information brought by this insider ($\tau - I$). The value is exogenous to the rest of the model, and proposition 5 can be applied. (In this case, $G(\delta, \tau) = 0$ if $\delta < I/\tau$, and $G(\delta, \tau) = \tau - I$ if $\delta \geq I/\tau$.)

A distinct, but closely related, argument for having a large shareholder is the following. Suppose that the potential raider (who collects the information) is small, but that there is some other large shareholder. Take the extreme case in which this shareholder owns more than 50 percent of the firm and hence has control. Now free-riding is much less of a problem: the raider can make a take-it-or-leave-it offer for the current value of the firm and expect the majority shareholder to tender, since without tendering there will be no takeover. This intuition extends to cases in which no one owns more than 50 percent of the shares but ownership is unevenly distributed.[22] The raider can rely on large shareholders to tender because their shares

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[22] See Holmström and Nalebuff (1992) for a model with uneven shareholdings, in which the raider can appropriate up to 50 percent of the increase in firm value without initially holding any shares.

are more critical for success. This allows the raider to bid less than the posttakeover value of the firm without diminishing the prospects for success. The general point here is that bargaining with many owners is typically more costly than bargaining with a few. Indeed, despite all the attention paid to hostile takeovers, the bulk of control transfers occur through friendly deals in which one side has control over the traded entity.

The example above shows that when strategic information relates to improvements in the operation of the firm, but not to the performance of the manager, there is no problem in incorporating strategic information acquisition into our model.[23] On the other hand, if strategic information concerns the ability of management, there may be more complicated interactions. For instance, a manager who is conscious of being evaluated by the market will typically try to influence market perceptions; in other words, market evaluation alone will act as an implicit incentive device.[24] The strength of the implicit incentive will depend on the insiders' share δ, since that in turn will affect the likely outcome of a takeover or proxy fight. An optimal explicit incentive scheme would have to take this into account.

VIII. Market Monitoring and the Size of the Stock Exchange

Our analysis so far has assumed that all shares sold to the public are bought by liquidity traders and that the other shares are owned by long-term traders. In this section we shall briefly consider what happens if, in addition to liquidity traders (short-term investors), there are long-term investors in the public market at date 0. By definition, long-term investors can hold on to their shares to the end (just like the insiders in our previous model). All investors can invest their money either in shares of the firms that go public or in risk-free bonds.

Since short-term investors lose money (in expectation) to the speculator but long-term investors do not, shares are less valuable to short-term investors than to long-term investors. Therefore, if there is enough long-term capital, long-term investors will buy up all the pub-

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[23] This includes the important, but often overlooked, case of information acquisition by board members for the simple purpose of helping management run the firm. The literature on takeovers often gives the impression that boards and managements are accomplices in a conspiracy. A cooperative board is viewed as a management puppet (see Mace 1971). A more balanced view must recognize that an adversarial relationship hinders cooperation and therefore will rarely be shown openly.

[24] The literature on takeovers has paid surprisingly little attention to the incentive properties of takeover threats. For exceptions, see Laffont and Tirole (1988), Scharfstein (1988), and Stein (1988).

licly offered shares and short-term investors will invest only in bonds. This will lead to an equilibrium in which no shares are retraded at date 1. Since the date 1 market will then be totally illiquid, the speculator cannot make any money on his private information and, consequently, will not collect any information. As a result, the interim market cannot function as a monitor of managerial performance. This may well be what we observe in poorly developed stock markets in which liquidity is low.

On the other hand, if there is a shortage of long-term capital relative to the number of firms that wish to go public, we can have an equilibrium in which all long-term capital and some short-term capital are invested in shares, with the balance of short-term capital invested in risk-free bonds. We proceed to describe such an equilibrium, which offers a reinterpretation of our earlier analysis. As a by-product of this analysis, we shall see that the size of the stock market is related to the amount of long-term capital, since all firms will not wish to go public.

The model is as follows. There is a continuum of identical firms with the technology described in Section II. At date 0, all firms are closely held and must decide whether to remain closely held or to go public. A firm that stays private earns π^c. A firm that goes public issues one share, which is divided among the buyers. Price setting for this perfectly divisible share will be described shortly. The firm goes public if the entire share is sold.

We assume that the profits π^c earned by a privately held firm exceed the profits earned by a publicly traded firm in which all owners are long-term investors; that is, $\pi^c > V(1) - ER(1) = V(1)$ (since no speculator will appear, $ER(1) = 0$). This is a natural assumption because it costs money to take a firm public. Also, there could be private benefits to keeping the firm closely held, as in family firms. On the other hand, we shall assume that it is socially desirable to have some firms go public; that is, the value of market monitoring is such that, for some values $\delta > 0$, $V(\delta) - ER(\delta) > \pi^c$. We shall also make the following assumption (see n. 25 for its rationale):

$$\pi^c \geq V(\delta) - \frac{ER(\delta)}{1 - \delta} \quad \text{for all } \delta. \tag{33}$$

There are two types of public investors at date 0: long-term investors, who live until period 2, and short-term (or liquidity) investors, who die at the end of period 1 with some probability. If δ is the fraction of a firm's share held by long-term investors, the variance of liquidity trading, normalized around its mean, is proportional to $(1 - \delta)^2$ (i.e., there are aggregate shocks in the death variables). Short-term investors sell their stock if they learn at date 1 that they

will die; else they hold on to their shares until date 2, when the firm is liquidated. All investors are risk neutral and have utility equal to the sum of their consumptions in the two periods. There is a continuum of investors, a fraction l of which are long-term. We shall later assume that l is small enough so that some firms do not go public.

Each date 0 investor has \$1.00 to invest. He can either invest it in a riskless bond that yields \$1.00 at date 1 or buy shares in a public corporation. As in the rest of the paper, new investors enter at date 1. Whether they are long-term or short-term is irrelevant because the firms are liquidated in period 2. We also assume that one speculator per publicly held firm appears (as before, we could allow for an arbitrary number of speculators). Finally, we need to specify what the initial owners of firms will do with the money they receive from a public offering. It is simplest to assume that these owners behave like liquidity traders so that the amount of short-term capital is unaffected by a public issue.

We begin by describing an equilibrium in which firms can perfectly price-discriminate between long-term and short-term investors, charging them prices p_{LT} and p_{ST} (per 100 percent), respectively. Of course, firms are unlikely, for informational reasons (as well as legal reasons), to tell long-term and short-term investors apart. However, note 25 shows that firms can achieve the same outcome as under perfect price discrimination by offering a menu of corporate securities.

Consider the following equilibrium behavior. A fraction m^* of firms go public and a fraction $(1 - m^*)$ remain closely held. All firms that go public offer the same share prices p_{LT}^* and p_{ST}^* to the two investor types. Long-term investors buy shares only. Short-term investors buy both shares and bonds; the proportion is determined so that in each publicly held firm the fraction of long-term investors equals δ^*. An equilibrium is thus characterized by the tuple $(\delta^*, m^*, p_{LT}^*, p_{ST}^*)$.

There are four equilibrium conditions. The first condition requires that short-term investors be indifferent between buying bonds and buying shares since they buy both. Since short-term investors bear the entire cost of market monitoring $(ER(\delta^*))$ and bonds earn zero interest, this implies that

$$p_{ST}^* = V(\delta^*) - \frac{ER(\delta^*)}{1 - \delta^*}. \tag{34}$$

The second equilibrium condition states that firms must be indifferent about going public or not, since all firms are identical and some of them go public but others do not $(0 < m^* < 1)$. This gives

$$\pi^c = \delta^* p_{LT}^* + (1 - \delta^*) p_{ST}^*, \tag{35}$$

where the right-hand side represents the proceeds to an entrepreneur from a public offer at prices p_{ST}^* and p_{LT}^*. Equations (34) and (35) determine p_{LT}^* uniquely. Using (33), we have $p_{LT}^* \geq \pi^c \geq p_{ST}^*$; the entrepreneur makes money on long-term investors only but needs the short-term investors for liquidity. The rate of return for each dollar invested by a long-term investor is

$$r_{LT}^* \equiv \frac{V(\delta^*)}{p_{LT}^*} = \frac{\delta^* V(\delta^*)}{\pi^c - (1 - \delta^*)V(\delta^*) + ER(\delta^*)}.$$

The numerator of the right-most expression represents the total dollar return to long-term investors and the denominator their total dollar investment. Since entrepreneurs compete for long-term capital, they must choose δ so that the rate of return r_{LT}^* is the highest possible, consistent with (34) and (35). Therefore,

$$\delta^* = \operatorname{argmax} \frac{\delta V(\delta)}{\pi^c - (1 - \delta)V(\delta) + ER(\delta)}. \tag{36}$$

Since we assumed that there exists δ such that $\pi^c - V(\delta) + ER(\delta) < 0$, δ^* will be chosen so that $\pi^c - V(\delta^*) + ER(\delta^*) < 0$. This will result in a rate of return $r_{LT}^* > 1$ (i.e., $p_{LT}^* < V(\delta^*)$). Long-term investors earn a higher rate of return from shares than from bonds (which equals one) and therefore invest in shares only. The fraction of firms that go public must be large enough that all long-term capital is exhausted. Thus m^* is determined by

$$\delta^* m^* = \frac{l}{p_{LT}^*}. \tag{37}$$

The assumption that there is a shortage of long-term capital means that l is small enough that m^* as defined in (37) is less than one.

The equilibrium $(\delta^*, m^*, p_{LT}^*, p_{ST}^*)$ is uniquely determined by the four conditions (34)–(37). It is readily checked that no deviation is profitable; according to (36), a firm cannot offer the long-term investor a better return without making a loss.[25]

[25] Let us show that this equilibrium can be supported with a menu of securities, even if firms cannot directly tell the two types of investors apart. The menu consists of two securities: *Pure equity:* At price p_{LT} (per 100 percent), investors can buy one unit of equity (a share). *Mixed equity and debt:* At price p_{ST} (per 100 percent), investors can buy a composite security that consists of one unit of equity (a share) and one unit of a bond with face value b to be paid out at date 1. This menu segments the market because long-term investors have a stronger preference for pure equity than short-term investors. Let firms offer pure equity in the amount δ^* at price p_{LT}^{**} (per 100 percent) and $1 - \delta^*$ of mixed shares at price $p_{ST}^{**} = p_{ST}^* + b$ (per 100 percent), where δ^*, p_{LT}^*, and p_{ST}^* are defined as above. The net returns to the various parties are the same as in the earlier described equilibrium. The net return to short-term investors is $V(\delta^*) - [ER(\delta^*)/(1 - \delta^*)] + b - p_{ST}^{**} = 0$, causing them to break even as before. The net

PROPOSITION 6. Assume that long-term investors are in short supply (m^*, as defined in [37], is less than one). The equilibrium allocation is the same whether the firms can perfectly discriminate between long- and short-term investors or not:

i) A fraction m^* of firms go public. This fraction increases with the fraction of long-term investors in the population.

ii) All long-term investors buy pure equity. Short-term investors allocate their funds between shares and bonds. The equilibrium fraction of long-term owners of firms, δ^*, maximizes the rate of return on a dollar of long-term capital invested in a public firm: $\delta V(\delta)/[\pi^c - (1 - \delta)V(\delta) + ER(\delta)]$.

Long-term capital earns a premium because it is in short supply. As we noted before, $r^*_{LT} > 1$, whereas the return on short-term capital is $r^*_{ST} = 1$ (the return on a bond). If these rates of return are taken as market determined, the entrepreneur chooses δ to maximize the proceeds from the issue of shares. Therefore, as an alternative to (36), we can write

$$\delta^* = \operatorname{argmax} \frac{\delta V(\delta)}{r^*_{LT}} + (1 - \delta)V(\delta) - ER(\delta). \tag{38}$$

From (38) we see that if $r^*_{LT} = 1$, we would get the same choice of δ as in Section V.

We close this section with a few additional remarks.

Remark 1. Subsidiaries are less likely to be publicly traded.—Section VI suggested that vertical integration (or majority control by a single firm) lowers the value of market monitoring, because of reduced liquidity. When different securities have to compete for scarce capital, such a reduction in value may cause a firm to withdraw the stock from public trading altogether. This can be illustrated with the model sketched above. Suppose that some of the firms (a fraction smaller than $1 - m^*$) enjoy synergies from being subsidiaries of some other firms (external to the model). Suppose further that $\delta^* < \frac{1}{2}$, so that majority control precludes a δ choice that maximizes the long-term investors' return (in [36]). In this case, all subsidiaries will form, but no subsidiary shares will be traded on the market. Since the net

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return to long-term investors is unaltered since they purchase exactly the same security as before. Finally, the entrepreneur receives $\delta^* p^*_{LT} + (1 - \delta^*)(p^{**}_{ST} - b) = \pi^c$, since the buyers have the same returns as before. One can check that $p^*_{LT} \geq p^*_{ST}$ (which results from [33] and [35]) implies that short-term investors prefer to subscribe to the composite security issue. One can also check that long-term investors prefer to subscribe to the pure equity issue. Finally, an entrepreneur cannot do better than perfectly price-discriminate, so the allocation above must in fact be an equilibrium when the entrepreneur can issue different kinds of securities.

value of market monitoring is zero even for firms that choose δ optimally, the net value must be negative for firms with a suboptimal choice of δ.

This extreme result occurs because firms are identical (except for synergy benefits). The result would be less sharp if firms differed in size or technology, but the basic logic would be unaltered.

Remark 2. Macroeconomic activity and the size of the stock exchange.—Part i of proposition 6 suggests a potential link between the size of the stock market and the level of economic activity. When economic difficulties reduce the amount of long-term capital (as appears to be the case in much of Europe today), fewer firms will wish to go public, and some will wish to delist their shares. While tentative, this connection deserves further study.

Remark 3. Liquidity, bid-ask spread, and firm value.[26]—Our model can help in interpreting some of the empirical facts discussed by Amihud and Mendelson (1986a, 1986b). They find that stocks with higher bid-ask spreads are held by investors with longer holding periods. This is consistent with the adverse selection logic in Kyle's (1985) model, on which our analysis is based. The theoretical model underlying Amihud and Mendelson's empirical work assumes that returns are independent of the firm's clientele and shows that each stock is held by a homogeneous clientele. In contrast, the theory developed in this section predicts that returns depend on the composition of the clientele and that each stock is held by a heterogeneous clientele in equilibrium.

One of the empirical puzzles in Amihud and Mendelson (1986b) deserves a comment. They observe that the empirical relationship between returns and bid-ask spreads implies (theoretically) a much higher trading frequency than what is actually observed. Our model offers a potential resolution. The bid-ask spread (i.e., the price discount in [34]) is determined by the trading frequency of liquidity traders alone. Long-term traders (more generally, those who trade less frequently) do not influence the price discount (since they enjoy rents). Thus the average trading frequency is typically much lower than the trading frequency of those who determine the bid-ask spread. A theoretical estimate based on a model with a single clientele will have a significant upward bias if the actual clientele is heterogeneous.

Remark 4. Other factors affecting liquidity.—We have focused exclusively on ownership structure as a determinant of liquidity. There are many other factors that influence liquidity: transaction costs (taxes and administrative fees), regulatory rules (Röell 1987), the choice

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[26] This remark and the next build on comments provided by Ailsa Röell.

between auction and dealership markets (Pagano and Röell 1990), and so on. In most cases, reduced liquidity will have the same consequence: going public will be less desirable because the value of market monitoring has gone down. Consider, for instance, an increase in the stamp duty. This cost will not influence the frequency of liquidity trading since it is exogenous in our model, but it will reduce the amount of speculative trading and hence information collection by the speculator. All the costs are ultimately paid by the firm, making market monitoring less desirable.

IX. Concluding Remark

Like any successful institution, the stock market serves several purposes, many of them unforeseen at the time the institution was created. There is little doubt that the stock market was set up for other reasons than managerial monitoring; in particular, risk sharing and acquisition of capital were major benefits (see, e.g., Rosenberg and Birdzell 1985). But it seems equally clear that the stock market today performs an important role as a monitor of management, both directly by assessing past contributions to value and indirectly as a market for corporate control.

   Some would argue that the stock market is no better informed about managerial performance than the board of directors. Stocks are volatile and are influenced by many factors beyond the control of management, whereas the board can observe management closely, taking into account the circumstances under which a given level of performance was obtained. So would it not be better to let the board be the sole judge of how well the manager has performed?

   This kind of reasoning overlooks the most significant virtue of stock prices—their integrity. The board of a company may be able to assess the manager's performance more accurately than the stock market.[27] The problem is that this kind of subjective information is not readily translated into compensation decisions. It is difficult for a board to punish a chief executive officer (short of firing him), because directors also need to cooperate with management along a number of dimensions. Stock prices are uniquely suited for compensation purposes, not so much because they are accurate, but because they are objective, third-party assessments. This, we believe, is why stock prices have come to play such a central role in managerial incentives and

[27] One may well question this claim. The board often has limited financial incentives to acquire information. Also, the board sometimes colludes with management (Mace 1971), even though the importance of collusion is likely to be exaggerated in view of the directors' need to cooperate with management.

why market monitoring is an important consideration when decisions are being made on changes in insiders' control.

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