# Information, Investment Horizon, and Price Reactions

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## Abstract

This paper studies the dynamic investment policies of firms under asymmetric information. Managers make decisions to maximize the wealth of *existing* shareholders. In equilibrium, the superior firms invest "myopically," choosing intrinsically lower-valued projects that produce "early" cash flows. The inferior firms follow the socially preferred rule of investing in intrinsically higher-valued projects that produce "late" cash flows. In addition to explaining investment myopia, the model generates numerous predictions regarding announcement effects of equity issues and attempts by firms to stockpile cash, firms' preferences for limits on mandatory disclosure rules, and the effects of managerial entrenchment motives.

## I. Introduction

Private information may cause the stock price of a firm to diverge from its manager's assessment of value, so that some component of the firm's (fundamental) value is not reflected in its price; Brennan (1990) calls this component a "latent asset." It is well recognized that latent assets encourage managers to engage in wealth-expropriating maneuvers such as selectively-timed corporate stock issuances or repurchases. Investors, although relatively uninformed, are rational. Thus, when they observe corporate actions that have wealth transfer potential, they revise their beliefs about the firm's value. The market price response to these corporate actions is then conditioned on these *revised* beliefs. Many authors, most notably Myers and Majluf (1984) (henceforth, MM), have pointed out that this process may be distortionary. In MM the distortion is extreme; the firm may forsake a positive NPV project rather than finance that project by issuing unfavorably priced equity. Less serious distortions appear in subsequent papers,[1] but they are present nonetheless.

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[1]For example, see Krasker (1986), Ambarish, John, and Williams (1987), Besanko and Thakor (1987), Giammarino and Lewis (1989), Ofer and Thakor (1987), and Raymar (1989).

In this paper, I study the impact of information-constrained stock valuation on the investment choice of the firm and, in particular, the price reactions to investment choices. I assume that the decisionmaker's objective is to maximize the wealth of the firm's *existing* shareholders. The focus is on the *nature* of investments chosen in a dynamic setting. The intended contributions are principally threefold. My main objective is to explore how market prices react to various types of investment decisions of firms.[2] The principal results here are as follows. Price reactions to capital expenditures expected to yield relatively more distant cash flows are negative, whereas price reactions to capital expenditures expected to yield relatively early cash flows are positive. The price reaction to cash stockpiling is negative. The absolute magnitude of the negative price reaction to an equity issue announcement is increasing in the frequency of *prior* equity issues.

A second intended contribution of this paper is to the investment myopia literature. One strand of this literature shows that managers may have personal incentives to make myopic investment choices that the shareholders do not prefer.[3] In contrast, I assume that all decisions are made in the best interests of existing shareholders. A second strand of this literature shows that myopic investment may be used as a dissipative signal of the firm's unobserved type because of a concern with the current stock price.[4] By contrast, the myopia characterized here is unrelated to any concern with the current stock price, and signalling is not an issue. Rather, managers invest myopically to limit the amount of *future* external financing they must raise at unfavorable prices. Even if no signal about the firm's investment choice in the first period is available to the market, the intrinsically higher-valued firm will invest myopically. A third strand of the literature is represented by Thakor (1990) in which hidden resource commitment leads to moral hazard in a *symmetric* precontract information environment and results in investment myopia. However, since that paper focuses on capital budgeting, it does not deal with price reactions to investment choices and cash accumulation decisions.

Third, I derive new implications of informationally-induced external financing costs for firms' preferences for mandated information disclosures and the interaction between managerial entrenchment motives and project choices. *All* firms may prefer to limit disclosures because noise is desirable. Moreover, managerial entrenchment motives reinforce investment myopia.

There are six additional sections. Section II reviews relevant empirical work. Section III presents the model. Section IV analyzes the full information outcome and defines the equilibrium under asymmetric information. Section V analyzes the equilibrium under asymmetric information. Section VI considers extensions of the model. Section VII concludes.

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[2]There has been limited work done in finance on real investment choices of firms. See McDonald and Siegel (1986) for an analysis of real investment options, and Hirshleifer and Suh (1992) for project choice distortions.

[3]See Narayanan (1985), Holmstrom and Ricart i Costa (1986), and Campbell and Marino (1988). In Hirshleifer and Thakor (1992), the investment distortion is a preoccupation with safety. In Boot (1992), the investment distortion is inefficient divestiture policy. Hirshleifer and Chordia (1991) analyze the manager's project choice when he wishes to influence the timing of resolution of uncertainty.

[4]See, for example, Brennan (1990) and Stein (1988). A somewhat different approach is taken in Shleifer and Vishny (1990) who assume that long-term projects stay mispriced longer than short-term projects and show that firms may select short-term projects.

# II. Empirical Content of Model and Relationship to Empirical Evidence

## A. Empirical Evidence

The MM prediction that equity offerings should elicit negative stock price reactions has considerable empirical support. Masulis and Korwar (1986) find statistically significant price effects following seasoned stock offering announcements. Smith (1986) notes that the riskier the security being issued, the larger is the absolute value of the negative change in the stock price. Mikkelson and Partch (1986) find that managers issue common stock when they believe it is overpriced. Asquith and Mullins (1986) encounter an equity-offering-announcement-day price reduction that is significantly and negatively related to the size of the (seasoned) equity offering. Barclay and Litzenberger (1988) use intraday price data and find a negative price reaction to equity issuance. Lease, Masulis, Page, and Young (1989) document a negative price reaction to equity announcements and an increase in the bid-ask spread for larger equity issues. Karpoff and Lee (1989) uncover insider selling of equity prior to the announcement of new stock issues, suggesting that managers issue equity when they believe it is overpriced.

A dynamic version of the MM model appears in Lucas and McDonald (1990). They show that equity issues on average are preceded by an abnormal runup in the market, and price declines follow equity issue announcements. It is conjectured that accumulating slack may not be an efficient way for the firm to reduce its cost of financing. Among other things, the analysis in this paper formally supports that conjecture.

## B. Empirical Content of the Model

I find some results consistent with these stylized facts, as well as others that are yet to be confronted with the data. In my model, the manager chooses between a higher-social-surplus project with payoffs in the more distant future (a "late bloomer") and a lower-valued project with earlier payoffs (an "early winner"). My results are as follows. 1) The price reaction to an equity issue at the beginning of the first period is negative if the market receives a signal that the firm has selected a late bloomer. Examples of late bloomers are investments in R&D, new product or market development, human resources development, etc.[5] On the other hand, the price reaction to an equity issue at the beginning of the first period is positive if the

[5] An SEC study (1985) found that the 20-day excess return for an announcement of an increased level of R&D was 1.8 percent, suggesting that the market placed a positive value on such announcements. Note, however, that the prediction in my model is a consequence of assuming that investment by the firm at $t = 0$ is *fully anticipated* and the only surprise is about the *type* of investment undertaken by the firm. If one were to add to the model the possibility of a third type of firm, namely one that has *no* investment opportunity at $t = 0$, then the price reaction to *any* investment announcement may be positive. In that case, my model would predict that short-term investments will elicit a larger positive price reaction than long-term investments.

There is indirect evidence that suggests that this prediction deserves further study. Hall (1988) finds that acquisitions by private and foreign firms in the domestic market were mainly of firms that were relatively less R&D intensive. If we assume that acquirers are able to learn the privately known values of targets at a cost, then we have the result that the undervalued firms that spend relatively less on R&D are acquisition targets.

market receives a signal that the firm has selected an early winner. McConnell and Muscarella (1985) and Masulis and Korwar (1986) provide evidence of positive price reactions to equity issues aimed at financing capital expenditures. However, these papers do not distinguish between projects the way this paper does. I am not aware of any paper that specifically tests for differential price reactions to capital expenditure announcements that differ in their intertemporal cash flow resolution profiles. 2) If the firm has a choice between financing a project out of retained earnings or through an equity issue, the market reaction to an equity announcement is always negative. 3) If a firm attempts to stockpile cash by raising more financing than is needed for its first-period investment, the market reaction is always negative as long as there is asymmetric information about firm value at the time that financing is raised. Thus, cash stockpiling is suboptimal under asymmetric information. It may be optimal under symmetric information if the cost of storage is low enough. 4) For two successive equity issues, the market *always* reacts negatively to the second equity issue announcement. For empirical testing, this indicates a positive relationship between the absolute magnitude of the negative price reaction to an equity issue announcement and the *frequency* of equity issues in the period preceding that announcement. 5) A ceteris paribus increase in the profitability of the second-period project for the intrinsically higher-valued firm has an ambiguous effect on the percentage price decline in response to a second-period equity issue. A ceteris paribus increase in the profitability of the second-period project for the intrinsically lower-valued firm *decreases* the percentage price decline in response to a second-period equity issue. 6) Some firms may prefer sufficient noise in the market's inference of their project choices. If a greater degree of mandatory disclosure (accompanying a public equity issue) is interpreted as leading to lesser noise in market inference, then even the initially undervalued firms—which have a priori the most to gain from less noise—may prefer limits on mandated disclosure. 7) A managerial entrenchment motive strengthens the desire of the intrinsically higher-valued firm to invest in the early winner, so that takeovers may exacerbate investment myopia.

## III. The Model

### A. Endowments, Preferences, Time Horizon, and Investment Choices

The economy has two time periods, the first from $t = 0$ to $t = 1$, and the second from $t = 1$ to $t = 2$. All agents are risk neutral and all firms are unlevered. Firms start out at $t = 0$ with no internal liquidity. They may have assets in place, but since these play no role in the analysis, I assume they are worthless. Each firm has an existing group of initial shareholders. At $t = 0$, each firm can choose one from among two indivisible and mutually exclusive *first-period* projects. One project is an "early winner" (EW), that yields a single random payoff at $t = 1$. The other project is a "late bloomer" (LB) that yields a single random payoff at $t = 2$. At $t = 1$, each firm can also invest in an indivisible *second-period* project that produces a single random payoff at $t = 2$. A fixed investment of $I > 0$ is required to activate either of the first-period projects or the second-period project. For now, the firm can raise no more than $\$I$ at any point in time; the implications of raising more than $\$I$ are examined later. Due to personal endowment constraints or other factors, the firm's initial shareholders cannot exclusively provide the additional capital the firm may need at $t = 0$ and $t = 1$.[6] This must be raised through public equity issues. For simplicity, the riskless (discount) rate is zero.

## B. Information Structure and Project Characteristics

At $t = 0$, there are two possible types of observationally indistinguishable firms: "good" and "bad." We will denote a firm's type by $i \in \{g, b\}$. At $t = 0$ if the firm invests in its EW, then at $t = 1$ it yields a cash flow of $Y > 0$ with probability (w.p.) $p_i \in (0, 1)$ and 0 w.p. $1 - p_i$.[7] If the firm invests in its LB at $t = 0$, then it receives at $t = 2$ a cash flow of $Z > 0$ w.p. $r_i \in (0, 1)$ and 0 w.p. $1 - r_i$. The second-period project yields at $t = 2$ a cash flow of $R > 0$ w.p. $q_i \in (0, 1)$ and 0 w.p. $1 - q_i$. Let $\tau_g > \tau_b \forall \tau \in \{p, r, q\}$, so that the good firm has a higher probability than the bad firm of realizing any positive cash flow. Moreover, for both types of firms, every project has positive net present value (NPV). That is, $p_b Y - I > 0$ and $q_b R - I > 0$. For both firms, LB is a better project than EW under symmetric information. That is, $r_i Z > p_i Y \ \forall \ i \in \{g, b\}$. Moreover, even if the good firm invests in the EW project and this project fails at $t = 1$, its value is higher at $t = 1$ than the value of the bad firm investing in the LB project, i.e., $q_g R > r_b Z + q_b R$.[8] Although neither the firm's existing nor its prospective shareholders know its type, it is common knowledge that all uninformed agents have the prior belief that there is a probability $\gamma \in (0, 1)$ that a firm is good and a probability $1 - \gamma$ that it is bad. All of the characteristics of the two types of firms described above are also common knowledge. Each firm is managed by a central decisionmaker (a manager) who knows his firm's type. A positive cash flow realization will be referred to as "project success" and a zero cash flow realization will be referred to as "project failure."

The market can observe whether a positive cash flow is realized at any point in time.[9] Also, although the market can observe whether or not an investment was made, a firm's project choice at any time is unobservable to all but that firm's manager. The market receives a noisy but informative signal, $s$, of the manager's first-period project choice. This signal has the following probability distribution: $\Pr(s = j | \text{project } j \text{ actually selected}) = \Pi \in (0.5, 1)$, where $j$ is either EW or LB.

[6]This assumption is standard, e.g., Giammarino and Lewis (1989) and MM (1984). It breaks the equivalence between internal and external financing, and captures one distinction between privately and publicly owned firms. In the former, all new capital infusions come from a well-defined group of *existing* owners (unless *they* choose to expand their group), whereas in the latter, the ownership group is in a state of flux. In the terminology of MM, I am assuming that managers maximize the welfare of current shareholders who are "passive." Dybvig and Zender (1991) have recently shown that if the portfolio rebalancing decisions of shareholders are explicitly accommodated in the determination of the wage contract used to motivate the manager, then the manager in their model attaches no weight to the current stock price.

[7]I assume that at $t = 1$ the market cannot tell the difference between a project that does not mature then and a project that matures then but yields a zero cash flow.

[8]In the numerical example considered in the proof of Proposition 5, it is verified that the set of exogenous parameter values for which all of these parametric restrictions are met is nonempty.

[9]However, I assume that (ex post) cash-flow-contingent contracts of the Bhattacharya (1980) type cannot be written. A simple way to preclude such contracts in this model is to assume that the values of the positive cash flows of every project are identical; this does not materially affect the analysis.

Across a group of firms that have chosen the same project, signals are independently and identically distributed random variables. No signals are available for the firm's second-period project choice; they are unnecessary since investment is observable and the firm has no choice of project type.

## C. Objective of the Firm and Market Structure

At any given point in time, the manager makes decisions to maximize the expected wealth of those who are the firm's shareholders at *that* point in time.[10] Further, the firm retains all cash flows—except those needed for investment—until $t = 2$. That is, a liquidating dividend is paid at $t = 2$, but no dividends are paid at $t = 0$ or $t = 1$.[11] The capital market is competitive and informationally-constrained efficient. Thus, each firm is priced at its expected value to investors, conditional on their information sets. I also assume that the firm's shareholders plan to hold on to their ownership in the firm until $t = 2$. That is, they "care" only about the firm's terminal payoffs and not about its interim stock price, except to the extent that it impinges on their share of the terminal payoff. This is true for the claimholders at $t = 0$ as well as those at $t = 1$.

## D. Ordering of Moves in Sequential Game

This is an incomplete information game in extensive form in which the informed agent (the firm's manager) moves first at each point in time by i) deciding whether to invest or not, ii) selecting a project, conditional on having decided to invest, and iii) deciding whether to fund the investment with an external equity issue or with internally-generated funds, if these are available. Having observed whatever possible about the manager's move, the uninformed agent (investors in the capital market) moves next by announcing a market value for the firm. Given the fixed investment, $I$, required for the project, this market value determines how much fractional ownership initial shareholders must relinquish in order to raise $I$ through a public equity issue. The physical process of issuing equity and investing in the project follows this market value determination.[12] This process first takes place at $t = 0$ and then at $t = 1$.

[10]This is closer to the shareholder wealth maximization assumption in neoclassical finance (e.g., Fama and Miller (1972)) than the "weighted average of current and future shareholders' wealth" assumption commonly encountered in signalling models (e.g., Miller and Rock (1985)).

[11]This assumption does not affect the analysis but it does simplify the notation a bit. Of course, if one assumes that a promised dividend *must* be paid, and dividends are endowed with an appropriate signalling cost structure, the good firm may be able to distinguish itself at $t = 0$ by promising a dividend payment at $t = 1$. I assume that dividends do not have such credible (and cost-effective) information communication capability.

[12]The financial instrument by which the firm raises external funds in my model is like equity but is not exactly the same. When the initial shareholders in my model raise $\$I$ at $t = 0$, they promise those buying the firm's securities a *fixed percentage* of the firm's terminal cash flow at $t = 2$. Then at $t = 1$, if the firm seeks an additional $\$I$ in external financing, it promises another fixed percentage of the terminal cash flow at $t = 2$ to those buying its securities at $t = 1$. However, this does not alter the fraction of the terminal cash flow accruing to those who bought the firm's claims at $t = 0$, i.e., they do not suffer any dilution. The entire effect of dilution is absorbed by those who started out owning the firm at $t = 0$. Although such a specification creates an imperfect correspondence between equity and the financial instrument, it significantly simplifies the algebra in the analysis. Moreover, none of the results are qualitatively affected.

# IV. Analysis of the First-Best and Definition of Equilibrium under Asymmetric Information

## A. The First-Best Outcome

Because all NPVs are positive and the LB project is higher valued than the EW project, each firm will choose LB at $t = 0$, finance it through a public equity issue, and then raise funds externally again to finance its second-period project at $t = 1$. Thus, under full information, good as well as bad firms behave nonmyopically and invest in the socially-preferred project.

## B. Definition of Equilibrium in the Second-Best Case

I use the Banks and Sobel (1987) universal divinity refinement of the sequential equilibrium of Kreps and Wilson (1982) as part of the definition of equilibrium. Let $c(i,t)$ represent the choice made by firm $i$ at time $t$, for $i \in \{g, b\}$ and $t \in \{0, 1\}$. The market's response to $c(i,t)$ is the assignment of a market value, $V(s(c(i,t)), s(c(i,[t-1] \vee 0)), t)$, which is a function of time $t$ as well as the signal the market observes about the firm's choice. Here "$\vee$" is the "maximum" operator. Later I will use "$\wedge$" as the "minimum" operator. At $t = 0$, for $i \in \{g, b\}$ we have $c(i,0) \in \{\text{DNIAP, REFI in EW, REFI in LB}\}$,

$$s(c(i,0)) = \begin{cases} \text{no investment if } c(i,0) = \text{DNIAP}, \\ \text{Project } j \text{ w.p. } \Pi \text{ and project } j' \text{ w.p. } 1 - \Pi \\ \quad \text{if } c(i,0) = \text{REFI in } j, j' \in \{\text{EW}, \text{LB}\}, \end{cases}$$

where DNIAP means "do not invest in any project," and REFI means "raise external financing and invest." At $t = 1$, for $i \in \{g, b\}$, we have

$$c(i,1) \in \left\{ \begin{array}{l} \text{DNIAP in second period, REFI in second period,} \\ \text{invest in second-period project using internally-generated funds} \end{array} \right\}.$$

The firm can invest internally-generated funds in the second-period project only if it invested in EW in the first period and realized a positive cash flow. Moreover, $s(c(i,1)) = c(i,1)$. Note that market valuation has a memory. In setting the firm's value at $t = 1$, the market impounds *both* its observation of events at $t = 1$ as well as its recorded signal at $t = 0$.

*Definition. A universally divine equilibrium (UDE)* in the investment game is a set of beliefs, investment choices, and market valuation responses, $\Omega^* \equiv \{c^*(i,t), V^*(s(c^*(i,t)), s(c^*(i,[t-1] \vee 0)), t) \,|\, i \in \{g,b\}, t \in \{0,1\}\}$, such that the following requirements are satisfied:

i) $c^*(\hat{i},\hat{t}) \in \Omega^*$ maximizes the expected terminal wealth of firm $\hat{i}$'s shareholders assessed at time $\hat{t}$, given $\Omega^* \backslash c^*(\hat{i},\hat{t})$.

ii) $V^*(s(c^*(i,t)), s(c^*(i, t-1 \vee 0)), t)$ is the total expected value of firm $i$ at time $t$, conditional on the market's observation of $s(c^*(i,t))$ and its previously recorded observation of $s(c^*(i, t-1 \vee 0))$. Conditional on observing $s(c^*(i, t-1 \vee 0))$, the market uses Bayes' rule to update its beliefs about the firm's type when it observes $s(c^*(i,t))$.

iii) For any $c(i,t) \notin \Omega^*$, $\nexists$ any firm $i \in \{g, b\}$ that wishes to choose $c(i,t)$ in preference to its equilibrium strategy when the market's beliefs about the defecting firm's type are governed by the universal divinity criterion. That is, given an observed out-of-equilibrium move, if the set of market valuation responses to that move that would induce type $i$ firm to defect is strictly nested within the set of market valuation responses that would induce type $j$ firm to defect, then investors must assign probability zero in their beliefs that the defector is type $i$.

## C. Conjectured Equilibrium

I conjecture the following investment choices for the UDE in this game. The good firm selects EW and the bad firm selects LB at $t = 0$. At $t = 1$, the bad firm surely raises external financing for its second-period project, while the good firm does so only if its EW project fails. If the good firm's EW project succeeds, it finances its second-period project from that cash flow.

The intuition is as follows. Since signals of project choices are noisy, the market is unsure of a given firm's type at $t = 0$ even though the equilibrium is perfectly separating in project choices. Thus, conditional on received signals, the market overvalues bad firms and undervalues good firms, *relative* to their respective full information values. This mispricing persists at $t = 1$ in those cases where external financing is sought at that time. Consequently, external financing at either $t = 0$ or $t = 1$ entails a relative wealth gain for the existing shareholders of the bad firm. Since the shareholders of the bad firm would want their manager to raise external funds whenever possible, their manager's second-best project choice coincides with the unconstrained optimum of selecting LB.[13] On the other hand, the good firm's shareholders prefer to avoid external financing whenever possible. This calls for investing in EW at $t = 0$, so that there is a positive probability of using internal financing at $t = 1$. The adverse impact of external financing is thus reduced without sacrificing the incremental value contribution of the first-period project.

# V. Analysis of the UDE under Asymmetric Information

I analyze the properties of the conjectured UDE first, and then establish its existence.

## A. Preliminary Analysis of Price Reactions at $t = 0$

Throughout the rest of the paper, $s = j \in \{\text{EW}, \text{LB}\}$ will indicate the signal received by the market, and $\delta(i|s = j)$ the posterior probability assessment of the market that the firm is of type $i$, conditional on having received a signal that project $j$ was selected. Using Bayes rule, we have

$$(1) \qquad \delta\left(g|s = \text{LB}\right) \;=\; \{[1 - \Pi]\gamma\}\{[1 - \Pi]\gamma + \Pi[1 - \gamma]\}^{-1},$$

[13]Only by selecting LB at $t = 0$ can the manager guarantee that external financing will be needed at $t = 1$ with probability 1.

$$(2) \qquad \delta\left(b|s=\text{LB}\right) = 1-\delta\left(g|s=\text{LB}\right).$$

$$(3) \qquad \delta\left(g|s=\text{EW}\right) = \Pi\gamma\{\Pi\gamma+[1-\Pi][1-\gamma]\}^{-1}$$

$$(4) \qquad \delta\left(b|s=\text{EW}\right) = 1-\delta\left(g|s=\text{EW}\right).$$

Since the discount rate is zero, the total market value of the firm at any point in time is simply the expected value of its aggregate cash flow at $t = 2$. This market value depends on the market's beliefs about the firm's type. I will distinguish market value from "true economic value" by referring to the latter as the manager's assessment of his firm's aggregate expected cash flow at $t = 2$, conditional on his private knowledge of his own firm's type. Given the conjectured equilibrium strategies of firms, the true economic value of the bad firm at $t = 0$ and $t = 1$ is

$$(5) \qquad V_b^* = r_b Z + q_b R.$$

At $t = 1$, the good firm's first-period project succeeds w.p. $p_g$. The firm's type is now revealed to the market since in equilibrium only the good firm chooses a project that possibly yields a cash flow at $t = 1$. This might suggest indifference on the firm's part between financing with retained earnings and financing with external equity. But I show later that a firm that has retained earnings and yet seeks external financing will be viewed as bad by the market. Thus, the firm finances its second-period project with internal funds and its true economic value at $t = 1$ is

$$(6) \qquad \hat{\hat{V}}_g^* = q_g R + Y - I.$$

If the good firm's first-period project fails at $t = 1$, the firm must seek external financing and its true economic value is

$$(7) \qquad \hat{V}_g^* = q_g R.$$

At $t = 0$, therefore, the true economic value of the good firm is

$$(8) \qquad \begin{aligned} V_g^* &= p_g \hat{\hat{V}}_g^* + \left[1-p_g\right] \hat{V}_g^* \\ &= p_g Y + q_g R - p_g I. \end{aligned}$$

Let $V(s = j, 0)$ represent the market value of a firm at $t = 0$ when the market receives a signal $s = j \in \{\text{EW}, \text{LB}\}$. Then,[14]

$$(9) \qquad V(s=\text{LB},0) = \delta\left(g|s=\text{LB}\right) V_g^* + \left[1-\delta\left(g|s=\text{LB}\right)\right] V_b^*,$$

$$(10) \qquad V(s=\text{EW},0) = \delta\left(g|s=\text{EW}\right) V_g^* + \left[1-\delta\left(g|s=\text{EW}\right)\right] V_b^*.$$

[14]Note that the expressions listed below are *total* market values of the firm at $t = 0$ and are determined by *investors' expectations* of the firm's *fundamental* value. They are unaffected by the firm's choice of external versus internal financing except to the extent that this choice communicates information to investors and thereby influences their expectations of fundamental value. The firm's financing choice can dilute the value of current shareholders' ownership in the firm, but not the firm's *aggregate* value. Hence, even though the wealth of existing shareholders is affected by whether the firm finances internally or externally at $t = 1$, the associated dilution has no *direct* effect on the firm's aggregate fundamental value; this dilution impinges on market value only through its effect on the market's posterior beliefs.

Let $\bar{V}(j,0)$ be the expected market value of a firm assessed by its manager contemplating the selection of project $j$. Thus,

$$(11) \qquad \bar{V}(\text{LB},0) = \Pi V(s=\text{LB},0) + [1-\Pi]V(s=\text{EW},0),$$

$$(12) \qquad \bar{V}(\text{EW},0) = \Pi V(s=\text{EW},0) + [1-\Pi]V(s=\text{LB},0).$$

We now have the following result.

*Proposition 1.* The market value of the firm at $t=0$ is higher if $s=\text{EW}$ is observed than if $s=\text{LB}$ is observed. Moreover, the expected market value assessed by a firm's manager at $t=0$ is higher conditional on EW being selected than it is conditional on LB being selected.

*Proof.* Since $\Pi > 1-\Pi$, we see from (1) and (3) that $\delta(g|s=\text{EW}) > \delta(g|s=\text{LB})$. Since $V_g^* > V_b^*$, this implies that $V(s=\text{EW},0) > V(s=\text{LB},0)$. This proves the first part of the proposition. The second part follows immediately from comparing (11) and (12). □

Thus, regardless of the firm's type, its manager knows that if he selects EW he can *expect* a higher total *market value* for his firm at $t=0$ than if he selects LB. To more clearly understand price reactions at $t=0$, note that all firms have a common market value of $\bar{V}(0)$ at $t=0$ *prior* to project choices being made. Here

$$\begin{aligned}\bar{V}(0) &= V(s{=}\text{LB},0)\Pr(s{=}\text{LB})+V(s{=}\text{EW},0)\Pr(s{=}\text{EW})\\ &= V(s{=}\text{LB},0)\left\{\Pr\left(s{=}\text{LB}|i{=}g\right)\Pr(i{=}g)+\Pr\left(s{=}\text{LB}|i{=}b\right)\Pr(i{=}b)\right\}\\ &\quad +V(s{=}\text{EW},0)\left\{\Pr\left(s{=}\text{EW}|i{=}g\right)\Pr(i{=}g)+\Pr\left(s{=}\text{EW}|i{=}b\right)\Pr(i{=}b)\right\}\\ (13) \quad &= V(s{=}\text{LB},0)\{[1-\Pi]\gamma+\Pi[1-\gamma]\}+V(s{=}\text{EW},0)\{\Pi\gamma+[1-\Pi][1-\gamma]\}.\end{aligned}$$

In light of Proposition 1, (13) implies that $V(s=\text{EW},0) > \bar{V}(0) > V(s=\text{LB},0)$, which means that the market reacts positively to a signal that the firm has selected an early winner, and negatively to a signal that it has selected a late bloomer. Such price behavior has sometimes been interpreted as (inefficient) stock market "preoccupation" with current and near future earnings. In this model, however, such price reactions stem from *efficient* valuation in an informationally-constrained stock market.

## B. Price Reactions at $t = 1$

For every $i \in \{g,b\}$ and $j \in \{\text{EW},\text{LB}\}$, denote $\delta(i|s=j,F)$ as the posterior probability assessment of the market at $t=1$ that the firm's type is $i$ when $s(c(i,0)) = j$ was observed at $t=0$ and external financing is sought at $t=1$. Using Bayes rule, we have

$$\delta\left(g|s=\text{LB},F\right) = \left\{\Pr\left(s=\text{LB},F|g\right)\Pr(g)\right\} \times \left\{\Pr\left(s=\text{LB},F|g\right)\Pr(g) + \Pr\left(s=\text{LB},F|b\right)\Pr(b)\right\}^{-1}.$$

In the conjectured equilibrium, the good firm selects EW and seeks external financing only if that project does not succeed, and the bad firm selects LB and seeks external financing surely. Thus,

$$(14)\quad \delta\left(g|s{=}\text{EW},F\right) = \Pi\left[1-p_g\right]\gamma\left\{\Pi\left[1-p_g\right]\gamma+[1-\Pi][1-\gamma]\right\}^{-1},$$

$$(15)\quad \delta\left(g|s{=}\text{LB},F\right) = [1-\Pi]\left[1-p_g\right]\gamma\left\{[1-\Pi]\left[1-p_g\right]\gamma+\Pi[1-\gamma]\right\}^{-1}.$$

Let $V(s = j, F, 1)$ be the firm's market value at $t = 1$ if it seeks external financing at $t = 1$ and the market had recorded the signal $s = j \in \{\text{EW}, \text{LB}\}$ at $t = 0$. Then

$$(16)\quad V(s = \text{LB}, F, 1) = \delta\left(g|s = \text{LB}, F\right)\hat{V}_g^* + \left[1 - \delta\left(g|s = \text{LB}, F\right)\right]V_b^*,$$

$$(17)\quad V(s = \text{EW}, F, 1) = \delta\left(g|s = \text{EW}, F\right)\hat{V}_g^* + \left[1 - \delta\left(g|s = \text{EW}, F\right)\right]V_b^*.$$

We now have a price reaction predicted by the model.

*Proposition 2*. Regardless of the signal received by the market at $t = 0$, the firm experiences a decline in its market value at $t = 1$ if it announces at that time that it plans to raise external financing for its second-period project.

*Proof.* It is straightforward to verify that

$$\delta\left(g|s = \text{LB}\right) > \delta\left(g|s = \text{LB}, F, 1\right) \text{ and } \delta\left(g|s = \text{EW}\right) > \delta\left(g|s = \text{EW}, F, 1\right).$$

The proof now follows directly from the observation that $V_g^* > \hat{V}_g^*$. □

The implication is that a public equity issue will provoke a negative stock price reaction, even when the issue is aimed at financing a capital expenditure. Strictly speaking, this is true in this model for an equity issue *following* another equity issue that was also used to finance a capital outlay. In general, the larger the frequency of equity issues preceding a particular equity issue, the larger will be the absolute value of the negative stock price reaction to the latter.[15] In interpreting this result, one should be careful to note that it applies to firms that conform to the information structure of the model. Firms that do not operate extensively in asymmetric information settings would not be subject to the same forces as firms in this model. For example, there is not much shareholder-relevant private information about regulated firms like utilities, so one would expect relatively small price reactions to almost all of their corporate activities. Thus, it is not surprising that utilities have the most frequent equity issues and also the smallest price reactions.

*Proposition 3*. Regardless of the signal received at $t = 0$, a *ceteris paribus* increase in the profitability of the second-period project for the bad firm *decreases* the

[15]This result depends in part on the assumption that the first-period positive cash flow exceeds the second-period investment $I$. If the second-period investment exceeded the first-period positive cash flow, the firm would need second-period external financing even if the first-period project succeeded at $t = 1$. This external financing needed to cover the shortfall would invoke a positive price reaction. However, the positive reaction would really be in response to the positive cash flow realization rather than to the external financing itself.

percentage price decline in response to an equity issue at $t = 1$. As long as $\delta(g|s=j,F)/\delta(g|s=j) < V(s=j,F,1)/V(s=j,0)$, a ceteris paribus increase in the profitability of the second-period project for the good firm *increases* the percentage price decline in response to an equity issue at $t = 1$, for any $j \in \{\text{EW}, \text{LB}\}$.

*Proof.* The proof follows from partially differentiating $P_1 \equiv [V(s=\text{EW},0) - V(s=\text{EW},F,1) - I][V(s=\text{EW},0)]^{-1}$ and $P_2 \equiv [V(s=\text{LB},0) - V(s=\text{LB},F,1) - I]$ $[V(s=\text{LB},0]^{-1}$ with respect to the $R$ that multiplies $q_b$, holding fixed the $R$ that multiplies $q_g$. It can be seen that $\partial P_1/\partial R|_{q_gR} < 0, \partial P_2/\partial R|_{q_gR} < 0$. Then differentiate $P_1$ and $P_2$ with respect to the $R$ that multiplies $q_g$, holding fixed the $R$ that multiplies $q_b$. Now it can be seen that $\partial P_1/\partial R|_{q_bR} > 0, \partial P_2/\partial R|_{q_bR} > 0$, as long as $\delta(g|s=j,F)/\delta(g|s=j) < V(s=j,F,1)/V(s=j,0)$. □

The intuition is as follows. An increase in the relative profitability of the second-period project for the good firm widens the gap between the intrinsic values of the good and bad firms; a similar increase for the bad firm narrows this gap. Thus, any shift in investors' posterior belief at $t = 1$—caused, for example, by the announcement of second-period external financing—in the direction of a higher probability that the firm is bad will have a greater impact on the price decline at $t = 1$ if the relative profitability of the second-period project rises for the good firm,[16] and a smaller impact if it rises for the bad firm.

## C. The Overall Problem at $t = 0$

I will use the backward induction of dynamic programming to obtain the equilibrium project choice at $t = 0$. Consider the beginning of the second period. Suppose the firm is raising external financing at $t = 1$ to fund its second-period project. Let $\alpha_1^j$ represent the share of *terminal* ($t = 2$) wealth that the shareholders of the firm must surrender to those buying the firm's shares at $t = 1$, conditional on the signal $s(c(i,0)) = j \in \{\text{EW}, \text{LB}\}$ having been observed at $t = 0$. Then, competitive capital market pricing implies

(18) $$\alpha_1^{\text{LB}} V(s=\text{LB},F,1) = I,$$

(19) $$\alpha_1^{\text{EW}} V(s=\text{EW},F,1) = I.$$

Going back to the first period, consider a firm that has selected a particular project and is seeking external financing after $s(c(i,0))$ has been observed by the market. Let $\alpha_0^j$ be the share of terminal wealth the shareholders must surrender to those buying the firm's shares at $t = 0$, conditional on the signal $s(c(i,0)) = j$ having been observed. Competitive capital market pricing again implies

(20) $$\alpha_0^{\text{LB}} V(s=\text{LB},0) = I,$$

[16]The reason why we need a parametric restriction in the case in which the profitability of the good firm increases is that we are working with percentage changes. When $R$ increases for the good firm, *both* $V(s=j,0)$ and $V(s=j,F,1)$ increase. In accord with our intuition, the *difference* $V(s=j,0) - V(s=j,F,1)$ increases with $R$ because the difference between good and bad firms increases. However, it is possible for $V(s=j,F,1)/V(s=j,0)$ to increase at the same time that $V(s=j,0) - V(s=j,F,1)$ increases. Under the stated condition, however, the percentage change works in the direction indicated by intuition.

$$(21) \qquad \alpha_0^{\mathrm{EW}} V(s = \mathrm{EW}, 0) = I.$$

At $t = 0$, if the manager of the bad firm opts for LB, the expected terminal wealth accruing to the *initial* ($t = 0$) shareholders is

$$(22) \quad T^* \left(\mathrm{LB}|b\right) = \Pi \left[1 - \alpha_0^{\mathrm{LB}} - \alpha_1^{\mathrm{LB}}\right] V_b^* + [1 - \Pi] \left[1 - \alpha_0^{\mathrm{EW}} - \alpha_1^{\mathrm{EW}}\right] V_b^*.$$

Consider now the good firm. Since in the conjectured equilibrium it chooses EW, it needs external financing at $t = 1$ only if its first-period project fails.[17] In this state, its market value coincides with that of a bad firm (seeking external financing), which had the same $s(c(i, 0))$ observed by the market and its true economic value is $\hat{V}_g^*$. If its first-period project succeeds, the second-period project is financed at $t = 1$ from the resulting cash flow, and its true economic value is $\hat{\hat{V}}_g^*$. If the manager of the good firm selects EW at $t = 0$, then the expected terminal wealth accruing to the initial ($t = 0$) shareholders is

$$(23) \quad T^* \left(\mathrm{EW}|g\right) = \Pi \left\{p_g \left[1 - \alpha_0^{\mathrm{EW}}\right] \hat{\hat{V}}_g^* + \left[1 - p_g\right]\left[1 - \alpha_0^{\mathrm{EW}} - \alpha_1^{\mathrm{EW}}\right] \hat{V}_g^*\right\}$$
$$+ [1 - \Pi] \left\{p_g \left[1 - \alpha_0^{\mathrm{LB}}\right] \hat{\hat{V}}_g^* + \left[1 - p_g\right]\left[1 - \alpha_0^{\mathrm{LB}} - \alpha_1^{\mathrm{LB}}\right] \hat{V}_g^*\right\}.$$

Some parametric restrictions are sufficient to enable us to focus on the conjectured equilibrium, and are discussed below.

(R-1) $\quad I \in (I_{\min}, I_{\max})$ where $(I_{\min}, I_{\max})$ is a finite subset of $(0, \infty)$.

(R-2) $\quad p_g \geq p_g^*$ where $p_g^*$ is a number in (0, 1).

(R-3) $\quad r_g [r_b]^{-1} \geq q_g \left[q_b\right]^{-1}$.

(R-4) $\quad r_b Z > Y$.

Restriction (R-1) implies that investment $I$ cannot be either too large or too small relative to asset values. Keeping $I$ not too large helps to limit the wealth transfer gains to the shareholders of the bad firm when they mimic the good firm's project choice. The larger the $I$, the higher is the fraction of the firm's value that is involved in the equity issue. Thus, mimicking is more profitable for the bad firm's initial shareholders when $I$ is large. The reason why $I$ cannot be too small is that it is the presence of underpricing that leads the good firm to stray from its first-best investment policy. If $I$ is "too small," the cost of underpricing is exceeded by the welfare loss in deviating from the first best, and asymmetric information is not distortionary.

Restriction (R-2) implies that $p_g$ should be sufficiently high. If this were not true, the good firm may be tempted to invest in the socially preferred LB project

[17] Having observed that the firm has realized a positive cash flow at $t = 1$, investors must update their priors and believe with probability 1 that this firm is good. Given that revision in the conjectured equilibrium, it is a matter of indifference for the firm's existing shareholders whether the second-period project is internally or externally financed. In this knife-edge case, I adopt the convention that the project will be internally financed. This convention means that seeking external financing after having realized a positive cash flow at $t = 1$ becomes an *out-of-equilibrium* move.

because its EW project does not promise to provide internal funds at $t = 1$ with sufficiently high probability.

Restriction (R-3) is a technical condition that is sufficient for proving that the equilibrium derived in this paper is universally divine.[18] If this condition does not hold, the equilibrium I focus on is sequential but not necessarily universally divine. Finally, (R-4) is a sufficiency condition that eases the algebra in the proof of the following proposition but can be easily dispensed with; indeed, it is not met in the proof of Proposition 5. These four parametric restrictions are jointly sufficient for the ensuing results, but not jointly necessary. It can now be proved that the conjectured equilibrium is indeed a UDE.

*Proposition 4.* Given (R-1), (R-2), (R-3), and (R-4), the following is a UDE.
1) The good firm selects EW at $t = 0$ and finances w.p. 1 its second-period project at $t = 1$. It does so out of retained earnings if EW succeeds at $t = 1$, and with external equity if it does not.
2) The bad firm selects LB at $t$=0 and finances w.p. 1 its second-period project at $t = 1$. It does so by issuing equity at $t = 1$.
3) Investors price every firm at every point in time at the expected value of its cumulative terminal cash flow, conditional on their beliefs, which are revised according to Bayes rule upon observing the equilibrium project and financing choices of managers. If any firm makes a (nonequilibrium) move that is not contained in the set of moves described in 1) and 2), investors believe w.p. 1 that this is a bad firm.

*Proof.* See the Appendix.

It is worth noting that the only out-of-equilibrium move at $t = 1$ is for a firm with retained earnings to issue equity. In the proof, I show that universal divinity dictates that the market must believe that such a firm is bad. This means that an announcement of such an issue will precipitate the largest relative price decline. Of course, unless a manager fails to maximize current shareholder welfare, such a move should not be observed, according to the model.[19] The following corollary can now be proved.

*Corollary 1.* The UDE in Proposition 3 is strategically stable in the sense of Kohlberg and Mertens (1986).[20]

*Proof.* See the Appendix.

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[18] This restriction is derived from the inequality $r_g Z[q_g R]^{-1} \geq r_b Z[q_b R]^{-1}$, which implies that the (gross) economic value of the late bloomer as a fraction of the economic value of the nondiscretionary assets is greater for the good firm than for the bad firm.

[19] In practice, firms with cash do issue risky securities. However, this is not necessarily a zero-probability event in the context of our model because a firm with cash that is *inadequate* to meet its financing needs would still have a "justifiable" need for external equity. For simplicity, we have modeled the firm's retained earnings as being either zero or enough to meet the firm's financing needs, but it is trivial to expand the state space so that it is possible to have positive retained earnings insufficient to meet the firm's financing needs.

[20] The proof below relies on the discussion of strategic stability in Banks and Sobel (1987). The notation co(A,B) in the proof denotes the convex hull of the sets A and B. Even with the parametric restrictions imposed on the model, there is a multiplicity of sequential equilibria, which is the motivation for using refinements.

Next, I show that the restrictions on exogenous parameters needed for Proposition 3 can be satisfied with a fairly wide range of exogenous parameters values.

*Proposition 5.* The set of exogenous parameter values for which the strategically stable equilibrium in Corollary 1 exists is nonempty.

*Proof.* The equilibrium in Proposition 4 can be reached with a wide range of exogenous parameter values. The table given below is an example of parameter values that lead to such an equilibrium. This equilibrium is strategically stable. In each case, a set of exogenous parameter values is given a number, and each row is a distinct set.

| Parameter Values Set # | $Y$ | $Z$ | $I$ | $p_g$ | $p_b$ | $r_g$ | $r_b$ | $R$ | $q_g$ | $q_b$ | $\pi$ | $\gamma$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 10 | 2 | 0.7 | 0.3 | 0.7 | 0.4374 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 2 | 8 | 10 | 2 | 0.87 | 0.3 | 0.7 | 0.4374 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 3 | 8 | 10 | 2 | 0.8 | 0.25 | 0.7 | 0.4374 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 4 | 8 | 10 | 2 | 0.8 | 0.48 | 0.7 | 0.4374 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 5 | 8 | 10 | 2 | 0.8 | 0.3 | 0.7 | 0.4374 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 6 | 8 | 10 | 2 | 0.8 | 0.3 | 0.8 | 0.4374 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 7 | 8 | 10 | 2 | 0.8 | 0.3 | 0.7 | 0.29 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 8 | 8 | 10 | 2 | 0.8 | 0.3 | 0.7 | 0.4374 | 20 | 0.8 | 0.5 | 0.6 | 0.5 |
| 9 | 4.3093 | 7.26429 | 2 | 0.9 | 0.4687 | 0.75 | 0.4688 | 20 | 0.8 | 0.5 | 0.61 | 0.5 |
| 10 | 4.3093 | 7.26429 | 2 | 0.99 | 0.4687 | 0.75 | 0.4688 | 20 | 0.8 | 0.5 | 0.61 | 0.5 |
| 11 | 4.3093 | 7.26429 | 2 | 0.9 | 0.465 | 0.75 | 0.4688 | 20 | 0.8 | 0.5 | 0.61 | 0.5 |
| 12 | 4.3093 | 7.26429 | 2 | 0.9 | 0.7 | 0.75 | 0.4688 | 20 | 0.8 | 0.5 | 0.61 | 0.5 |
| 13 | 4.3093 | 7.26429 | 2 | 0.9 | 0.4688 | 0.7513 | 0.4688 | 20 | 0.8 | 0.5 | 0.61 | 0.5 |
| 14 | 4.3093 | 7.26429 | 2 | 0.9 | 0.4688 | 0.75 | 0.345 | 20 | 0.8 | 0.5 | 0.61 | 0.5 |
| 15 | 4.3093 | 7.26429 | 2 | 0.9 | 0.4688 | 0.75 | 0.4688 | 20 | 0.8 | 0.5 | 0.61 | 0.5 |

□

I now ask what would happen if the signal $s$ were unavailable to the market, so that the market has no information about project choice at $t = 0$. This eliminates one benefit of choosing the EW project in the first period, namely the expected positive price reaction at $t = 0$. However, if the second-period investment is large enough, the loss from second-period external financing to the good firm's shareholders will be sufficient to induce that firm to choose EW at $t = 0$ in order to reduce the likelihood of this loss. Hence, the investment myopia in this model may persist even if there is no project choice signal; concern with the current stock price is *not* the driving force behind investment myopia. The reason for introducing the signal is merely to study price reactions to (imperfectly observed) project choices at $t = 0$.

## VI. Extensions of the Model and Additional Implications

I now consider three simple extensions of the model that permit additional implications.

## A. Signal Informativeness and the Desirability of Noise

The probability $\Pi$ is an indicator of the informativeness of the signal the market receives about the firm's investment choice. I have assumed that $\Pi < 1$ to model the notion that it is usually not in the firm's interest to reveal *everything* that it knows about the project,[21] or that even if it could, there is some exogenous noise that garbles the information transmission. Suppose that $\Pi$ is determined by mandatory disclosure rules that accompany public equity issues. It seems intuitive that the good firm in this model would want $\Pi$ to be high, since this makes the market's inference of its project choice more accurate and results in a more positive price response. This is true up to a point. Beyond that, however, somewhat surprisingly, it is not in the good firm's interest to have $\Pi$ increased. The reason is that the higher the $\Pi$, the more attractive it is for the bad firm to mimic the good firm's investment choice, since the price-response benefit of choosing the EW is greater. A sufficiently high $\Pi$ would make it impossible to ensure incentive compatibility. An equilibrium that is separating in investment choices will be unattainable and both types of firms will choose the LB. If the prior belief of uninformed investors puts a sufficiently high weight on the likelihood that the firm is bad (i.e., $\gamma$ is sufficiently low), the expected terminal wealth of the current shareholders of the good firm could be lower in this pooling outcome than in the separating equilibrium described in Propositions 4 and 5. That is, even if the good firm did not have to worry about revealing information about its project to competitors, its shareholders would not want the signal s to be "too informative." In other words, there is an endogenous rationale for the firm wishing to limit mandatory disclosure since *noise may be privately desirable.* From a social efficiency standpoint, however, eliminating noise is desirable because it would change the equilibrium to one that involves first-best investment choice by both types of firms.

## B. The Issue of Cash Stockpiling

So far it has been assumed that if the firm seeks to invest, it can only raise $\$I$ at either $t = 0$ or $t = 1$. This assumption is related to the fact that there is common knowledge about the size of the firm's investment. However, suppose we allowed firms to choose the amount of investment funds they wanted to raise. The purpose in doing so at $t = 0$ would be to "stockpile" cash (in excess of $\$I$) for future investment use at $t = 1$. Imagine that a firm announces that it will raise $\$NI$ at $t = 0$, with $N > 1$. This is an out-of-equilibrium move relative to the UDE characterized in the previous section. What belief should investors have about this deviant firm's type?

To answer this question, note that the probability that external financing will *not* be required at $t = 1$ is higher for the good firm than it is for the bad firm. Hence, the manager of the good firm assesses the *expected mispricing* of his firm at $t = 1$ to be *less* than the expected mispricing (with the expectation taken with respect to the probability distribution of the project choice signal) of his firm at

[21]See Bhattacharya and Ritter (1983) and Darrough and Stoughton (1989) who model a tension between the firm's desire to disclose good news to the financial market and withhold it from competitors.

$t = 0$. On the other hand, the market value of the bad firm at $t = 1$ is always lower than its market value at $t = 0$. This means that if we define $A_i$ as the set of market valuation responses that induce the type $i$ firm to strictly wish to defect (with external financing exceeding \$$I$ at $t = 0$) from the equilibrium and $A_i^o$ as the set of market valuation responses that leave such a firm indifferent between defecting and not defecting from the equilibrium, then $\{A_g \cup A_g^o\} \subset A_b$. So, by universal divinity, investors must believe that Pr(defector is a good firm|external financing $> I$) = 0. Hence, if a firm were to attempt to stockpile cash at $t = 0$, it would be viewed as a bad firm and would suffer a price decline. Clearly, neither type of firm will wish to raise external financing in excess of \$$I$.

While liquidity stockpiling is suboptimal when firms know their own types and investors do not, would this result hold in a *symmetric* information setting in which firms' managers as well as shareholders have the same beliefs about each firm's type? That is, suppose we moved back one period from $t = 0$ to $t = -1$, at which time the manager of a firm believes (as investors do) that there is a probability $\gamma$ that his firm is good and a probability $1 - \gamma$ that it is bad. It is also common knowledge that at $t = 0$ the manager will come to know his firm's type but investors will not. Is it worthwhile stockpiling liquidity at $t = -1$ when there is no information asymmetry? The answer depends on the cost of issuing equity and the cost of "storing" slack.

Consider first the case in which, as in the present model, the firm has access to an elastic supply of zero-NPV projects, so that storage of capital is costless. Then, in the symmetric information environment at $t = -1$, the firm should raise enough capital to ensure that, regardless of its first-period project choice, it will have sufficient funds to finance *both* the first- and second-period projects. The firm can then invest in LB at $t = 0$, regardless of its type. From an ex ante ($t = -1$) standpoint, this would be preferred to the strategy of waiting until $t = 0$ to raise funds. That is, raising external financing when information is symmetric dominates attempting to do so when information is asymmetric. This observation has received empirical support in the work of Korajczyk, Lucas, and McDonald (1988) who find that equity issues tend to be clustered around information disclosure events such as earnings announcements.

On the other hand, suppose that storage is very costly. This is likely when a long amount of time must elapse for the firm to get from $t = -1$ to $t = 0$, zero-NPV projects are scarce, and the presence of cash on the balance sheet is likely to attract (hostile) raiders. In this case, the desirability of cash stockpiling at $t = -1$ depends on the tradeoff between the cost of storage and the investment distortion the firm would suffer in the event that it turns out to be good at $t = 0$ and has waited until then to raise external capital. Moreover, as Lucas and McDonald (1990) point out, by issuing equity to hold slack, the firm pays equity issue costs before it is necessary to do so, so that firm liquidation prior to project arrival would mean a waste of issue costs; Smith (1977) estimates these costs for large underwritten offerings to be 4 to 7 percent of the value of the issue.

### C. Investment Myopia and Takeovers

I now examine how takeovers affect investment choices when management has an entrenchment motive. Suppose that a bidder can learn the firm's true value at $t = 1$ at a cost $k > 0$. In keeping with Roll's (1986) hubris hypothesis, imagine two types of bidders: "clever" and "inept." A fraction $p \in (0, 1)$ of all bidders is clever and a fraction $1 - p$ is inept. But *all* potential bidders *think* they are clever. A clever bidder can invest $k > 0$ to discover a firm's type. No shortselling is allowed, so a bidder can benefit from investing in information only if it discovers a good firm. While a clever bidder can correctly discover a firm's type, an inept bidder spends $k$ but learns nothing beyond what the market knows, i.e., a firm that such a bidder identifies as good has a probability of being good that merely equals the market's posteriors at $t = 1$. However, since the bidder does not know it is inept, it believes that it knows more than the market.

In this setting, the bidder's takeover attempt is motivated solely by the desire to effect a wealth transfer from the target firm's shareholders to itself. Thus, the only viable targets are firms that are seeking external financing at $t = 1$. The reason is that a firm that has internally generated cash to finance its second-period project is identified with probability 1 as a good firm and, hence, is not underpriced. The market price of a potential target is $V(s, F, 1)$. If a bid is made for such a firm, investors must believe that the probability is $p$ that the firm is worth $\hat{V}_g^*$, and it is $1-p$ that the firm is worth $V(s, F, 1)$. Hence, the shareholders of the target will wish to sell out to the bidder if the latter offers $p\hat{V}_g^* + [1 - p]V(s, F, 1) + \epsilon$ (with $\epsilon > 0$) for the firm.[22]

There are three points worth noting. First, the usual free rider problem is absent here because shareholders are being offered more than the expected value of the firm. Second, since the manager knows the true value of his firm, he will resist the takeover attempt in the *shareholders'* best interest. If the manager personally values control, then management resistance is a mixed signal for the shareholders, but the manager will display an even stronger preference for the EW. Choosing the EW now serves two purposes: it benefits the shareholders of the good firm *and* it reduces the likelihood of a future takeover bid.

## VII. Conclusion

I have shown that managers may favor short-term projects over intrinsically more valuable long-term projects even when they make decisions to maximize current shareholder wealth. My principal focus has been on stock price reactions to investment choices. The market reacts positively to a project that is an early cash generator because the choice of such a project indicates that corporate insiders view their firm as undervalued; they make a project choice that minimizes their need for future external financing. This approach leads to as-yet-untested predictions about price reactions to equity issues and the *nature* of capital expenditures.

[22]For simplicity, I assume that there are no competing bidders. Moreover, I assume that $\delta(g|s, F)\{[\hat{V}_g^* - V(s, F, 1)][1 - p]\} - k > 0$, so that it pays for a potential bidder to invest $k$ to discover whether a given firm is good or bad.

While I have used a simple model, its findings are robust to many variations. Instead of assuming that the late bloomer does not yield a cash flow at the end of the first period, one could assume that it yields a random cash flow that may be realized either in the first period or in the second period. The market will react negatively to any project that is not expected to yield cash flows over future time periods when the firm needs investment funds; such a project increases the likelihood of capital market access in future periods. The key property for my results to hold is that the firm does not believe that its investment choice will be precisely revealed to the market with probability 1 prior to the next point in time at which the firm will need investment funds.[23] The project payoff distributional assumptions can be relaxed too as long as the lower end point of the support of every associated density function is strictly less than the required investment.[24] One could also extend the model to more than two firm types and give it a richer dynamic structure.[25] The model is also robust to a change in the way the intrinsic values of the two projects are related. Because I wished to focus on investment myopia, I assumed that the late bloomer had higher intrinsic value than the early winner. If instead the early winner had the higher intrinsic value, then the good firm would choose the EW and, given appropriate parametric assumptions, the bad firm would choose the LB. Although the investment *distortion* now shifts to a bias toward inefficient long-term investments, the equilibrium project choices as well as the associated price reactions remain the same as in the present model.

In closing then, the principal results in this paper rest on two basic premises. One is that, after all is said and done, managers know at least a little bit more about their firms than investors do. And the other is that shareholders are not indifferent to the price at which their firm trades.

## Appendix

*Proof of Proposition 4.* I will first show that the strategies of firms stipulated in the proposition are incentive compatible. If the manager of the bad firm mimics that of the good firm, the expected terminal wealth (with the expectation taken at $t = 0$) accruing to the shareholders of the bad firm is

$$\text{(A-1)}\quad T\left(\text{EW}|b\right) = \Pi\left\{p_b\left[1-\alpha_0^{\text{EW}}\right]\hat{\hat{V}}_b^* + \left[1-p_b\right]\left[1-\alpha_0^{\text{EW}}-\alpha_1^{\text{EW}}\right]\hat{V}_b^*\right\}$$
$$+\left[1-\Pi\right]\left\{p_b\left[1-\alpha_0^{\text{LB}}\right]\hat{\hat{V}}_b^* + \left[1-p_b\right]\left[1-\alpha_0^{\text{LB}}-\alpha_1^{\text{LB}}\right]\hat{V}_b^*\right\},$$

where

[23] An example of a situation in which this property is not satisfied is if the EW yields a cash flow at $t = 1$ even if it fails and investors can observe this cash flow. In this case, the firm's project choice becomes known with probability 1 to investors at $t = 1$. However, a simple way around this is to assume that, in addition to a large cash flow at $t = 2$, the LB yields a (small) cash flow at $t = 1$ that is identical to the cash flow from the EW upon failure.

[24] This precludes riskless debt.

[25] If the feasible set of projects remains unchanged, then with three or more types, there will be at least one type that will pool with either the good or the bad firm in its first-period investment choice or randomize over project choices. A longer time horizon is unlikely to change much as long as projects can be rank-ordered by their cash flow timing properties as in this model.

(A-2) $$\hat{\hat{V}}_b^* \equiv q_b R + Y - I,$$

(A-3) $$\hat{V}_b^* \equiv q_b R.$$

It needs to be proven that $T^*(\text{LB}|b) > T(\text{EW}|b)$. I will begin by showing

(A-4) $$\left[1-\alpha_0^{\text{LB}}-\alpha_1^{\text{LB}}\right] V_b^* > p_b\left[1-\alpha_0^{\text{LB}}\right]\hat{\hat{V}}_b^* + \left[1-p_b\right]\left[1-\alpha_0^{\text{LB}}-\alpha_1^{\text{LB}}\right]\hat{V}_b^*.$$

Since $\hat{\hat{V}}_b^* > \hat{V}_b^*$, to prove the above inequality it is sufficient to show that

(A-5) $$\left[1-\alpha_0^{\text{LB}}-\alpha_1^{\text{LB}}\right] V_b^* > \left[1-\alpha_0^{\text{LB}}\right]\hat{\hat{V}}_b^*.$$

Note now that

(A-6) $$\alpha_1^{\text{LB}} V_b^* = I V_b^* \left[V(s=\text{LB}, F, 1)\right]^{-1} < I.$$

Thus, for (A-5) to be satisfied, it is sufficient that

(A-7) $$\left[1-\alpha_0^{\text{LB}}\right] V_b^* - I > \left[1-\alpha_0^{\text{LB}}\right]\hat{\hat{V}}_b^*.$$

Upon substituting for $V_b^*$ and $\hat{\hat{V}}_b^*$, we can write (A-7) as

(A-8) $$\left[1-\alpha_0^{\text{LB}}\right]\left[r_b Z - Y + I\right] > I$$

or $$1 - I\left[V(S=\text{LB},0)\right]^{-1} > I\left[r_b Z - Y + I\right].$$

Since $r_b Z > Y$, the RHS of (A-8) is less than 1. Now, (A-8) clearly holds for $I = 0$. Moreover, the RHS of (A-8) is increasing in $I$ and the LHS is decreasing in $I$. Thus, by continuity, $\exists\, I^* \in (0,\infty) \ni$ (A-8) holds as an equality for $I = I^*$. Hence, for $I < I^*$, (A-4) is satisfied. Next I will show that

(A-9) $$\left[1-\alpha_0^{\text{EW}}-\alpha_1^{\text{EW}}\right] V_b^* > p_b\left[1-\alpha_0^{\text{EW}}\right]\hat{\hat{V}}_b^* + \left[1-p_b\right]\left[1-\alpha_0^{\text{EW}}-\alpha_1^{\text{EW}}\right]\hat{V}_b^*.$$

Following steps similar to those used in demonstrating that (A-4) holds, it can be seen that a sufficient condition for (A-9) to hold is that

(A-10) $$1 - I\left[V(s=\text{EW},0)\right]^{-1} > I\left[r_b Z - Y + I\right]$$

be satisfied. Again, we see that $\exists\, I^{**} \in (0,\infty) \ni$ (A-10) holds as an equality for $I = I^{**}$. It is also straightforward to verify that $I^{**} > I^*$ since $V(s=\text{EW},0) > V(s=\text{LB},0)$. Now define $I_{\max} \equiv I^*$, so that (A-5) and (A-9) simultaneously hold for $I < I_{\max}$. With a few algebraic manipulations, (A-5) and (A-9) can now be combined to verify that, since $\Pi > 0.5$, we have $T^*(\text{LB}|b) > T(\text{EW}|b)$. Next, one needs to prove that $T^*(\text{EW}|g) > T(\text{LB}|g)$, where

(A-11) $$T\left(\text{LB}|g\right) \equiv \Pi\left[1-\alpha_0^{\text{LB}}-\alpha_1^{\text{LB}}\right]\tilde{V}_g^* + \left[1-\Pi\right]\left[1-\alpha_0^{\text{EW}}-\alpha_1^{\text{EW}}\right]\tilde{V}_g^*,$$

where

(A-12) $$\tilde{V}_g^* \equiv q_g R + r_g Z.$$

I will begin by showing that

$$\text{(A-13)}\quad p_g\left[1-\alpha_0^{\mathrm{EW}}\right]\hat{V}_g^* + \left[1-p_g\right]\left[1-\alpha_0^{\mathrm{EW}}-\alpha_1^{\mathrm{EW}}\right]\hat{V}_g^* > \left[1-\alpha_0^{\mathrm{EW}}-\alpha_1^{\mathrm{EW}}\right]\bar{V}_g^*.$$

To show (A-13), a useful intermediate step is to show that

$$\text{(A-14)}\qquad \left[1-\alpha_0^{\mathrm{EW}}\right]\hat{V}_g^* > \left[1-\alpha_0^{\mathrm{EW}}-\alpha_1^{\mathrm{EW}}\right]\bar{V}_g^*.$$

Upon substituting for $\hat{V}_g^*$ and $\bar{V}_g^*$, (A-14) can be simplified to $\alpha_1^{\mathrm{EW}}\bar{V}_g^* > [1-\alpha_0^{\mathrm{EW}}][r_gZ - Y + I]$, which can be written as

$$\text{(A-15)}\quad I\left[V(s=\mathrm{EW},F,1)\right]^{-1}\left[q_gR + r_gZ\right]^{-1} > \left[1-\alpha_0^{\mathrm{EW}}\right]\left[r_gZ - Y + I\right].$$

Since $V(s=\mathrm{EW},F,1) < \hat{V}_g^*$, a sufficient condition for (A-15) to hold is that

$$\text{(A-16)}\qquad I\left[q_gR + r_gZ\right]\left[q_gR\right]^{-1} > \left[1-\alpha_0^{\mathrm{EW}}\right]\left[r_gZ - Y + I\right].$$

Clearly, (A-16) fails to hold at $I = 0$. But in (A-16), $\partial\mathrm{LHS}/\partial I > \partial\mathrm{RHS}/\partial I$. Thus, by continuity of the LHS and the RHS in $I$, $\exists\, \hat{I} \in (0,\infty) \ni$ (A-16) holds as an equality for $I = \hat{I}$. Thus, if $I > \hat{I}$, (A-13) holds if $p_g = 1$ and does not hold if $p_g = 0$. Hence, by continuity of the LHS of (A-13) in $p_g$, $\exists\, \hat{\beta}_g \in (0,1) \ni$ (A-13) holds for $1 > p_g > \hat{\beta}_g$. Using similar steps we can show that $\exists\, \hat{\hat{I}} \in (0,\infty)$ and $\hat{\hat{\beta}}_g \in (0,1)$ such that

$$\text{(A-17)}\quad p_g\left[1-\alpha_0^{\mathrm{LB}}\right]\hat{V}_g^* + \left[1-p_g\right]\left[1-\alpha_0^{\mathrm{LB}}-\alpha_1^{\mathrm{LB}}\right]\hat{V}_g^* > \left[1-\alpha_0^{\mathrm{EW}}-\alpha_1^{\mathrm{EW}}\right]\bar{V}_g^*,$$

if $I > \hat{\hat{I}}$ and $1 > p_g > \hat{\hat{\beta}}_g$. Define $I_{\min} = \max\{\hat{I},\hat{\hat{I}}\}$ and $p_g^* = \max\{\hat{\beta}_g,\hat{\hat{\beta}}_g\}$. Then, since $\Pi > 0.5$, it has been proven that $T^*(\mathrm{EW}|g) > \hat{T}(\mathrm{LB}|g)$ if $I > I_{\min}$ and $p_g > p_g^*$.

All that remains is to examine out-of-equilibrium moves. The only out-of-equilibrium move at $t = 0$ is for the firm to not invest. The potential gain would be to be identified as a good firm with sufficiently high probability, so that second-period financing can be raised at favorable prices. Let $\mu(g|NI)$ denote the probability the market attaches to the event that the defecting firm is good when it observes no investment at $t = 0$. Let $\mu_g(g|NI)$ be the *minimum* value of this probability such that the good firm is indifferent to defecting or not defecting and let $\mu_b(g|NI)$ be the minimum value of this probability such that the bad firm is indifferent. Since the rest of the proof would be trivial if $\mu_g(g|NI)$ equalled 1, let us assume that $\mu_g(g|NI) \in (0,1)$. (Note that proving that this equilibrium is sequential is straightforward; those steps are skipped here.) Let $\alpha_1^{\mu}$ be the ownership share that the current shareholders must give up to outsiders when the firm raises external financing at $t = 1$ and the market has beliefs given by $\mu(g|NI)$. Clearly, $\alpha_1^{\mu}$ is decreasing in $\mu$. Let $\alpha_1^{\mu}(i)$ be the critical ownership share value corresponding to $\mu_i(g|NI)$, with $i \in \{g,b\}$. That is,

$$\text{(A-18)}\qquad T^*\left(\mathrm{EW}|g\right) = \left[1-\alpha_1^{\mu}(g)\right]\left[q_gR\right],$$

$$\text{(A-19)}\qquad T^*\left(\mathrm{LB}|b\right) = \left[1-\alpha_1^{\mu}(b)\right]\left[q_bR\right].$$

Now,

$$\text{(A-20)} \qquad \left[1 - \alpha_1^{\mu}(b)\right] = \Psi\left[1 + r_b Z\{q_b R\}^{-1}\right],$$

$$\text{where} \qquad \Psi \equiv \Pi\left[1 - a_0^{\text{LB}} - \alpha_1^{\text{LB}}\right] + [1 - \Pi]\left[1 - \alpha_0^{\text{EW}} - \alpha_1^{\text{EW}}\right].$$

Define $1 - \hat{a}_1^{\mu}(g) \equiv \Psi[1 + r_g Z\{q_g R\}^{-1}]$. It is clear that $1 - \hat{\alpha}_1^{\mu}(g) < 1 - \alpha_1^{\mu}(g)$. Moreover, given (R-3), we have $1 - \alpha_1^{\mu}(b) \leq 1 - \hat{\alpha}_1^{\mu}(g)$. Let $A_g = [0, \alpha_1^{\mu}(g))$, $A_g^o = \{\alpha_1^{\mu}(g)\}$ and $A_b = [0, \alpha_1^{\mu}(b))$. Then, the arguments above have shown that $\{A_g \cup A_g^o\} \subset A_b$. By the universal divinity criterion for assignment of beliefs in response to out-of-equilibrium moves, investors must believe that Pr(defector is a good firm$|NI$) = 0. Given these beliefs, it obviously pays no firm to defect at $t = 0$.

Finally, the only possible defection at $t = 1$ is that a positive cash flow is realized but external financing is still sought. It is transparent that, regardless of investors' beliefs about the defector's identity in the face of this defection, the good firm is never strictly better off by defecting than by pursuing its equilibrium strategy. Thus, the only admissible belief is $\mu(g|NI) = 0$. Given this, it pays no firm to defect. Thus, the overall equilibrium is a UDE. □

*Proof of Corollary 1.* Consider the defection at $t = 0$. For all beliefs $\mu(g|NI) < \mu_b(g|NI)$, no firm wishes to defect from the equilibrium. Consider a belief $\mu(g|NI) \geq \mu_b(g|NI)$. Can such a belief be "stabilized?" To see this, note that for $\mu(g|NI) = \mu_b(g|NI)$, the bad firm is indifferent to defecting or not defecting, and the good firm is strictly worse off by defecting. It is clear that any $\mu(g|NI) \geq \mu_b(g|NI)$ can be stabilized in the sense that $\mu_b(g|NI) \in \text{co}(\mu(g|NI), \mu^*(b))$, where $\mu^*(b) =$ Pr(defector is a bad firm$|NI$) = 1. Thus, by a theorem in Banks and Sobel (1987), the equilibrium is stable with respect to the out-of-equilibrium move at $t = 0$. This completes the proof since the equilibrium is obviously stable with respect to the out-of-equilibrium move at $t = 1$. □

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