How Frequent Financial Reporting Can Cause Managerial Short-Termism: An Analysis of the Costs and Benefits of Increasing Reporting Frequency*

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Abstract

We develop a cost-benefit tradeoff that provides new insights into the frequency with which firms should be required to report the results of their operations to the capital market. The benefit to increasing the frequency of financial reporting is that it causes market prices to better deter investments in negative net present value projects. The cost of increased frequency is that it increases the probability of inducing managerial short-termism. We analyze the tradeoff between these costs and benefits and develop conditions under which greater reporting frequency is desirable and conditions under which it is not.

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1. Introduction

How frequently should publicly traded firms be required to report the results of their operations to the capital market? This is an important policy question of concern to accounting regulators. In the United States the frequency of mandatory reporting has risen from annual reporting to semi-annual reporting to quarterly reporting. With increasing demands for greater accountability and transparency of financial information, it is likely there will be pressure on regulators to call for even more frequent reporting. In the absence of a clear sense of the potential costs and benefits associated with the frequency of financial reporting, the conventional wisdom that “more information is preferred to less” will likely prevail. The conventional wisdom is supported by studies of disclosure in pure exchange settings. In such settings the only effect of public disclosure is to reduce the risk premium in stock prices or to reduce informational differences across traders and thus increase liquidity. Because both of these effects are socially desirable, it would appear that more disclosure/greater frequency is always preferred to less.

In this paper, we study reporting frequency from a “real effects” perspective and develop a cost-benefit tradeoff that provides new insights into the desirability of greater reporting frequency. We demonstrate that frequency of disclosure affects firms’ project selection strategies. Specifically, we show that the price pressure created by high reporting frequency induces managers to adopt a short-term perspective (myopia) in choosing the firm’s investments. This represents the cost side of the cost-benefit tradeoff to be studied. But, there are also benefits to greater reporting frequency. When the capital market possesses less information than the firm’s manager, periodic performance reports to the capital market enable market prices to impose discipline on the firm’s choices (see Kanodia and Lee (1998)). In the present paper we show that such discipline decreases the probability with which the firm undertakes negative net present value projects. Greater reporting frequency provides more effective discipline. We develop these costs and benefits in a rational expectations equilibrium, study their tradeoff, and
derive conditions under which greater reporting frequency is desirable and conditions under which it is not.

One of the difficulties associated with studies of mandatory disclosure is that the social costs to disclosure (besides compliance costs) are difficult to identify. In the literature on voluntary disclosure, proprietary costs arising from informing the strategies of rival firms is commonly cited as a potent force that limits disclosure. However such proprietary costs, while damaging to the cash flows of a disclosing firm, would enhance the cash flows of competing firms, so the social costs to such disclosure could be small or even non-existent. Hirshleifer (1971) was the first to identify an important social cost to public disclosure, namely, the destruction of risk sharing opportunities among risk averse individuals. Gigler and Hemmer [1998] identify another potential cost that is explicitly related to reporting frequency. They argue that moral hazard problems arising from the unobservable effort of a firm’s manager become more severe if reporting frequency is increased.

Neither proprietary costs nor moral hazard costs arise from price pressure caused by disclosure to the capital market. They arise because disclosure to capital markets informs other parties. One plausible cost that could arise directly from capital market pricing comes from the fact that accounting accrual errors would become more severe if the measurement window is shortened due to more frequent disclosure requirements. Kanodia and Mukherji [1996], and Kanodia, Sapra and Venugopalan [2004] show how such measurement errors distort market pricing and create price pressure to forego or decrease desirable investments that are not directly observable.

The recent debate that occurred following the proposal to mandate quarterly reporting in Europe, Singapore and Australia identified another possibly potent social cost that could be triggered by increasing the frequency of financial reporting. In this debate, the practitioner

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1 For examples, see Dye [1986], Darrough and Stoughton [1990], and Gigler [1994].
community expressed strong concern that increasing the frequency of financial reporting would have the unintended consequence of promoting managerial short-termism. Bhojraj and Libby [2005] report the following excerpts from the popular press:

- “Some of Europe’s most powerful investors are calling on the European Commission to drop plans to introduce mandatory quarterly reporting for companies….it (quarterly reporting) has not helped prevent corporate scandals in the U.S., and there is risk that it will encourage short-termism.”  (Financial Times, January 27, 2003)

- “Hong Kong says no to quarterly reporting …..Critics say an unintended consequence will be short-termism in the market, with investors focused on seasonal profits rather than long-term earnings growth.”  (Investor Relations Magazine, November 15, 2002)

In summarizing the European debate, Rahman, Tay, Ong, and Cai [2007] observed that “those in opposition argued that it encourages short-termism, which can lead to earnings management and stock price volatility.” They also report that: “In the United Kingdom, Chartered Institute of Management Accountants (CIMA) warned that without the conclusion of enough management commentary on business outlook in quarterly reports, companies ran the risk of making short-term decisions to make the bottom-line numbers attractive to investors.”

In light of these concerns, in 2004, the European Union Parliament rejected the proposal to mandate quarterly reporting, and in Singapore, the Council on Corporate Disclosure and Governance recommended that companies with a market capitalization of less than $75 million should be exempt from quarterly reporting. A similar example in the U.S. received much publicity. During Google’s IPO offering in 2004, the management of Google explicitly declined to provide frequent earnings guidance to analysts, saying that it did not want to lose focus on its long-term goals.
Importantly, the practitioner intuition is that this short-termism is caused by price pressure from the capital market, rather than an outcome of managerial career concerns or the result of poorly designed performance measures. In this paper, we formalize this managerial short-termism/myopia hypothesis, and develop conditions under which an increase in the frequency of financial reporting would precipitate managerial short-termism as an equilibrium response solely to price pressure from the capital market.

The layman’s intuition is that corporate myopia is caused by impatient traders in the capital market who hold the firm only for short-term capital gains and consequently demand quick returns to managerial actions. This popular intuition is incomplete. It is true that impatient shareholders are concerned, not with long term cash flows, but only with the price at which they can immediately sell their holdings to the next generation of shareholders. But this next generation, which is equally impatient, must care about what the succeeding generation will pay for the firm’s stock, thus inducing the first generation to care about what the third generation will pay. This effect continues down the chain, and induces the first generation of impatient shareholders to care about what the last generation of impatient shareholders will pay for the firm’s stock, and this last generation must care about the entire stream of cash flows generated by the firm since they are the ultimate claimants to these cash flows. This chain effect makes market pricing infinitely long-term even though each individual shareholder only cares about short-term price movements.

The above intuition suggests that actions that favor short-term cash flows at the expense of greater long-term value creation would be immediately punished by lower capital market prices. Therefore, a manager who is guided by market prices would be induced to adopt a long-term perspective in selecting a firm’s investments, even though at every point of time the shares of the firm are held only by short term investors. However, this disciplinary role of market prices works perfectly only when the market is “fully” informed. Stein (1989) shows that when the market is unable to directly observe the manager’s actions, price pressure will cause the manager
to behave myopically even though the market is fully efficient, correctly anticipates the equilibrium actions of the manager and correctly prices the firm.

We build on Stein’s insights and relate managerial short-termism explicitly to the frequency of financial reporting and to the degree of impatience in the capital market. We show that frequent reporting results in price pressures that are analogous to the pressure caused by the premature evaluation of any action whose value is probabilistically manifested only over the long term. These premature evaluations are tempered by subsequent evaluations, but the damage caused by early evaluations cannot be overcome when shareholders are sufficiently impatient. Thus frequent reports, combined with shareholder impatience, magnify the attraction of managerial actions that are more likely to produce quick bottom line results. Such pressures disappear when the reporting frequency is decreased. Thus, infrequent reports could provide better incentives for project selection decisions even though they provide less information to the capital market.

2. Related Literature

Prior theoretical work has investigated how capital market pressure and different types of information asymmetries can distort managers’ investment decisions. In the paper referenced above, Stein (1989) shows how capital market pressure induces managers to borrow earnings at unfavorable rates in order to boost current market prices at the cost of destroying shareholder value in the long run when such borrowing is unobservable. Bebchuk and Stole (1993) investigate the informational frictions that can induce firms to either underinvest or overinvest. They show that when firms’ investment decisions are unobservable, managers are induced to underinvest in order to boost their current period earnings. Such underinvestment, in turn, boosts a firm’s current stock price because current earnings are positively correlated with future earnings. However, when a firm’s investment decisions are observable but the profitability of the investment is unobservable, firms acquire an incentive to overinvest in an attempt to convey rosy information about the future. Kanodia and Lee (1998) show that in this case periodic
performance reports play a vital role in disciplining the incentive to overinvest. More recently, Ewert and Wagenhofer (2005) show that increased price pressure results in less efficient decisions by management. In their setting tighter accounting standards result in greater price pressure because the relationship between accounting earnings and underlying transactions is strengthened. Consequently tightening accounting standards makes the accounting more "value relevant" and increases the incentive to engage in real earnings management.

Our paper differs from prior literature in some important ways. Our main objective is not to study the impact of price pressure \textit{per se}. Rather we seek to identify the costs and benefits of increasing the frequency of financial reporting. We show that when the firm’s project choice is unobservable, increasing the frequency of financial reporting increases price pressure on insiders. As in prior studies, such as Stein (1989) and Ewert and Wagenhofer (2005), this price pressure could induce firms to choose myopic projects in order to boost their current market prices. We also show that there are clear benefits to increasing the frequency of financial reporting. As in Kanodia and Lee (1998), the benefit of more reporting is to discipline the incentive to invest in negative NPV projects when investment is observable but profitability is not. We thereby identify a novel trade-off to increasing the frequency of reporting and illustrate how this trade-off should be made. \footnote{In a different kind of model, Dye (2010) showed that managers who gradually divest their shares over time prefer rules that allows bunching of disclosures at a single point in time, rather than rules that require continuous dissemination of information over the disclosure horizon.}

Prior empirical evidence on the effect of reporting frequency is consistent with our findings. Bhojraj and Libby (2005) manipulate reporting frequency and price pressure in a laboratory experiment and show that corporate managers behave myopically when faced with price pressure and high reporting frequency. These results were obtained in the absence of agency frictions and even when managers had the opportunity to make voluntary disclosures. Ernstberger, Link, and Vogler (2011) empirically investigated the real effects of reporting
frequency in the European Union where less than half of the countries adopted mandatory quarterly reporting while others did not. They found that, relative to semi-annual reporters, quarterly reporters generally exhibit higher levels of “real activities management,” in the form of myopic decisions that increase short-term cash flows at the expense of long-term value.

There are other empirical studies that provide tangential evidence that is consistent with our theoretical predictions. Our model predicts that when firms’ investment decisions are unobservable, price pressure induces them to make sub-optimal investments. This prediction is consistent with the finding of Polk and Sapienza (2009) who show that short-term price pressure (proxied by high share turnover) induces sub-optimal investment for firms whose investments are hard to observe. Our model also predicts that a frequent reporting regime imposes greater discipline on the firm’s investment than an infrequent reporting regime by curbing incentives to invest in negative net present value projects. This prediction implies that firms will be more likely to forego overinvestment and return cash to shareholders in the frequent reporting regime. Consistent with this prediction, Von and Megginson (2008) show that during the period 1989 to 2005 the dividend payout of European Union firms was positively associated with reporting frequency.

3. The Model

Consider a setting where the real cash flow returns to investment by a publicly traded firm depend stochastically upon one of two possible states of nature, state $G$ (good) or state $B$ (bad). Investment is desirable in state $G$ but not in state $B$, in a sense to be described below. The state itself is not observable to any agent in the economy, but can be probabilistically inferred from investment outcomes and signals. The firm’s manager observes a noisy signal $\tilde{S}$ that is informative about the state, before she makes an investment decision. We refer to the state generically as $\sigma$, so $\sigma \in \{G, B\}$ and $\lambda$ as the prior probability that $\sigma = G$. The signal $\tilde{S}$ has fixed support on an interval $[S, \bar{S}]$ and the stochastic relationship between signals and states is
described by the conditional density functions $\xi(S \mid G)$ and $\xi(S \mid B)$. We assume these conditional densities satisfy the strict monotone likelihood ratio property (MLRP), so that higher values of $S$ represent good news. We further assume that the signal becomes perfectly informative in the limit. More explicitly, we assume that:

$$\frac{\xi(S \mid G)}{\xi(S \mid B)}$$

is strictly increasing in $S$.

Also, $\frac{\xi(S \mid G)}{\xi(S \mid B)} \to \infty$ as $S \to \bar{S}$ and $\to 0$ as $S \to \underline{S}$. These assumptions imply that $\text{Prob}(G \mid S)$ is strictly increasing in $S$, that $\lim_{S \to \bar{S}} \text{Prob}(G \mid S) = 1$ and $\lim_{S \to \underline{S}} \text{Prob}(G \mid S) = 0$.

The manager chooses whether or not to invest after observing the signal $S$ and, if she chooses to invest, she chooses between a short-term project and a long-term project (projects $M$ and $L$ respectively). The investment choice is therefore $I \in \{\emptyset, M, L\}$, where the choice of $\emptyset$ indicates the manager does not invest. Cash flows are normalized such that if no investment is made, all period cash flows are identically zero. For reasons that will become apparent later, we assume that projects $M$ and $L$ require the same initial investment of $K$. Investment outlays occur at date zero, and the chosen project, either $M$ or $L$, yields stochastic cash inflows in periods 1 and 2. Let $\tilde{x}_t$ denote the stochastic cash inflows at date $t$ from the chosen project where $t \in \{1, 2\}$.

We assume, for simplicity, that if the state is $B$ then the period by period distributions of cash inflows are identical for each of the two projects, $M$ or $L$, i.e., project choice affects cash inflows only if the state is $G$. Let $f_i(x_t \mid G, L)$ and $f_i(x_t \mid G, M)$, $t \in \{1, 2\}$ denote the probability density functions of cash inflows from projects $L$ and $M$ respectively if the state is $G$ and let $f_i(x_t \mid B, L) = f_i(x_t \mid B, M) = f_i(x_t \mid B)$, $t \in \{1, 2\}$ denote the probability density function of the period $t$ cash inflow if the state is $B$. Each period’s cash inflow from each of the two projects is
stochastically bigger in state $G$ than in state $B$.\(^3\) Additionally, the period 1 cash inflow satisfies strict monotone likelihood ordering
\[
\frac{f_1(x_1 \mid G, I)}{f_1(x_1 \mid B)} \text{ is strictly increasing in } x_1 \text{ for each } I \in \{M, L\}.
\] (2)

Thus, conditional on each of the two projects that the firm can choose, the date 1 cash flow is informative about the state with higher cash inflows increasing the probability that state $G$ has occurred. We additionally assume that, conditional on the state and the project, cash inflows from investment are inter-temporally independent so that the date 1 cash inflow is informative about the date 2 cash inflow only through the information it contains about the state.

The key difference between the long-term and the short-term project is that, in state $G$, the period 1 cash inflow for the short-term project is stochastically bigger than the period 1 cash inflow for the long-term project, but the cumulative cash inflows in the long term (i.e. over two periods) are stochastically smaller for the short-term project than for the long-term project. More precisely:

\[
\tilde{x}_1 \mid G, M \text{ is stochastically bigger than } \tilde{x}_1 \mid G, L, \quad (3)
\]
\[
\tilde{x}_1 + \tilde{x}_2 \mid G, M \text{ is stochastically smaller than } \tilde{x}_1 + \tilde{x}_2 \mid G, L. \quad (4)
\]

Thus, if there is any probability mass on state $G$, no matter how small, the long-term project has a higher expected net present value than the short-term project.\(^4\) Consistent with the idea that investment is desirable in the good state, but undesirable in the bad state, we assume:

\[
E(x_1 + x_2 \mid G, L) > E(x_1 + x_2 \mid G, M) > K, \quad \text{and} \quad (5)
\]

\(^3\) Throughout the paper we use the phrase “stochastically bigger” in the sense of first order stochastic dominance.

\(^4\) Because risk aversion and discounting are irrelevant to the tradeoffs we wish to study, we assume throughout the paper that all agents in the economy are risk neutral and there is no discounting of future cash flows.
We assume that the prior probability of the good state is sufficiently large so that prior to observing \( S \), the long-term project has positive NPV, i.e.,

\[
\lambda E(x_1 + x_2 \mid G, L) + (1 - \lambda) E(x_1 + x_2 \mid B) - K > 0. \quad (7)
\]

Because \( \text{Prob}(G \mid S) \) is strictly increasing in \( S \) and has the limiting properties described in (1), there exists a unique interior threshold \( S_L^* \in (\underline{S}, \bar{S}) \) satisfying:

\[
\text{Prob}(G \mid S_L^*)E(x_1 + x_2 \mid G, L) + \text{Prob}(B \mid S_L^*)E(x_1 + x_2 \mid B) - K = 0 \quad (8)
\]

Therefore the long-term project has negative expected net present value when \( S < S_L^* \) and positive expected net present value when \( S > S_L^* \). Similarly, there exists a unique interior threshold \( S_M^* \in (\underline{S}, \bar{S}) \) satisfying:

\[
\text{Prob}(G \mid S_M^*)E(x_1 + x_2 \mid G, M) + \text{Prob}(B \mid S_M^*)E(x_1 + x_2 \mid B) - K = 0,
\]

so that the short-term project has negative net present value when \( S < S_M^* \) and positive net present value when \( S > S_M^* \). Obviously, \( S_L^* < S_M^* \) and \( \text{Prob}(G \mid S_L^*) < \lambda \).

The firm outlives its current shareholders, and all cash inflows are retained in the firm until some terminal date later than date 2. Thus, current shareholders derive their returns entirely through the pricing of the firm in the capital market. This last assumption is essential to the existence of “price pressure.” If all current shareholders hold the firm until the terminal date and obtain their returns entirely from a liquidating dividend, market pricing becomes irrelevant and there is no scope for price pressure.\(^6\) We assume that each individual shareholder may be one of

\[^5\] This assumption is without loss of generality. The tradeoffs we wish to capture are essentially unaffected if the inequality in (7) is reversed.

\[^6\] Realistically, publicly traded firms do not have well defined terminal dates and do not pay liquidating dividends unless they go into bankruptcy. Also the composition of its shareholders is continuously changing, as witnessed by the enormous volume of trading in the capital market. So the assumption that
two types: a short-term investor who must sell at date 1 or a long-term investor who sells at date 2. Shareholders discover their type only in period 1. Initially at date 0 all shareholders are identical. The probability of being a short-term investor is common knowledge and exogenous, and is parameterized by $\alpha \in [0, 1]$. Thus, ex ante, before shareholder types are revealed, all shareholders would like the firm to choose its investment strategy to maximize:

$$\max \{ \alpha E_0(\tilde{P}_1 | S, I) + (1 - \alpha) E_0(\tilde{P}_2 | S, I) \},$$

where $\tilde{P}_1$ and $\tilde{P}_2$ are equilibrium capital market prices of the firm at dates 1 and 2, respectively, and $E_0$ denotes expectation at date zero conditional on the information available at date zero.\(^7\) In order to isolate the role of price pressure in myopia phenomena, we assume the manager is benevolent and imbibes the preferences of the current shareholders, i.e, the manager always chooses the investment project that maximizes (9). Thus, in our model, there are no conflicts of interest between corporate managers and their shareholders, no managerial career concerns, and therefore no incentive issues that would generate a demand for compensation contracts.\(^8\)

We vary the parameter $\alpha \in [0, 1]$ to capture different degrees of impatience in the shareholder population. Bigger values of the parameter $\alpha$ represent greater impatience in the capital market. While we have exogenously assumed impatience in the capital market, such an assumption is not tantamount to assuming the myopia phenomenon that we wish to explain. We will show that impatience in the capital market, no matter how extreme, cannot by itself produce shareholders obtain their returns through market pricing is much more realistic than the more commonly made assumption that shareholders obtain their returns from terminal dividends.

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\(^7\) This type of objective function is commonly used in models with investors facing uncertain future needs for liquidity. See for example Diamond and Dybvig (1983), Miller and Rock (1985), and Diamond and Verrecchia (1991).

\(^8\) Equivalently we assume that current shareholders have contracted with the manager in such a way that the optimal contract ensures that the manager’s interests are perfectly aligned with those of current shareholders. The existence of this contract would not affect our results. In the concluding section we additionally comment on the possibility of using contracts to alleviate managerial short-termism.
the kind of price pressure that would induce managerial myopia. The sustainability of managerial myopia requires a combination of impatience in the capital market, informational imperfections and frequent financial reporting.

4. Equilibrium with fully informed Capital Markets: The First Best Benchmark

We define a first best world as one where the capital market observes everything that is observable in the economic setting under study. Specifically, the capital market observes all realizations of periodic cash flows, observes the manager’s signal $S$ about the state, observes whether or not the manager has invested and, if she has, whether she has chosen the short-term or the long-term project. In this fully informed economy the date 1 and 2 capital market prices that would prevail, given each of the two project choices $I \in \{L, M\}$ are:

$$P_1(S, I, x_1) = x_1 + \text{Prob}(G | S, I, x_1)E(x_2 | G, I) + \text{Prob}(B | S, I, x_1)E(x_2 | B) - K$$

and,

$$P_2(S, I, x_1, x_2) = x_1 + x_2 - K$$

Also, given that zero investment generates zero cash flow, $P_1(S, \emptyset) = P_2(S, \emptyset) = 0$. The date 1 capital market price, described in (10) incorporates inferences about the hidden state because the expectation of future cash flows depends on which state has occurred. Both $S$ and $x_1$ are incrementally informative about the state, but the information content of $x_1$ depends on which project generated this cash flow. Hence the assessed probability of state $G$ is conditioned by the triple $\{S, I, x_1\}$. However the date 2 price, described in (11), is simply the sum of realized cash flows. There are no inferences about the state embedded in the date 2 price because there are no additional future cash flows from the chosen project.9

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9 Earlier versions of this paper modeled additional cash inflows beyond date 2, in which case the date 2 price also incorporates inferences about the state. The resulting analysis is considerably more complex and
Let \( I(S, \alpha) \) denote the firm’s equilibrium investment strategy. We now examine how impatience in the capital market affects the firm’s equilibrium investment strategy when markets are fully informed.

**Proposition 1:**

*When markets are fully informed, the firm’s equilibrium investment strategy for every value of \( \alpha \in (0,1) \), is:

\[
I(S, \alpha) = L \text{ when } S \geq S^*_L \text{ and } I(S, \alpha) = \emptyset \text{ when } S < S^*_L.
\]

**Proof:** Given the date 1 price function specified in (10):

\[
E_0[P_1 \mid S, I] = E_0(x_1 \mid S, I) + E_0[\text{Prob}(G \mid S, I, x_i) \mid S, I]E_0(x_2 \mid G, I) + E_0[\text{Prob}(B \mid S, I, x_i) \mid S, I]E_0(x_2 \mid B) - K
\]

But, by the law of iterated expectations:

\[
E_0[\text{Prob}(G \mid S, I, x_i) \mid S, I] = \text{Prob}(G \mid S)
\]

Therefore, the date 0 expectation of the date 1 price reduces to:

\[
E_0[P_1 \mid S, I] = \text{Prob}(G \mid S)E_0(x_1 \mid G, I) + \text{Prob}(B \mid S)E_0(x_1 \mid B) + \text{Prob}(G \mid S)E_0(x_2 \mid G, I) + \text{Prob}(B \mid S)E_0(x_2 \mid B) - K
\]

\[
= \text{Prob}(G \mid S)E_0(x_1 + x_2 \mid G, I) + \text{Prob}(B \mid S)E_0(x_1 + x_2 \mid B) - K = E_0(P_2 \mid S, I)
\]

Thus, the date zero expectation of the date 1 and date 2 prices are exactly the same, and simply equal the date 0 expected net present value of the chosen project. Therefore, the relative weight on the date 1 price becomes irrelevant and, for every value of \( \alpha \in [0,1] \), the firm’s project selection problem collapses to:

\[
\max_{i} \text{Prob}(G \mid S)E_0(x_1 + x_2 \mid G, I) + \text{Prob}(B \mid S)E_0(x_1 + x_2 \mid B) - K
\]

requires many more restrictive statistical assumptions, but the tradeoffs of interest are essentially the same as those captured in the present version of the paper.
By (5) and (6) project $L$ is preferred to $M$ for all $S$, and by (8) $∅$ is preferred to $L$ when $L$ has negative net present value, i.e. when $S < S'_L$. $Q.E.D.$

The above result establishes that if the market and the manager have the same information, managerial short-termism cannot be caused by price pressure, no matter how impatient the firm’s current shareholders are. This result is much more general than it seems and easily extends to settings where the returns to investment accrue over an arbitrary number of periods into the future and there are many successive generations of shareholders with each generation caring only about short term price movements. The law of iterated expectations ensures that the date 0 expectation of all future expectations of cash flows is the same as the date 0 expectation of these cash flows. Therefore the date 0 price of the firm equals the expectation of the date 1 price which equals the expectation of the date 2 price and so on and the relative weights on prices doesn’t matter. In such situations, the cost of any myopic behavior is fully internalized by the firm’s current shareholders. They cannot possibly gain by producing attractive short-term cash flows at the expense of long-term cash flows.

But, the assumption that the outside world has the same information as the firm’s manager, at every point of time, is implausible. Realistically, managers make choices based on large amounts of detailed information collected at considerable expense, which is either unavailable to outsiders or difficult to interpret by outsiders. Furthermore, this information is usually soft, sensitive, and unverifiable. This kind of detailed information cannot and is not disclosed in mandatory financial statements that are disseminated to the world at large, nor can it be disclosed on a voluntary basis. What is disclosed is verifiable information on managerial choices and verifiable results of operations. Consistent with these observations, we make the following informational assumptions in the remainder of the paper. First, we assume the capital market cannot observe the manager’s information, $S$, in the light of which she makes her choice. Second, we assume that, while the market can observe the amount of the firm’s investment, it
cannot directly observe whether the project chosen was the short-term project or the long-term project. Third, we assume that accounting reports regarding the results of operations consist of reporting the cumulative cash inflows, $x_1, x_1 + x_2, \ldots$ and so on. In our simple setting with inter-temporal independence of cash flows and perfect measurement of investment outlays, there is no scope for informative accounting accruals. Such accruals arise in more complex settings and cause measurement difficulties and measurement errors of the kind studied in Kanodia and Mukherji [1996] and Kanodia, Sapra and Venugopalan [2004].

When managers make decisions in the light of information that is not available to the capital market, periodic performance reports play a vital role in disciplining those decisions, as shown in Kanodia and Lee [1998]. In the present setting if there were no performance reports in either of the two periods, then market prices in both periods would be based solely on whether the firm has invested or not invested. If the firm has not invested its market price is zero. What is its market price if the firm has been observed to invest? We claim that in the absence of performance reports, investment by itself cannot sustain any inference about the manager’s private information. If investment results in a positive price then all S-types will invest, if it results in a negative price then no S-type will invest. Thus, the manager’s private observation of the signal $S$ is not used at all to guide the manager’s decisions. Consequently, capital market prices must reflect only the prior probability of state G.\(^{10}\) Because the prior probability of state G is sufficiently favorable, as assumed in (7), undisciplined price pressure from the capital market would entrap the firm in a very bad equilibrium where the firm always invests no matter how unfavorable is the manager’s privately observed signal. Thus, the firm would frequently undertake projects that have negative net present value. This observation indicates that some performance reporting is essential, but doesn’t answer the main issue to be examined in this

\(^{10}\) See Brandenburger and Polak (1996) for a fully articulated model of this type.
paper: how frequently should the firm be required to release performance reports to the capital market?

In our two period model, we consider two levels of frequency that we refer to as “frequent” and “infrequent” reporting. In the frequent reporting regime, firms are required to provide reports on the results of their operations at both dates 1 and 2, while in the infrequent reporting regime there is no report at date 1 and the date 2 report discloses the cumulative result of operations up to date 2. In both regimes, at date zero, the market observes the amount that the firm has invested (0 or $K$) but never observes which of the two projects the firm has chosen.

More precisely:

Frequent Reporting: date 1 report is $\{x_1\}$, date 2 report is $\{x_1 + x_2\}$,

Infrequent Reporting: no report at date 1, date 2 report is $\{x_1 + x_2\}$.

Note that while frequent reporting obviously provides more information at date 1, in principle it could also provide more information at date 2 relative to infrequent reporting. In the frequent reporting regime the market can calculate $x_2$ from the date 2 and the date 1 reports, so that the information in the market at date 2 is $\{x_1, x_2\}$. However, in the infrequent reporting regime, information about $x_1$ is lost because of the failure to measure it at date 1, so that at date 2 the market learns only the aggregate two-period cash flow, $x_1 + x_2$. Thus, in principle, frequent reporting could provide both timely and less aggregated information than infrequent reporting. Our model does not do justice to the potential date 2 loss of information due to infrequent reporting because in our model, date 2 is a terminal date and there are no inferences about the future that need to be made.

We do not consider the possibility of voluntary disclosure of the firm’s date 1 cash flow in the infrequent reporting regime. Disclosure is meaningful only if the disclosure is credible. We believe this credibility requirement is largely satisfied for mandatory disclosure because mandatory disclosure is accompanied by mechanisms such as measurement rules, record keeping, paper trails, mandatory audits, and legal liability that are deliberately designed to make the
disclosure credible. The literature on voluntary disclosure simply assumes that any disclosure can be immediately verified without cost so that credible disclosures can be made at will. Then, given that credible disclosure is feasible, silence produces such extreme skepticism that any disclosure becomes preferable to silence. Thus, economic agents would voluntarily and immediately disclose any and all information they possess, making disclosure frequency a moot issue (Grossman (1981) with modifications by Dye (1986) and Jovanovic (1982)). We are unwilling to make the assumptions that make disclosures at will credible because these assumptions are inconsistent with many observed accounting institutions such as the existence of mandatory audits, disclosure mandates, and accounting standards. This does not mean that voluntary disclosures would never be observed. Early voluntary announcements of news that will later be reported in a credible manner (for example, provision of earnings guidance) are certainly feasible. In our analysis a voluntary report of date 1 cash flows would not simply be an early release of credible date 2 reports because the performance report at date 2 describes only the cumulative cash flow up to that date.

5. **Equilibrium with Infrequent Reporting**

In both the infrequent and frequent reporting regimes the date 1 price must reflect the market’s expectation of the date 2 cash flows and therefore the market’s inferences about the hidden state \((G \text{ or } B)\) and the hidden project \((L \text{ or } M)\), while the date 2 price is simply the aggregate cash flow of the firm that is realized and reported at date 2. When capital markets are fully informed, the date 1 price is based upon inferences about the state made from observation of both the information signal \(S\) and the realization of the date 1 cash inflow. However, when the market cannot directly see which project the manager has invested in, or the signal \(S\) that the manager has observed, market prices must be based upon a belief/conjecture of which project the firm has chosen and an inference about the manager’s signal. We impose as an equilibrium requirement that the investment strategy conjectured by the market in forming its prices is the
same investment strategy induced by those prices, i.e., the market’s beliefs are not arbitrary but come from an understanding of how the equilibrium plays out. Because project choice is endogenous and optimal and the market believes it can figure out which project will be selected, there is no scope for Bayesian revisions of the market’s beliefs about project choice in response to noisy cash flow information that may arrive later. These cash flows are used to update beliefs about which state has occurred but cannot be used to update beliefs about which project the firm has undertaken.

In the infrequent reporting regime the date 1 cash inflow $x_1$ is not observed by the market as there is no performance report provided at date 1. So, the date 1 price must incorporate an assessed probability of state $G$ based solely on the observation that the firm chose to invest, rather than to not invest. At date 2, however, the realized cumulative cash inflow $x_1 + x_2$ is reported and is fully reflected in the date 2 price. This implies that the manager’s date zero expectation of the date 2 price will incorporate her actual project choice and her actual observation of $S$. Thus when the manager has observed a value of $S$ below $S_L^*$ she privately expects the date 2 price to be negative even if she invests in the long term project. This disciplines her investment incentives, but the extent of the discipline depends upon the weight $(1 - \alpha)$ on the date 2 price.

Hereafter, we use $\hat{I}$ to denote the market’s conjecture of the firm’s project choice and $I$ to denote its actual project choice. Let $\Omega(\alpha, \hat{I}) \subset [\bar{S}, \bar{S}]$ be the set of signal values at which the market believes the firm will invest, given the relative weight on the date 1 price and
given the market’s belief about which project the firm chooses when it invests. Then investment conveys the information $S \in \Omega(\alpha, \hat{I})$. Given such beliefs and inferences, the date 1 price is:  

$$\varphi_1(\alpha, \hat{I}, x_1 + x_2) = \text{Prob}(\hat{S} | S \in \Omega(\alpha, \hat{I})) E_0(x_1 + x_2 | \hat{S}, \hat{I}) + \text{Prob}(\hat{B} | S \in \Omega(\alpha, \hat{I})) E_0(x_1 + x_2 | \hat{B}) - K$$  

(12)

As in the fully informed economy, the date 2 price does not depend upon any inferences or beliefs and merely equals the cumulative realized cash flow reported at date 2:

$$\varphi_2(\alpha, \hat{I}, x_1 + x_2) = x_1 + x_2 - K$$

(13)

The manager takes these pricing rules as given and beyond her control. Specifically, the beliefs $\hat{I}$ and $\Omega(\alpha, \hat{I})$ used by the market to price the firm at date 1 are beyond the manager’s control and are taken as given. Given this price taking behavior, the date 1 price, $\varphi_1(\alpha, \hat{I})$, as described in (12) is a constant, in the sense that it does not depend upon the project that is actually chosen by the manager or the signal $S$ that she observed. Therefore, for every $\alpha$, the manager’s objective function:

$$\max_{I \in \{L, M\}} \left[ \alpha E_0(\varphi_1 | S, I) + (1 - \alpha) E_0(\varphi_2 | S, I) \right]$$

is equivalent to:

$$\max_{I \in \{L, M\}} \left[ E_0(\varphi_2 | S, I) \right].$$

It is immediate from this observation that the manager has no incentive to invest in the short-term project, yielding:

**Proposition 2:**

*In the infrequent reporting regime, no matter what market beliefs $\{\hat{I}, \Omega(\alpha, \hat{I})\}$ are incorporated in stock prices, the manager strictly prefers project $L$ to project $M$ at every signal $S$ that she may observe and at every value of $\alpha$.*

---

11 In order to distinguish equilibrium prices in this setting from prices in other settings we use the notation $\varphi$ to represent prices in the infrequent reporting regime.
Proof: Obvious from (13) and (4).

Proposition 2 implies that managerial short-termism cannot occur in the infrequent reporting regime, no matter how impatient the firm's current shareholders are. The only reason why the short-term project could be more attractive than the long-term project is that it could boost the date 1 price. But, since there is no performance report at date 1, the date 1 price becomes an exogenous constant. It cannot be boosted by producing attractive short-term cash flows by choosing the short-term project.

Proposition 2 also implies that the only sustainable belief for the capital market is that whenever the firm chooses to invest, it invests in project $L$ rather than project $M$. The equilibrium pricing rules in the capital market must reflect this fact, and therefore in equations (12) and (13) the conjectured project $\hat{I}$ must be replaced by the known project $L$. We use this fact in the remainder of the analysis.

We now examine the firm's choice between projects $L$ and $\emptyset$ and establish the properties of the set $\Omega(\alpha, L)$ of $S$ values at which the firm prefers $L$ to $\emptyset$ and therefore chooses to invest. If the firm does not invest its expected payoff is zero, regardless of the signal $S$ that it has observed. If it invests in project $L$, the firm's expected payoff is:

$$\alpha \varphi_1 + (1 - \alpha) E_0[\varphi_2 | S, L].$$

Because $\operatorname{Prob}(G | S)$ is strictly increasing in $S$,

$$E_0[\varphi_2 | S, L] = \operatorname{Prob}(G | S) E_0(x_1 + x_2 | G, L) + \operatorname{Prob}(B | S) E_0(x_1 + x_2 | B) - K$$

is strictly increasing in $S$ while $\varphi_1$ is a constant independent of $S$. Consequently the firm's expected payoff from investing in project $L$ is strictly increasing in $S$. Therefore, if any type $\hat{S}$ prefers investing in $L$ to not investing, then all higher types will also prefer to invest in $L$. Therefore, there exists some threshold $T_I(\alpha, L) \geq \hat{S}$ in the signal space such that $\Omega(\alpha, L)$ is the upper interval $[T_I(\alpha, L), \bar{S}]$. 

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Given that the set of types who invest must constitute an upper interval the date 1 price can be rewritten as:

\[ \varphi_1(T_I(\alpha, L), L) = \text{Prob}(G \mid S \geq T_I(\alpha, L))E_0(x_1 + x_2 \mid G, L) + \text{Prob}(B \mid S \geq T_I(\alpha, L))E_0(x_1 + x_2 \mid B) - K \]  

(15)

The threshold \( T_I(\alpha, L) \) describes the discipline that is present in the infrequent reporting regime. If at some values of \( \alpha \), \( T_I(\alpha, L) = S \) then at those values of \( \alpha \) there is no discipline because all types invest no matter how negative the NPV of project \( L \)–associated with those types–are. But if \( T_I(\alpha, L) > S \) sufficiently low types are deterred from investing, so the probability that the firm undertakes negative NPV projects is diminished. Perfect discipline requires that \( T_I(\alpha, L) = S^*_L, \forall \alpha \). If \( T_I(\alpha, L) > S \) the marginal type \( S = T_I(\alpha, L) \) must be indifferent between investing in project \( L \) and not investing. In this case \( T_I(\alpha, L) \) must satisfy:

\[ \alpha\varphi_1(T_I(\alpha, L), L) + (1 - \alpha)E_0[x_1 + x_2 - K \mid S = T_I(\alpha, L), L] = 0 \]  

(16)

The properties of the equilibrium threshold are derived below:

**Proposition 3:** In the infrequent reporting regime, the threshold below which the firm refrains from investing satisfies:

i. \( T_I(\alpha, L) = S \) if and only if \( \alpha \) is sufficiently close to 1,

ii. \( T_I(\alpha, L) = S^*_L \) at \( \alpha = 0 \),

iii. \( T_I(\alpha, L) < S^*_L, \forall \alpha > 0 \)

iv. \( T_I(\alpha, L) \) is strictly decreasing at all values of \( \alpha \) where \( T_I(\alpha, L) > S \)

**Proof:** See the Appendix.

Proposition 3 indicates that the date 2 performance report dissuades the manager from investing if the net present value of the project is sufficiently negative. But, the discipline is not
perfect since $T_i < S_L^*$ at almost all values of $\alpha$. Also, the date 2 performance report is less
effective when there is greater impatience in the capital market ($\alpha$ is larger).

6. Equilibrium with Frequent Reporting

The only difference between the frequent and infrequent reporting regimes is that in the
frequent reporting regime there is a performance report at date 1 that reveals the first period cash
inflow $x_1$, in addition to the date 2 performance report that reveals the cumulative two period cash
flow $x_1 + x_2$. As in the infrequent reporting regime, the date 1 capital market price is based upon
a conjectured investment project because the firm’s actual project choice is not observed. Also,
because of the discipline provided by performance reports, there will be thresholds in the space of
signals such that the firm invests only if the private signal it observes lies above this threshold.

Let $\hat{I}, I \in \{L, M\}$ be the conjectured and actual project choices of the firm, respectively. Let $T_F$ be the threshold above which the market believes that the firm invests, so that upon seeing
that the firm has invested the market must infer that $S \geq T_F$. We show later that $T_F$ depends
upon $\alpha$ and $\hat{I}$, but suppress this dependence for the time being. The pair $\{T_F, \hat{I}\}$ constitutes
market pricing parameters on which the firm has no control, and must take as given. Given these
parameters and given that $x_1$ is reported at date 1, the date 1 price of the firm is:

$$P_1(T_F, x_1, \hat{I}) = x_1 + \text{Prob}(G \mid S \geq T_F, x_1, \hat{I}) E(x_2 \mid G, \hat{I}) + \text{Prob}(B \mid S \geq T_F, x_1, \hat{I}) E(x_2 \mid B) - K$$

(17)

As described in (17), the market’s assessment of the probability of state $G$ is conditioned by the
inference that $S \geq T_F$ and by the value of $x_1$ as revealed by the performance report. The presence
of $\hat{I}$ in this assessment is due to the fact that the information extracted from $x_1$ depends on which
project the market believes generated that cash flow. Because the date 1 cash flow satisfies
MLRP, as specified in (2), higher values of $x_1$ increase the assessed probability of state $G$ for
each specification of $T_f, \hat{I}$. Therefore, the date 1 price is strictly increasing in $x_1$ for all possible values of the pricing parameters, $T_f, \hat{I}$. As before, the date 2 price does not depend upon any inference and simply equals the realized and reported cumulative cash flows:

$$P_2 = x_1 + x_2 - K$$ (18)

Because the date 1 price is strictly increasing in $x_1$ and because the short-term project produces stochastically bigger date 1 cash flows, the manager’s expectation of the date 1 price, conditional on every observed value of $S$, must be greater if the manager undertakes the short-term project than the long-term project, i.e.,:

$$E_0[P_1 \mid S, M] > E_0[P_1 \mid S, L], \forall \{S, T_f, \hat{I}\}$$

And because the long-term project produces stochastically bigger cumulative cash flows over the two period horizon:

$$E_0[P_2 \mid S, M] < E_0[P_2 \mid S, L], \forall S$$

Thus, in the frequent reporting regime, the manager faces a non-trivial tradeoff when choosing between the short and long-term projects. The first period price pressures the manager to choose the short-term project, while the second period price pressures the manager to choose the long-term project. Let:

$$\Delta_1 \equiv E_0(P_1 \mid S, M) - E_0(P_1 \mid S, L), \text{ and}$$

$$\Delta_2 \equiv E_0(P_2 \mid S, L) - E_0(P_2 \mid S, M)$$

Note that both $\Delta_1$ and $\Delta_2$ vary with $S$, and additionally $\Delta_1$ depends on the pricing parameters $\{T_f, \hat{I}\}$ that are incorporated in the date 1 price. Then, given the pricing parameters $\{T_f, \hat{I}\}$, the manager prefers the long-term project to the short-term project at $\{\alpha, S\}$ if and only if:

$$\alpha \Delta_1 \leq (1 - \alpha) \Delta_2$$ (19)
In general, the manager’s preferences between the short-term and long-term projects are extremely complex because the satisfaction of (19) depends on the 4-tuple, \( \alpha, S, T_F, \hat{I} \).

However our assumption that cash flows in the bad state \( B \) are independent of the project that is implemented simplifies the manager’s preferences considerably:

**Lemma 1:**

The firm’s preferences over projects \( L \) and \( M \) are unaffected by variations in \( S \) at each given triple \( \{ \alpha, T_F, \hat{I} \} \). At each \( \{ \alpha, S, T_F, \hat{I} \} \), the firm prefers project \( L \) over \( M \) if and only if:

\[
E(x_1 \mid G, M) - E(x_1 \mid G, L) + \alpha \left[ E(x_2 \mid G, L) - E(x_2 \mid B) \right] \int \text{Prob}(S \geq T_F, x_1, \hat{I})[f_1(x_1 \mid G, M) - f_1(x_1 \mid G, L)] dx_1 \geq 0
\]

\[
(1 - \alpha) \left[ E(x_2 \mid G, L) - E(x_2 \mid G, M) \right] \leq (1 - \alpha) \left[ E(x_2 \mid G, L) - E(x_2 \mid G, M) \right]
\]

**Proof:** See the Appendix.

The reason why the manager’s private information \( S \) does not affect her preferences between projects \( L \) and \( M \) is as follows: our assumption that the choice of project affects cash flows only in state \( G \) and not in state \( B \) implies that the manager’s preferences are affected only by her assessment of cash flows in state \( G \). This assumption, in turn, implies that the probability of state \( G \) becomes irrelevant to the manager. Because the manager uses her knowledge of \( S \) only to upgrade her assessment of state \( G \), her preferences become independent of \( S \).

In equilibrium, the parameters \( \{T_F, \hat{I}\} \) that are imbedded in the date 1 pricing rule must be such that the firm is indifferent between projects \( \hat{I} \) and \( \emptyset \) when its private signal \( S \) equals \( T_F \). Therefore if \( T_F > S \), \( T_F \) must satisfy:

\[
\alpha E_0 \left[ \left( x_1 + \text{Prob}(G \mid S \geq T_F, x_1, \hat{I}) E(x_2 \mid G, \hat{I}) + \text{Prob}(B \mid S \geq T_F, x_1, \hat{I}) E(x_2 \mid B) \right) \mid S = T_F(\alpha, \hat{I}, \hat{I}) \right] + (1 - \alpha) E_0[x_1 + x_2 \mid S = T_F(\alpha, \hat{I}, \hat{I})] - K = 0
\]
Since the expected payoff to investment depends on the weights on the date 1 and date 2 prices as well as on the conjectured project that is built into these prices, as described in (21), the thresholds at which the firm is indifferent between investing and not investing varies with \( \alpha \) and \( \hat{I} \). Also, because the left hand side of (21) is strictly increasing in \( T_F \), \( T_F(\alpha, \hat{I}) = S \) if the left hand side of (21) is strictly greater than zero at \( T_F = S \).

The equilibrium properties of these thresholds are developed in Proposition 4 below which, in turn, depends on the price relationships described in Lemma 2.

**Lemma 2**

For any given \( T_F \in [S, \overline{S}] \) and any given \( \hat{I} \in \{L, M\} \),

\[
E_0[P \mid S = T_F, \hat{I}] > E_0[P_2 \mid S = T_F, \hat{I}]
\]

**Proof:** See the Appendix.

Lemma 2 says that, conditional on the marginal type that invests and conditional on any conjectured project, the expectation of the first period price is strictly larger than the expectation of the second period price. This effect is due to the discipline provided by performance reporting. There is more discipline built into the second period price than the first period price because the second period price is disciplined by both the first and second period performance reports, while the first period price is disciplined by only the first period performance report.

**Proposition 4:**

In the frequent reporting regime, the threshold \( T_F(\alpha, L) \) at which the firm is indifferent between \( L \) and \( \emptyset \) and the threshold \( T_F(\alpha, M) \) at which the firm is indifferent between \( M \) and \( \emptyset \) satisfy:

1. At \( \alpha = 0 \), \( T_F(\alpha, L) = S_L^* \), and \( T_F(\alpha, M) = S_M^* \)
ii. At all values of \( \alpha > 0 \), \( T_F(\alpha, L) < S_L^* \), and \( T_F(\alpha, M) < S_M^* \)

iii. \( \frac{\partial}{\partial \alpha} T_F(\alpha, \hat{I}) < 0 \) if \( T_F(\alpha, \hat{I}) > S, \ \forall \hat{I} \in \{L, M\} \).

**Proof:** See the Appendix.

Equilibrium requires that the project conjectured by the market and built into the pricing rule is the same project that is actually chosen by the manager. Therefore, Project \( L \) is sustained in equilibrium at \( \{\alpha, S\} \) if and only if \( L \) is preferred to both \( M \) and \( \emptyset \) when the parameters \( \{T_F, \hat{I}\} \) that are built into the pricing rule are \( T_F = T_F(\alpha, L) \) and \( \hat{I} = L \). Thus, project \( L \) is sustained in equilibrium at \( \{\alpha, S\} \) if and only if \( S \geq T_F(\alpha, L) \) and from (21):

\[
E(x_1 \mid G, M) - E(x_1 \mid G, L) + \alpha [E(x_2 \mid G, L) - E(x_2 \mid B)] \int \text{Prob}(G \mid S \geq T_F(\alpha, L), x_1, L)[f_1(x_1 \mid G, M) - f_1(x_1 \mid G, L)] dx_1 \leq (1 - \alpha) [E(x_2 \mid G, L) - E(x_2 \mid G, M)]
\]

(22)

Similarly project \( M \) is sustained in equilibrium at \( \{\alpha, S\} \) if and only if \( S \geq T_F(\alpha, M) \) and

\[
E(x_1 \mid G, M) - E(x_1 \mid G, L) + \alpha [E(x_2 \mid G, L) - E(x_2 \mid B)] \int \text{Prob}(G \mid S \geq T_F(\alpha, M), x_1, M)[f_1(x_1 \mid G, M) - f_1(x_1 \mid G, L)] dx_1 > (1 - \alpha) [E(x_2 \mid G, L) - E(x_2 \mid G, M)]
\]

(23)

We first determine sufficient conditions under which myopia is sustained in equilibrium, i.e., conditions under which (23) is satisfied. The second term in (23) is strictly positive at every \( \alpha > 0 \) because \( E(x_2 \mid G, L) > E(x_2 \mid B) \) and stochastic dominance implies,

\[
\int \text{Prob}(G \mid S \geq T_F(\alpha, M), x_1, M)[f_1(x_1 \mid G, M) - f_1(x_1 \mid G, L)] dx_1 > 0
\]

Therefore sufficient conditions for project \( M \) to be sustained in equilibrium are \( S \geq T_F(\alpha, M) \) and:

\[
\{E(x_1 \mid G, M) - E(x_1 \mid G, L)\} > (1 - \alpha)\{E(x_2 \mid G, L) - E(x_2 \mid G, M)\}
\]

(24)
or equivalently if:

$$\alpha > \alpha^* \equiv \frac{E(x_1 + x_2 \mid G,L) - E(x_1 + x_2 \mid G,M)}{E(x_2 \mid G,L) - E(x_2 \mid G,M)} \tag{25}$$

Because $E(x_1 \mid G,L) - E(x_1 \mid G,M) < 0$ it is necessarily the case that $0 < \alpha^* < 1$. Also, the satisfaction of (24) implies that (22) is necessarily violated. Therefore in the interval $\alpha \geq \alpha^*$, project $M$ is the uniquely sustainable investment project.

The conditions under which project $L$ is sustained in equilibrium are implicitly described by (22). While it is numerically feasible to verify whether (22) is satisfied or not at any specified value of $\alpha$, it is difficult to restate (22) in terms of sufficient conditions on the value of $\alpha$ because the expression $\int \text{Prob}(G \mid S \geq T_F, x_1, M)[f_1(x_1 \mid G, M) - f_1(x_1 \mid G, L)] \, dx_1$ contained in the left hand side of (22) cannot be ignored. This quantity varies with $\alpha$ in unknown ways because, even though the threshold $T_F$ varies with $\alpha$ in a predictable way, nothing is known about how

$$\int \text{Prob}(G \mid S \geq T_F, x_1, M)[f_1(x_1 \mid G, M) - f_1(x_1 \mid G, L)] \, dx_1$$

varies with $T_F$. However, the limiting behavior of (22) sheds some light on when project $L$ is clearly sustainable. As $\alpha \to 0$ the left hand side of (22) converges to the constant $E(x_1 \mid G, M) - E(x_1 \mid G, L)$ and the right hand side of (22) converges to $E(x_2 \mid G, L) - E(x_2 \mid G, M)$. Then since $E(x_1 \mid G, M) - E(x_1 \mid G, L) < E(x_2 \mid G, L) - E(x_2 \mid G, M)$, project $L$ is clearly sustained in equilibrium at values of $\alpha$ close to zero. The following proposition summarizes our findings.

**Proposition 5:**

If the firm’s shareholders are sufficiently patient ($\alpha$ close to zero) the long-term project is sustained in the equilibrium of the frequent reporting regime. There exists a critical level of impatience ($\alpha^*$) beyond which only the short-term project can be sustained in equilibrium.
Non-sustainability of the short-term project at some value of $\alpha$ does not imply that the long-term project is sustained in equilibrium at that value of $\alpha$ because it is possible that (22) and (23) are simultaneously violated. At such a value of $\alpha$, the manager prefers the short-term project when the market prices the firm as if it has implemented the long-term project and, at the same time, the manager prefers the long-term project when the market prices the firm as if it has implemented the short-term project. Therefore, in this case, there is no pure strategy equilibrium, and mixed project selection strategies could emerge.

However, we have shown that frequent reporting will unambiguously induce managerial short-termism if the degree of impatience in the capital market is sufficiently high ($\alpha \geq \alpha^*$). This result is consistent with the intuition expressed in the European debate, described earlier. Since managerial short-termism never occurs in the infrequent reporting regime, but does occur in the frequent reporting regime, Proposition 5 identifies a potentially large endogenous cost that could be precipitated by increasing the frequency of financial reporting.

7. Is Frequent Reporting Socially Desirable?

We measure social welfare as the \textit{ex ante} expected surplus (before $S$ is privately observed by managers) over the two period investment horizon, without regard to how that surplus is divided between individual shareholders (current and future). We have in mind a regulator who is concerned solely with economic efficiency. The regulator is empowered to choose the reporting frequency and implement it by fiat.

Welfare comparisons depend upon whether the long-term or short-term project is sustained in the equilibrium of the frequent reporting regime. First, consider the case where the long-term project is sustained in the equilibrium of the frequent reporting regime. The values of $S$ at which the firm invests in the long-term project are $S \geq T_I(\alpha, L)$ in the infrequent reporting regime and $S \geq T_F(\alpha, L)$ in the frequent reporting regime. Since both thresholds lie below the first best threshold $S^*_I$ at every value of $\alpha > 0$, in both regimes the firm sometimes invests in
negative net present value projects. We show that, at every value of $\alpha > 0$, the frequent reporting regime imposes greater discipline on the firm’s investment so that the probability of investing in negative net present value projects is strictly smaller in the frequent reporting regime than in the infrequent reporting regime.

**Proposition 6:**

(i) If $T_F(\alpha, L) = S$ then $T_I(\alpha, L) = T_F(\alpha, L)$

(ii) If $T_F(\alpha, L) > S$ then $T_I(\alpha, L) < T_F(\alpha, L)$

**Proof:** See the Appendix.

We have shown that when the firm’s shareholders are sufficiently patient ($\alpha$ close to zero), there are strict benefits to increasing the reporting frequency and there are no costs since greater reporting frequency does not result in managerial short-termism. The benefits are due to the greater discipline imposed by more frequent reporting on the firm’s incentive to invest in negative net present value projects. This implies:

**Proposition 7:** If the firm’s current shareholders are sufficiently patient so that the long-term project is sustained in the equilibrium of the frequent reporting regime then frequent reporting of the results of operations dominates infrequent reporting.

Now consider the case where the firm’s shareholders are sufficiently impatient ($\alpha > \alpha^*$ as defined in (25)), so that frequent reporting triggers short-termism. Since the short-term project has lower net present value than the long-term project, this induced myopia lowers social welfare. But, because frequent reporting provides greater discipline it could decrease the probability of undertaking negative net present value projects. So, potentially, there are also benefits to frequent reporting. We explore this tradeoff below.

Given that in the infrequent reporting regime the firm always invests in project $L$, but in the frequent reporting regime the firm invests in project $M$, the relevant thresholds above which the firm invests are $T_I(\alpha, L)$ in the infrequent reporting regime and $T_F(\alpha, M)$ in the frequent
reporting regime. While it is true that \( T_f(\alpha, M) \leq T_f(\alpha, M) \), without imposing additional restrictions, the thresholds \( T_f(\alpha, L) \) and \( T_f(\alpha, M) \) are not comparable. We therefore consider each possibility. If \( T_f(\alpha, L) \geq T_f(\alpha, M) \) at some value of \( \alpha \) where frequent reporting triggers managerial short-termism, then there are no benefits to frequent reporting while the cost remains, so that infrequent reporting unambiguously dominates frequent reporting. However, if \( T_f(\alpha, L) < T_f(\alpha, M) \) there are both costs and benefits to frequent reporting, so there is a non-trivial tradeoff.

Let \( \Pi_f(\alpha) \) and \( \Pi_F(\alpha) \) be the \textit{ex ante} expected surplus from investment in the infrequent and frequent reporting regimes, respectively. Let \( \xi(S) = \lambda \xi(S | G) + (1 - \lambda) \xi(S | B) \) be the unconditional density of the manager’s private signal. Then, for values of \( \alpha \) at which frequent reporting induces managerial short-termism:

\[
\Pi_f(\alpha) = \\
\int_{T_f(\alpha, L)}^S \{ \text{Prob}(G | S) E_0(x_1 + x_2 | G, L) + \text{Prob}(B | S) E_0(x_1 + x_2 | B, L) - K \} \xi(S) dS ,
\]

and

\[
\Pi_F(\alpha) = \\
\int_{T_f(\alpha, M)}^S \{ \text{Prob}(G | S) E_0(x_1 + x_2 | G, M) + \text{Prob}(B | S) E_0(x_1 + x_2 | B, M) - K \} \xi(S) dS
\]

Therefore, if \( T_f(\alpha, L) < T_f(\alpha, M) \),

\[
\Pi_f(\alpha) - \Pi_F(\alpha) = \\
\int_{T_f(\alpha, L)}^{T_f(\alpha, M)} \{ \text{Prob}(G | S) E_0(x_1 + x_2 | G, L) + \text{Prob}(B | S) E_0(x_1 + x_2 | B) - K \} \xi(S) dS \\
+ \int_{T_f(\alpha, M)}^S \{ \text{Prob}(G | S) [E_0(x_1 + x_2 | G, L) - E_0(x_1 + x_2 | G, M)] \} \xi(S) dS \quad (26)
\]
The second term in (26) is positive since the long-term project has a higher net present value than the short-term project in state $G$. The first term in (26) is negative since, at $\alpha > \alpha^*$, $T_F(\alpha, M) < S^*_{L}$ and the long-term project has negative net present value at each $S < S^*_{L}$.

The second term of (26) describes the benefit of infrequent reporting arising from the result that infrequent reporting sustains the long-term project while frequent reporting causes managerial short-termism. The first term describes the cost associated with infrequent reporting arising from the lower discipline imposed by infrequent reporting relative to frequent reporting. If the sum of these two terms is positive then infrequent reporting dominates frequent reporting given that the degree of impatience in the capital market is large enough to trigger managerial short-termism.

The tradeoff specified in (26) is specific to the degree of impatience in the capital market, and it also depends upon the endogenous thresholds $T_I(\alpha, L)$ and $T_F(\alpha, M)$. An unconditional result that applies to all of the impatience levels that cause managerial short-termism can be obtained by calculating a lower bound to the benefits and an upper bound to the costs of infrequent reporting relative to frequent reporting. These bounds can be calculated by replacing $T_F(\alpha, M)$ by $S^*_{M}$, and replacing $T_I(\alpha, L)$ by $S$ in (26). This yields:

**Proposition 8:**

In frequent reporting dominates frequent reporting for all levels of impatience exceeding the threshold that triggers managerial short-termism if:

$$\int_{S^*_{L}}^{S^*_{M}} \left[ \text{Prob}(G | S) \left[ E_0(x_1 + x_2 | G, L) - E_0(x_1 + x_2 | G, M) \right] \right] \xi(S) dS + \int_{S^*_{M}}^{S} \left[ \text{Prob}(G | S) E_0(x_1 + x_2 | G, L) + \text{Prob}(B | S) E_0(x_1 + x_2 | B) - K \right] \xi(S) dS > (27)$$

8. Discussions and Conclusions
The policy implications we have derived from a study of the real effects of disclosure stand in strong contrast to the policy implications implied by the study of pure exchange economies. In pure exchange economies, the firm’s business decisions are held fixed, so the only effect of disclosure is to decrease the residual uncertainty of a fixed exogenous distribution of liquidating dividends. In a risk averse economy, such reductions in residual uncertainty decrease the risk premium incorporated in equilibrium capital market prices.\footnote{See Verrecchia [2001]} Thus, one would mistakenly conclude that greater frequency of disclosure is always desirable, and the only cost that would prevent disclosure frequency from degenerating into weekly or even daily reports is the legal and book-keeping costs of compliance. Our study also illustrates the importance of distinguishing “price efficiency” from “economic efficiency.” It may seem that any new disclosure mandate that adds information to the capital market and thus makes prices “more efficient” must promote social welfare. Such a result always holds in a first best world or when enhanced disclosure is so rich that it moves the economy to a first best world. However, when a first best world is unattainable, the provision of new information to the capital market could motivate firms to change their business decisions in such a way that economic efficiency suffers even though price efficiency is enhanced. By explicitly analyzing such real effects, we have shown that infrequent reporting could provide better incentives for investment by destroying information. This result may seem counterintuitive in the light of Blackwell’s theorem, but begins to make sense when we take into account that that information has strategic consequences, i.e., it changes the world that is being assessed.

We have chosen to model the benefits to periodic performance reporting in terms of the discipline they impose on managerial decisions that are made prior to the release of the report, as first described in Kanodia and Lee [1998]. An alternative, and more popular, view is that such reports guide subsequent investment decisions that new investors may intend to make after
buying into the firm. Our view is that such a situation is analogous to the raising of new capital through an IPO or a seasoned equity offering. Not only are such offerings rare, but they are always accompanied by a detailed prospectus and forecasts by underwriters and analysts that contain much more information than is typically contained in periodic accounting reports. We have tried to capture the benefits of performance reports that are *routinely* disseminated to the capital market at fixed pre-specified intervals, regardless of whether the firm intends to raise new capital. We think the debate on disclosure frequency is more concerned with such routine periodic reports.

It may seem that the inefficiency caused by frequent disclosure could easily be mitigated by appropriately designed managerial compensation contracts. Surely, any compensation contract that rewards the manager solely on the basis of cumulative long-term cash flows would induce her to choose the long-term project, rather than the short-term project. It may seem that such a contract would also benefit the firm’s current shareholders, since capital market valuations would improve. However, the benefit to current shareholders, from such a contract, comes not from aligning the incentives of the manager with that of current shareholders – by assumption, their incentives are already perfectly aligned. The benefits come from signaling to *future* shareholders that the manager will not behave opportunistically. But having so convinced future shareholders, current shareholders would *want* the manager to behave in an opportunistic way, so any such contract would quickly unravel.\(^\text{13}\) The problem lies not in the short-termism of the manager but in the short-termism of current shareholders. So, what would be needed is a contract between *current* and *future shareholders* which alleviates the short-termism of current shareholders. Such a contract is problematic because future shareholders constitute an unidentifiable faceless crowd in the capital market. We think that regulators, such as the SEC, are mindful of such difficulties associated with contracting, and have chosen mandatory corporate

\(^{\text{13}}\) See Persons [1994] for a rigorous articulation of such an argument.
Disclosure as the principal mechanism for mediating the tension between current and future shareholders. In previous work, we have demonstrated repeatedly that the effectiveness of such disclosure requirements depends critically on the choice of accounting measurement rules. In the present paper, we have shown that the frequency of disclosure is also a critical policy choice available to regulators and we have demonstrated that a judicious choice of disclosure frequency could help in curbing managerial short-termism.

\[14\] See Kanodia [2006] for a survey of research that documents the effect of accounting measurement rules on corporate decisions through the interaction of those decisions with market pricing.
Appendix

Proof of Proposition 3:

To prove part (i) of the proposition note that \( \text{Prob}(G | S \geq S) = \lambda \) where \( \lambda \) is the prior probability of state \( G \), and \( \text{Pr} \, ob(G | S = S) = 0 \). Using these facts, \( T_I(\alpha, L) = S \) if and only if:

\[
\alpha \left[ \lambda E_0(x_1 + x_2 | G, L) + (1 - \lambda)E_0(x_1 + x_2 | B) - K \right] + (1 - \alpha) \left[ E_0(x_1 + x_2 | B) - K \right] \geq 0
\]

(A1)

The inequality assumed in (7) guarantees that (A1) holds at \( \alpha = 1 \), and by continuity it must continue to hold at values of \( \alpha \) sufficiently close to 1. But (A1) cannot hold for all values of \( \alpha \) because \( E_0(x_1 + x_2 | B) - K < 0 \). Part (ii) of the proposition follows from the fact that at \( \alpha = 0 \), \( T_I(\alpha, L) \) must satisfy:

\[
\text{Prob}(G | T_j)E_0(x_1 + x_2 | G, L) + \text{Prob}(B | T_j)E_0(x_1 + x_2 | B) - K = 0
\]

which, by definition, is satisfied uniquely at \( T_i = S^*_L \). Part (iii) of the proposition is implied by part (iv), so we turn to proving part (iv).

Since (16) must hold at all \( \alpha \) where \( T_I(\alpha, L) > S \),

\[
\frac{\partial}{\partial \alpha} \left[ \alpha \varphi_i(T_I(\alpha, L), L) + (1 - \alpha)E_0[x_1 + x_2 - K | S = T_I(\alpha, L), L] \right] = 0
\]

Therefore,

\[
\varphi_i(T_i, L) - E_0[x_1 + x_2 - K | T_i, L] + \frac{\partial T_i}{\partial \alpha} \left( \alpha \frac{\partial \varphi_i}{\partial T_i} + (1 - \alpha) \frac{\partial E_0(x_1 + x_2 | T_i, L)}{\partial T_i} \right) = 0 \quad \text{(A2)}
\]

Now from (14) and (15),

\[
\varphi_i(T_i, L) > E_0(x_1 + x_2 - K | T_i, L) \quad \text{because} \quad \text{Prob}(G | S \geq T_i) > \text{Pr} \, ob(G | T_i).
\]

Also, from (15), \( \frac{\partial \varphi_i}{\partial T_i} > 0 \) because \( \frac{\partial \text{Prob}(G | S \geq T_i)}{\partial T_i} > 0 \)
and from (14) \( \frac{\partial E_0(x_1 + x_2 | T_i, L)}{\partial T_i} > 0 \) because \( \frac{\partial \text{Prob}(G | T_i)}{\partial T_i} > 0 \).

Therefore, (A2) implies \( \frac{dT_i}{d\alpha} < 0 \). \( Q.E.D. \)

**Proof of Lemma 1**

By definition:

\[
\Delta_1 = \int P_i(T_F, x_1, \hat{I})[f_1(x_1 | S, M) - f_1(x_1 | S, L)] dx_1.
\]

But,

\[
f_1(x_1 | S, M) - f_1(x_1 | S, L) = \text{Prob}(G | S)f_1(x_1 | G, M) + \text{Prob}(B | S)f_1(x_1 | B) - [\text{Prob}(G | S)f_1(x_1 | G, L) + \text{Prob}(B | S)f_1(x_1 | B)].
\]

Therefore,

\[
\Delta_1 = \text{Prob}(G | S) \int P_i(T_F, x_1, \hat{I})[f_1(x_1 | G, M) - f_1(x_1 | G, L)] dx_1.
\]

Using the pricing rule described in (18),

\[
\Delta_2 = E(x_1 + x_2 | S, L) - E(x_1 + x_2 | S, M)
\]

\[
= \text{Prob}(G | S)E(x_1 + x_2 | G, L) + \text{Prob}(B | S)E(x_1 + x_2 | B) - [\text{Prob}(G | S)E(x_1 + x_2 | G, M) + \text{Prob}(B | S)E(x_1 + x_2 | B)]
\]

\[
= \text{Prob}(G | S)[E(x_1 + x_2 | G, L) - E(x_1 + x_2 | G, M)]
\]

Therefore, (19) is equivalent to:

\[
\alpha \int P_i(T_F, x_1, \hat{I})[f_1(x_1 | G, M) - f_1(x_1 | G, L)] dx_1 \leq (1 - \alpha)[E(x_1 + x_2 | G, L) - E(x_1 + x_2 | G, M)]
\]

which does not depend on \( S \). Using the pricing rule for the date 1 price described in (17), the above inequality is equivalent to:

\[
\alpha[E(x_1 | G, M) - E(x_1 | G, L)] + \alpha[E(x_2 | G, \hat{I}) - E(x_2 | B)] \int \text{Prob}(G | S \geq T_F, x_1, \hat{I})[f_1(x_1 | G, M) - f_1(x_1 | G, L)] dx_1
\]
\[ \leq (1 - \alpha)[E(x_1 | G,L) + E(x_2 | G,L) - E(x_1 | G,M) - E(x_2 | G,M)] \]

which is equivalent to (20). \( Q.E.D. \)

**Proof of Lemma 2**

From the perspective of the marginal type who invests, the date 0 expectation of the date 1 price is:

\[ E_0[P_1 | T_F, \hat{I}] = E_0(x_1 | T_F, \hat{I}) + E_0[\text{Prob}(G | S \geq T_F, x_1, \hat{I} | T_F, \hat{I})E(x_2 | G, \hat{I}) + \]

\[ E_0[\text{Prob}(B | S \geq T_F, x_1, \hat{I} | T_F, \hat{I})E(x_2 | B) - K] \]

The date 0 expectation of the date 2 price is:

\[ E_0[P_2 | T_F, \hat{I}] = E_0(x_1 | T_F, \hat{I}) + E_0(x_2 | T_F, \hat{I}) - K \]

where,

\[ E(x_2 | T_F, \hat{I}) = \text{Prob}(G | T_F)E(x_2 | G, \hat{I}) + \text{Prob}(B | T_F)E(x_2 | B) \]

Therefore it suffices to prove that:

\[ E_0[\text{Prob}(G | S \geq T_F, x_1, \hat{I} | T_F, \hat{I}) > \text{Prob}(G | T_F) \]

But since \( \{S \geq T_F\} \) is a more favorable event for state \( G \) than \( \{S = T_F\} \),

\[ \text{Prob}(G | S \geq T_F, x_1, \hat{I}) > \text{Prob}(G | T_F, x_1, \hat{I}), \forall x_1, \forall \hat{I} \]

Therefore,

\[ E_0[\text{Prob}(G | S \geq T_F, x_1, \hat{I} | T_F, \hat{I}) > E_0[\text{Prob}(G | T_F, x_1, \hat{I} | T_F, \hat{I}) = \text{Prob}(G | T_F) \]

where the last equality is due to the law of iterated expectations. \( Q.E.D. \)

**Proof of Proposition 4**

If \( T_F(\alpha, \hat{I}) > S \) then \( T_F \) must satisfy the indifference condition:
\[ \alpha E_0(P_1 \mid T_F, \hat{I}) + (1 - \alpha) E_0(P_2 \mid T_F, \hat{I}) = 0 \]  \hspace{1cm} (A3)

We first show that \( T_F(\alpha, \hat{I}) \) as defined in (A3) is strictly decreasing in \( \alpha \). Differentiating (A3) with respect to \( \alpha \) gives:

\[ E_0[P_1 \mid T_F, \hat{I}] - E_0[P_2 \mid T_F, \hat{I}] + \]
\[ \frac{\partial T_F}{\partial \alpha} \left\{ \alpha \frac{\partial}{\partial T_F} E_0[P_1(T_F, x_1, \hat{I}) \mid T_F, \hat{I}] + (1 - \alpha) \frac{\partial}{\partial T_F} E_0[(x_1 + x_2 - K) \mid T_F, \hat{I}] \right\} = 0 \]  \hspace{1cm} (A4)

The first term in (A4) is the expected difference in the first and second period prices which is strictly positive as proved in Lemma 2. Additionally:

\[ \frac{\partial}{\partial T_F} \left\{ E_0[P_1(T_F, x_1, \hat{I}) \mid T_F, \hat{I}] \right\} = \]
\[ \int \frac{\partial P_1}{\partial T_F} f_1(x_1 \mid T_F, \hat{I}) \, dx_1 + \int P_1 \frac{\partial}{\partial T_F} f_1(x_1 \mid T_F, \hat{I}) \, dx_1 \]  \hspace{1cm} (A5)

The second term in (A5) is strictly positive because \( P_1 \) is strictly increasing in \( x_1 \) and the distribution of \( x_1 \) moves to the right as \( T_F \) increases. The first term in (A5) can be expressed as:

\[ [E(x_2 \mid G, \hat{I}) - E(x_2 \mid B)] \int \frac{\partial}{\partial T_F} \left\{ \text{Prob}(G \mid S \geq T_F, x_1, \hat{I}) \right\} f_1(x_1 \mid T_F, \hat{I}) \, dx_1 \], which is also strictly positive since \( E(x_2 \mid G, \hat{I}) - E(x_2 \mid B) > 0 \) and \( \text{Prob}(G \mid S \geq T_F, x_1, \hat{I}) \) is strictly increasing in \( T_F \).

Additionally, \( \frac{\partial}{\partial T_F} \left\{ E_0[(x_1 + x_2 - K) \mid T_F, \hat{I}] \right\} > 0 \) because \( \frac{\partial \text{Prob}(G \mid T_F)}{\partial T_F} > 0 \). These facts imply that both of the factors multiplying \( \frac{\partial T_F}{\partial \alpha} \) in (A4) are strictly positive. Therefore, the satisfaction of (A4) requires \( \frac{\partial T_F}{\partial \alpha} < 0 \).
The proof of part (i) of the proposition is identical to the similar claim in Proposition 4, and part (ii) follows from (i) and (iii). \textit{Q.E.D}

\textbf{Proof of Proposition 6}

We first prove part (i) of the proposition. Using our assumption that $\Pr(G | S = \underline{S}) = 0$, $T_F(\alpha, L) = \underline{S}$ if and only if:

$$
\left[ E(x_1 | B) + E[\Pr(G | S \geq \underline{S}, x_1, L) | \underline{S}, L] E(x_2 | G, L) + \\
E[\Pr(B | S \geq \underline{S}, x_1, L) | \underline{S}, L] E(x_2 | B) - K \right] \\
+ (1 - \alpha) \left[ E(x_1 + x_2 | B) - K \right] \geq 0
$$

(A6)

and $T_f(\alpha, L) = \underline{S}$ if and only if (A1) is satisfied. Compare the left hand sides of (A6) and (A1).

$$
E(x_1 | B) < \lambda E(x_1 | G, L) + (1 - \lambda) E(x_1 | B)
$$

(A7)

Also, $E[\Pr(G | S \geq \underline{S}, x_1, L) | \underline{S}, L] < E[\Pr(G | S \geq \underline{S}, x_1, L) | S \geq \underline{S}, L] = \Pr(G | S \geq \underline{S}) = \lambda$

Therefore,

$$
E[\Pr(G | S \geq \underline{S}, x_1, L) | \underline{S}, L] E(x_2 | G, L) + \\
E[\Pr(B | S \geq \underline{S}, x_1, L) | \underline{S}, L] E(x_2 | B) < \\
\lambda E(x_2 | G, L) + (1 - \lambda) E(x_2 | B)
$$

(A8)

Together (A7) and (A8) imply that the left hand side of (A6) is strictly less than the left hand side of (A1), which proves part (i).

To prove part (ii) of the proposition, consider values of $\alpha > 0$ at which $T_F(\alpha, L) > \underline{S}$. At such values of $\alpha$ $T_F(\alpha, L)$ must satisfy:
\[
\alpha \left[ E_0[x_1 | S = T_F(\alpha, L), L] + E_0[\text{Prob}(G | S \geq T_F(\alpha, L), x_1, L) | S = T_F(\alpha, L), L] E(x_2 | G, L) \right] \\
+ E_0[\text{Prob}(B | S \geq T_F(\alpha, L), x_1, L) | S = T_F(\alpha, L), L] E(x_2 | B - K) \\
+ (1 - \alpha) \left[ E_0[x_1 + x_2 | S = T_F(\alpha, L), L] - K \right] = 0 \quad (A9)
\]

If \( T_I(\alpha, L) = T_F(\alpha, L) \) then \( T_F(\alpha, L) \) must also satisfy:
\[
\alpha \left[ E(x_1 | S \geq T_F, L) + E(x_2 | S \geq T_F, L) \right] + (1 - \alpha) \left[ E[x_1 + x_2 | T_F, L] \right] - K = 0 \quad (A10)
\]

This is impossible because \( E(x_1 | S \geq T_F, L) > E(x_1 | T_F, L) \), and:
\[
\text{Prob}(G | S \geq T_F) = E[\text{Prob}(G | S \geq T_F, x_1, L) | S \geq T_F, L] > E[\text{Prob}(G | S \geq T_F, x_1, L) | S = T_F, L],
\]

implying that
\[
E(x_2 | S \geq T_F, L) \geq E[\text{Prob}(G | S \geq T_F, x_1, L) | S = T_F, L] E(x_2 | G, L) \\
+ E[\text{Prob}(B | S \geq T_F, x_1, L) | S = T_F, L] E(x_2 | B)
\]

The threshold that satisfies (A10) must lie strictly below the threshold that satisfies (A9) implying that \( T_I(\alpha, L) < T_F(\alpha, L) \).

\[ Q.E.D. \]
References


