ISSN 1045-6333

DO SHORT-TERM MANAGERIAL OBJECTIVES LEAD TO UNDER- OR OVER-INVESTMENT IN LONG-TERM PROJECTS?

Lucian Arye Bebchuk*

and

Lars A. Stole**

Discussion Paper No. 87

2/91

Program in Law and Economics
Harvard Law School
Cambridge, MA 02138

The Program in Law and Economics is supported by a grant from the John M. Olin Foundation.

*Professor, Harvard Law School

**John M. Olin Fellow in Law and Economics and Ph.D economics candidate at M.I.T.

Do Short-Term Managerial Objectives Lead to Under- or Over-investment in Long-Term Projects?

Lucian Arye Bebchuk*

and

Lars A. Stole†

February 1991

*Harvard University Law School and the National Bureau of Economic Research.

†Department of Economics, Massachusetts Institute of Technology. We are grateful to David Scharfstein, Steve Shavell, Jeremy Stein, and Jeff Zwiebel for helpful comments. Both authors' work has been supported by the Harvard Law School Program in Law and Economics, which is funded by the John M. Olin Foundation, and the National Science Foundation. Lars Stole also gratefully acknowledges financial support from a Claude Lambe Fellowship. Any errors are our own.

Abstract

This paper studies managerial decisions about investment in long-run projects in the presence of imperfect information (the market knows less about such investments than the firm's managers) and short-term managerial objectives (the managers are concerned about the short-term stock price as well as the long-term stock price). Prior work has suggested that imperfect information and short-term managerial objectives induce managers to underinvest in long-run projects. We show that either underinvestment or overinvestment is possible, and we identify the connection between the type of informational imperfection present and the direction of the distortion. When investors cannot observe the level of investment in long-run projects, suboptimal investment will be induced. When investors can observe investment but not its productivity, however, an excessive level of investment will be induced.

1 Introduction

There has been in recent years substantial public debate on the question of whether the long-run investment decisions of the managers of publicly traded companies may be distorted by market pressures. Recent work by economists has tried to identify the potential source and nature of such distortions. See e.g. Stein [1988,1989] and Shleifer and Vishny [1990]. Research has naturally focused on situations that are characterized by (*i*) short-term managerial objectives – the managers are concerned not only with the firm's long-run stock price but also with the firm's short-run stock price (due to incentive schemes or the fear of losing control), and (*ii*) imperfect information – the market has less information than the firm's managers about the firm's long-run projects. Research has indicated that in some situations, short-term objectives and imperfect information may lead to underinvestment in long-run projects. (See Stein [1988,1989], Shleifer and Vishny [1990], and also Bebchuk [1990].)

This paper seeks to extend prior work on the effects of short-term objectives and imperfect information on long-run investment decisions. We demonstrate that imperfect information, together with an emphasis on a firm's short-run valuation, may lead either to *underinvestment or overinvestment* in long-run projects, where the direction of the distortion depends upon the nature of the manager's information advantage over uninformed investors. As will be shown, two common types of informational imperfections produce different types of distortions. Thus, the existence of short-term objectives does not necessarily imply underinvestment inefficiencies.

In modeling the long-run investment decisions of managers, we consider two different situations. In the first, investors cannot observe the level of investment in long- run projects.

In the second, investors observe the level of investment in a long-run project, but not its productivity.

When the managers' private information concerns the level of investment in a long-run project, we show (as prior work has also demonstrated) that underinvestment may result. The manager underinvests in future projects because increased investment capital affects the current stock market price less than the increase in net present value. On the margin, this distorts investment below efficient profit-maximizing levels.

However, when the private information possessed by a manager with short-term objectives concerns not the level of investment in a long-run project but rather its productivity, overinvestment may result. A manager with a highly productive investment opportunity may signal to the market that the long-run outlook of the firm is good by overinvesting in the future – an action that a manager with a lesser long-run project would be unwilling to choose. Therefore, when the market has incomplete information regarding the returns to investment from the long-term project but can actually observe investment levels (R&D, etc.), asymmetries of information may induce overinvestment in the future.

It appears that each of the two cases analyzed is likely to occur with some frequency. Clearly, there are many situations in which managers are likely to have some private information about the amount invested in a long-run project. An obvious example is the amount of managerial time and attention devoted to such a project.

It is equally clear, however, that there are other situations in which investors have adequate information about the level of investment in a long-run project, but the managers have private information regarding the project's returns on investment. The amount of money invested by a company in a given division or project is often disclosed by the firm (and verified by the firm's auditors). Consider, for example, investments in research and development, which is a type of long-run investment that has received much attention in the policy debate. Both the standards of the Financial Accounting Standards Board and the rules of the Securities Exchange Commission require companies to disclose and provide certain details about any material R&D expenditures (see, e.g., Anthony, R. and J. Reece, [1989], p. 67).

Thus, given that both of the cases we analyzed are plausible, no general conclusion can be established about the direction in which short-term objectives distort long-run investment. As the model below illustrates, in any given situation an examination of the nature of managers' private information is necessary to determine the likely consequences of short-term objectives.

2 The Model

2.1 Framework of Analysis

For simplicity, we consider a two-period time horizon – the short-term and the long-term. Managers make an investment decision among two projects. The short-run project will realize a return after one period; the long-run project will realize a return in the second period. We denote the stock market's valuation in period t of a firm's total value over both periods by $\mathcal{V}_t$.

We take as our starting point, as other authors have done, the assumption that the managers are concerned not only about the long-term value of the firm, $\mathcal{V}_2$, but also the market's immediate valuation, $\mathcal{V}_1$. See, for example, Stein [1988, 1989], Vishny and Shleifer [1990]. This phenomena of short-term objectives is now commonly accepted, for two reasons. First, managers commonly receive compensation packages that are partly tied to $\mathcal{V}_1$.

Second, a higher $\mathcal{V}_1$ makes it less likely that the managers will lose their position at $t = 1$ as a result of a takeover or proxy contest. Consistent with this emphasis by managers on the current stock market price of their firm, Abegglen and Stalk [1985] find survey evidence that suggests that U.S. managers have a narrower focus on immediate stock market performance than their Japanese counterparts.

Following the above arguments about managerial objectives, we can model managers as having utility that depends upon both first-period firm valuation as well as second-period valuation, $\mathcal{U}(\mathcal{V}_1, \mathcal{V}_2)$. Like Stein [1989] and Shleifer and Vishny [1990], we consider the case of linear preferences of the form

$$\mathcal{U}(\mathcal{V}_1, \mathcal{V}_2) = \gamma + \alpha_1 \mathcal{V}_1 + \alpha_2 \mathcal{V}_2, \tag{1}$$

for some $\alpha_1, \alpha_2 > 0$.[1]

Two projects exist in which the manager can invest a fixed amount of capital. The short-term project realizes a return in the first period; the long-term project yields a return in the second. The realization of the short-term projects return is $\tilde{S} = S(k_1) + \epsilon$, where k_1 is the level of short-term investment, $S'(k_1) > 0$, $S''(k_1) < 0$, and ϵ is a random disturbance with mean zero and unbounded support. The long-term project yields a return of $\tilde{L} = \theta L(k_2) + \eta$ where k_2 is the level of long-term investment, θ is a measure of the productivity of the long-run project, $L'(k_2) > 0$, $L''(k_2) < 0$, and η is another mean-zero disturbance.

It is assumed that except for k_1, k_2, and θ, everything is common knowledge between the market and the manager. Lastly, throughout this paper we assume that the market

[1] Like Stein, and Shleifer-Vishny, we take managerial preferences as exogenous to our model. Bebchuk [1990] considers the determination of α_1 and α_2 and, in particular, examines whether the shortening of investors' horizons should be expected to lead them to favor incentive schemes with more weight on short-term objectives (i.e., a higher α_1/α_2.)

forms rational expectations about the firm's value given the information available to it.

The manager has a limited amount of capital of which to allocate among the two investment projects: K.[2] Consequently, the investment decision can be reduced to a single variable, x, the level of long-run investment ($K - x$ is invested in the short-run project). As a benchmark, let x^* represent the value-maximizing level of investment in the long-term project; that is, x^* solves

$$\max_{x \in [0,K]} W(x) = S(K - x) + \theta L(x).$$

In period one, the output of the short-run project will be known by the manager and the market. The expected output of the long-run project, however, will be known by the manager but unobserved by the market. The manager knows x and θ in all cases, but two interesting assumptions regarding the market's information present themselves. In Section 2.2, we assume that the market only observes θ; in Section 2.3 we assume that the market only observes x. Unfortunately, under each of the two private information assumption we will find that the manager cannot be expected to choose x^*.

2.2 Unobservable Investment

As a first attempt at understanding the effects of short-term objectives on investment decisions, we assume that θ is common knowledge (and without loss of generality equal to one). In this section, we additionally assume that the stock market does not know x. Consequently, once the market learns at t=1 the value of $\tilde{S}$, it can use $\tilde{S}$ to form expectations regarding both x and $\tilde{L}$, which will in turn determine the period 1 valuation

[2] We additionally assume as a technical convenience that $S'(0) = L'(0) = \infty$, so that it is never optimal to invest all available capital in one project.

of the firm. Let $\tilde{x}^e(x) = E_\epsilon[x|\tilde{S}] = E_\epsilon[x|S(K-x) + \tilde{\epsilon}]$ be the market's expectation of long run investment, where x affects $\tilde{x}^e$ through its expected affect on $\tilde{S}$. The manager's expected utility is given by

$$\mathcal{U} = \gamma + \alpha_1 \left[S(K-x) + E_\epsilon[L(\tilde{x}^e(x))]\right] + \alpha_2 \left[S(K-x) + L(x)\right].$$

Providing that $\tilde{x}^e(x)$ is differentiable, it is straightforward to see that x will be chosen to satisfy the manager's first-order condition, which yields

$$S'(K-x) - L'(x) = \frac{\alpha_1}{\alpha_1 + \alpha_2}\left[E_\epsilon[L'(\tilde{x}^e(x))\frac{\partial \tilde{x}^e}{\partial x}] - L'(x)\right].$$

Consequently, there is a distortion from the first-best incentive contract to the extent that $\frac{\partial \tilde{x}^e}{\partial x} \neq 1$.

Unfortunately, a pure-strategy Nash equilibrium necessarily has such properties. Because the strategies of the managers are deterministic and the support of ϵ is sufficiently large, the market does not consider $\tilde{S}$ informative: $\frac{\partial \tilde{x}^e}{\partial x} = 0$. Knowing that investment has no effect on the stock market's valuation of the firm, the manager will choose to underinvest with x such that

$$S'(K-x) - L'(x) = \frac{\alpha_1}{\alpha_1 + \alpha_2} L'(x).$$

Thus, we have the following proposition.

Proposition 1 *A unique pure-strategy Nash equilibrium exists in which the manager underinvests in the long run project relative to the first best.*

As a consequence, a manager will always choose to underinvest in future projects when the market does not observe the apportionment of the firms capital between short-run and long-run projects. Additionally, as the above first-order condition indicates, as the importance of the current period stock price intensifies (i.e., α_1/α_2 increases), the underinvestment distortion increases. This result, however, depends crucially upon our informational assumptions as the following section indicates.

2.3 Unobservable Productivity

Previously, we assumed that the market could not observe long-term investment by the manager. In this section, we assume instead that the market can observe the level of long-term investment, but cannot observe θ, the parameter representing the profitability of such investment; θ is known only by the manager. That is, our model was previously one of hidden action; now, our model is one of hidden information. As we will see, this plausible change of assumptions radically affects our results.

It is common knowledge by both the market and the manager that θ is distributed according to the continuous probability function $f(\theta)$ on $[\underline{\theta}, \overline{\theta}]$. Clearly a manager with a highly profitable project would prefer to demonstrate to the market today that the firm's θ is high and increase current market valuation rather than wait for the market to react to the realization of $\theta L(x)$ in the future. Given our assumptions about the manager's preferences, it is less costly for a manager to overinvest in a highly productive (high θ) long-term project than to overinvest in a less productive (lower θ) long-term project. This condition will imply that a signaling equilibrium has managers with profitable long-run projects signaling their the profitability of their projects by overinvesting in them.

We search for a separating equilibrium in which managers signal the productivity of long-term projects through their levels of investment. A pure-strategy equilibrium will have the form that a manager of type θ chooses x, and so we can represent an equilibrium by the function $x(\theta)$. Let $\Theta(x)$ be the set of all θ that choose x. That is, $\Theta(x)$ is the inverse of $x(\theta)$ which may be a multi-valued function. The market will have expectations of θ which will be a function of x. These expectations, by Bayes' rule, are given by

$$\theta^e(x) = E[\theta|x] = \frac{\int_{\Theta(x)} \theta f(\theta) d\theta}{\int_{\Theta(x)} f(\theta) d\theta}.$$

When $x(\theta)$ is strictly increasing in θ, these expectations are merely the inverse of $x(\theta)$. Given these expectations, the manager's utility is given by

$$U(x,\theta) \equiv \gamma + \alpha_1 \left[S(K - x) + \theta^e(x)L(x)\right] + \alpha_2 \left[S(K - x) + \theta L(x)\right]. \tag{2}$$

We can immediately state the following:

Lemma *In any Nash equilibrium of the signaling game, $x(\theta)$ will be a nondecreasing function of θ.*

This result is proved using the standard revealed preference argument and is in the Appendix. Because $x(\theta)$ is monotonic, it follows that it is differentiable almost everywhere. Consequently, we can use simple differential arguments to characterize the equilibrium in the investment game. Our results are stated in the following Proposition, which is proved in the Appendix.

Proposition 2 *A unique fully-separating Perfect Bayesian Equilibrium exists which involves overinvestment with probability one and where the equilibrium choice of investment, $x(\theta)$, is such that $x(\underline{\theta}) = x^*(\underline{\theta})$ and for all $\theta \in (\underline{\theta}, \overline{\theta}]$*

$$\frac{d\theta}{dx} = \frac{\alpha_1 + \alpha_2}{\alpha_1} \frac{S'(K - x) - \theta L'(x)}{L(x)}. \tag{3}$$

The proposition indicates that in the separating equilibrium managers of every firm but the worst overinvest to signal to the market that the firm's productivity of its long-term project is high, and thereby increase the current valuation of the firm. In this sense, the equilibrium is similar the the results in Spence [1973], where the fully-separating equilibrium in his job market model has talented employees overinvesting in education so as to signal their product of labor to employers.

The distortion evident in Proposition 2 arises from short-term managerial objectives; i.e., $\alpha_1 > 0$. In the case where $\alpha_1 = 0$, no gain from deceiving the market exists, and so no signaling via overinvestment occurs: The absence of short-term objectives results in the first-best level of investment.

3 Conclusion

We have shown that the existence of short-term managerial objectives (coupled with incomplete information) may lead to either underinvestment or overinvestment in long-run projects. Whether underinvestment or overinvestment results depends critically on the nature of the managers' informational advantage over the stock market. Our model enables us to predict the likely direction of the distortion in a given situation.

Underinvestment will occur when the market has incomplete information about the level of investment undertaken. This is likely to be the case with respect to many types of "soft" investment. Thus, for example, managers can be expected to underinvest in the amount of managerial time and attention devoted to their decision-making about the future. Similarly, when expenses made to boost the company's long-run reputation or worker morale are unobservable by the market, managers can be expected to underinvest in such expenditures. On the other hand, overinvestment will occur when the market observes the level of investment but not its productivity. This is likely to be the case with respect to many types of "hard" investment as well as with respect to some "soft" investments which are credibly disclosed by the company. Thus, for example, the amount invested in plants, equipment, and R&D is often observable to the market (either because it is disclosed by the company or otherwise), and in such cases excessive investment can be expected.[3]

Finally, it is worth noting one main direction in which the theoretical analysis of this paper calls for extension. While our model takes as given whether the amount spent on a certain type of investment is observable, observability may often be affected by managerial action. In many situations, an investment would be unobservable unless the managers, possible at a cost, take action to make it observable (say, by making expenditures to secure separate and verifiable reporting). Conversely, in many other situations, an investment would be observable unless the managers take actions, possible at some cost, to make it unobservable. Once the implications of observability for the direction of divergence from optimal long-run investment are recognized, the question naturally arises as to when managers will take actions to make an unobservable investment observable, and, finally, when such actions will increase or decrease firm value.

[3] Assuming that unobservability is especially likely to occur with respect to "soft" investments, one implication of our model is that, as the weight of short-term objectives decreases in managers' objective functions, their investment in long-run projects is likely to be characterized by a higher ratio of soft/hard investment. As a consequence, if the common claim that Japanese managers give less weight to short-term objectives is correct, then the investments in long-run projects by Japanese companies should be characterized by a greater soft/hard investment ratio. These implications would be difficult to test, however, because some "soft" investments may well be unobservable not only to the market but also to the researcher.

Appendix

Proof of Lemma: Suppose otherwise. Let (x, θ) and (x', θ') be two investment-type pairs used in equilibrium by managers where $\theta > \theta'$ but $x' > x$. It must be the case, by revealed preference, that

$$U(x, \theta) \geq U(x', \theta),$$
$$U(x', \theta') \geq U(x, \theta').$$

Adding these inequalities yields (after simplification)

$$\alpha_2 \theta L(x) + \alpha_2 \theta' L(x') \geq \alpha_2 \theta L(x') + \alpha_2 \theta' L(x),$$

or equivalently,

$$(\theta - \theta')(L(x) - L(x')) \geq 0,$$

which contradicts our initial hypothesis. □

Proof of Proposition 2: We know that any Perfect Bayesian Equilibrium in the investment game must have beliefs which are a nondecreasing function of investment. Because $\lim_{x\to 0} \frac{\partial U(x,\theta)}{\partial x} = +\infty$ and $\lim_{x\to K} \frac{\partial U(x,\theta)}{\partial x} = -\infty$, necessary conditions for the manager's choice of investment are

$$\frac{\partial U(x, \theta)}{\partial x} = 0, \frac{\partial^2 U(x, \theta)}{\partial x^2} \leq 0,$$

$\forall x, \theta$. The first-order condition gives us an identity in x and θ which we can totally differentiate to obtain

$$\frac{\partial^2 U(x, \theta)}{\partial \theta \partial x} + \frac{\partial^2 U(x, \theta)}{\partial x^2} \frac{dx}{d\theta} \equiv 0.$$

Thus, the necessary local second-order condition above can be restated as $U_{x\theta} \geq 0$, which is true by our assumption that $L'(x) > 0$.

Furthermore, if $x(\theta)$ is nondecreasing, the local conditions for a maximum are sufficient. To see that the monotonicity of $x(\theta)$ and the first- order condition are sufficient for a separating equilibrium, suppose $x(\theta)$ satisfies these conditions but the manager prefers to choose otherwise. Suppose that x' (where $x' = x(\theta')$) rather than x is the chosen investment by a manager with productivity θ. Then, revealed preference implies $U(x(\theta'), \theta) - U(x(\theta), \theta) > 0$. Integrating, we obtain

$$\int_{\theta}^{\theta'} U_x(x(s), \theta) \frac{dx(s)}{ds} ds > 0.$$

But by hypothesis, $U_x(x(\theta), \theta) = 0$ for all θ. Thus,

$$\int_{\theta}^{\theta'} \left[U_x(x(s), \theta) - U_x(x(s), s) \right] \frac{dx(s)}{ds} ds > 0.$$

Integrating again,

$$\int_{\underline{\theta}}^{\theta'} \int_{s}^{\theta} U_{x\theta}(s,t)\frac{dx(s)}{ds}dtds > 0.$$

But by assumption, the above double integral is always nonpositive, which contradicts our hypothesis.

Consequently, if our solution satisfies the local first-order condition and the manager's investment function is nondecreasing in θ, we have characterized the equilibrium path of a Perfect Bayesian-Nash equilibrium. The first order condition is

$$\frac{\partial U(x,\theta)}{\partial x} = (\alpha_1 + \alpha_2)\left[\theta L'(x) - S'(K-x)\right] + \alpha_1 \frac{d\theta}{dx} L(x) = 0.$$

Rearranging the terms,

$$\frac{d\theta}{dx} = \frac{\alpha_1 + \alpha_2}{\alpha_1} \frac{S'(K-x) - \theta L'(x)}{L(x)}.$$

Let $x^*(\theta)$ be the efficient level of investment for a given productivity, θ. In a fully separating equilibrium, the worst inference which the market can place on a manager is that the productivity of the long-term project is $\underline{\theta}$ and, consequently, the worst firm's manager must earn at least $U(x^*(\underline{\theta}), \underline{\theta})$. Thus, in a fully separating equilibrium, $x(\underline{\theta}) = x^*(\underline{\theta})$, and we have an initial condition to the ordinary differential equation above in (3).

Lastly, we must specify beliefs off the equilibrium path. Let $\mathcal{X} = [\underline{x}, \overline{x}]$ be the set of all investment levels which arise with positive probability in the equilibrium of the signaling game. One set of arbitrary beliefs which holds together the equilibrium has the market believing that for any $x \in [0, \underline{x})$ the firm's type is $\underline{\theta}$, and for any $x > \overline{x}$ the firm's type is $\overline{\theta}$.

The above differential equation implies that $\frac{dx}{d\theta} = \infty$ at $\underline{\theta}$ and at any other points where $x(\theta) = x^*(\theta)$. Because the signaling condition requires that $x(\theta)$ is monotonic in θ, and by construction $x^*(\theta)$ has finite slope, $x(\theta)$ must remain above $x^*(\theta)$ for all $\theta \in (\underline{\theta}, \overline{\theta}]$. Hence, we have a uniquely defined (up to arbitrary off-the-equilibrium-path beliefs) the fully-separating equilibrium which exhibits overinvestment with probability one. □

References

ABEGGLEN, J. AND STALK, G., 1985, *Kaisha, The Japanese Corporation*, New York: Basic Books.

ANTHONY, R. AND REECE, J., 1989, *Accounting Principles*, Homewood, Ill.: Irwin Publishers, 6th edition.

BEBCHUK, L., 1990, "On the Link between Investors' and Managers' Horizons," *mimeo*, Harvard University Law School.

LAFFONT, J.-J. AND TIROLE, J., 1987, "Managerial Switching and Myopia," *mimeo*, Massachusetts Institute of Technology.

MYERS, S. AND MAJLUF, 1984, "Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have," *Journal of Financial Economics*, Vol. 13, pp. 187-221.

SCHARFSTEIN, D. AND STEIN, J., 1990, "Herd Behavior and Investment," *American Economic Review*, Vol. 80, pp. 465-479.

SHLEIFER, A. AND VISHNY, R. 1990, "Equilibrium Short Horizons of Investors and Firms," *American Economic Review*, Vol. 80, pp. 148-153.

SPENCE, M. 1973, "Job Market Signaling," *Quarterly Journal of Economics*, Vol. 87, pp. 355-374.

STEIN, J., 1989, "Efficient Capital Markets, Inefficient Firms: A Model of Myopic Corporate Behavior," *Quarterly Journal of Economics*, Vol. 104, pp. 655-669.

STEIN, J., 1988, "Takeover Threats and Managerial Myopia," *Journal of Political Economy*, Vol. 96, pp. 61-80.