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INFORMATION EXTERNALITIES, SHARE-PRICE BASED  
INCENTIVES AND MANAGERIAL BEHAVIOUR

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# Information Externalities, Share-Price Based Incentives and Managerial Behaviour\*

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## Abstract

We survey recent theoretical research on the effects of short-term share-price based managerial incentive schemes. Such schemes can induce inefficient managerial behaviour in both hidden action and hidden type contexts. These problems arise from informational asymmetries: managers take actions to manipulate the information flow rather than to maximize firm value. More generally, imperfect transmission of information between managers and shareholders or between managers of different firms can lead to similar distortions even when the parties' interests are aligned.

JEL # G30, J33

**Keywords:** information externalities, share-price based incentives

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# 1 Introduction

Few areas of economics have attracted more attention over the last two decades than the principal-agent model. The model focuses on the use of incentives to align the interests of individuals with otherwise opposing aims. It has altered the way in which economists analyse markets and institutions. An important example of a principal-agent relationship is that between the manager of a firm and its shareholders. This paper surveys some recent developments in the theory of incentives and asymmetric information as it applies to this relationship. In particular, we consider the issue of motivating desirable managerial behaviour through short-term share-price based incentives and the problems that may arise with such incentive schemes. Many of these problems arise from information asymmetries between relevant parties. In this sense, the problems inherent in such incentive schemes exemplify a wider class of problems concerning managers' responses to imperfect information flows between the firm and the share market, and between managers of different firms.

There are attractions to using the short-term share price as a component of incentive contracts. Both Diamond and Verrecchia (1982) and Holmstrom and Tirole (1993) present models where the optimal managerial contract includes incentives that depend on short-term share prices. The share price is a powerful incentive device as it aggregates the information of many investors about the value of the firm. Share prices may provide information about managers' activities which cannot be inferred by analysing the long-term value of the firms. Setting a contract that links managerial rewards and penalties to the rise and fall of the share price would appear to offer shareholders a simple, easily verifiable way of overcoming many managerial incentive problems.

Simple share-price based contracts may, however, create as many problems as they solve. Clearly, if managerial contracts include share-price based incentives then managers will care about share prices. But, actions aimed to boost today's share price may sometimes reduce long-term firm value and (may) harm shareholders. In Section 2, we consider this possibility and examine the distortions that may arise through using share-price based incentives when a manager's actions cannot be perfectly observed. Section 3 then considers the problems that arise when the manager has private information. If the managers care about short-term share prices, they may try to signal their private information to the market, or prevent such signalling, in a way which is damaging to the firm. The problems of private information may,

however, be more subtle. To the degree that a manager's information is either better than, or in conflict with, the public's information, managers either may avoid value-maximising activities, or may undertake actions that ignore their private information. Section 4 extends our analysis to consider distortions that may result from imperfect information flows even when managers are acting to maximise their firms' long-term value. We show that it is not merely managerial opportunism arising from share-price based incentives that lies at the heart of the behaviour identified in sections 2 and 3. Rather the key issue is asymmetric information between various interested parties.

The aim of this survey is to provide stripped-down versions of models (sometimes even numerical examples) that capture the gist of some of the main recent theoretical contributions in this area. We do not attempt to be comprehensive: the interested reader should also consult Hirshleifer (1992, 1993). For the most part, the articles we survey here take as given both the managerial incentive scheme and the information structure. There is also a literature in which either the contract design or the information structure is endogenous. Those articles attempt to explain the existence of particular share-price based incentives and information structures as solutions to constrained optimisation problems whereas most of the articles we survey concentrate on the consequences of given (possibly suboptimal) contracts and structures.

Empirical research on the form of contracts, in particular the relationship between managerial rewards and share performance, has been relatively scarce. Jensen and Murphy (1990) use data from the annual Forbes Executive Compensation Surveys to measure the sensitivity of managerial wealth to shareholder returns. They find a statistically significant positive relationship between CEO salary and bonus payments and shareholder wealth but that the absolute size of these rewards is relatively small — between 1.35 and 2.2 cents for each \$1000 increase in shareholder wealth. This is equivalent to managers receiving approximately a 0.4% increase in salary and bonuses for each 10% rise in the value of the firm.<sup>1</sup> By comparison Murphy (1985) obtains an estimate of 1.8% and Gibbons and Murphy (1990) of 1.6%. Joskow and Rose (1995) find that past as well as current performance has a significant effect on managerial compensation. They estimate that the combined effect is equivalent to a one-time increase of 2.5%. Coughlan and Schmidt (1985), however, consider management compensation based on relative share performance. They estimate that “an executive who places shareholders in the top 1 percent of the return distribution will receive an upward adjustment [in salary and bonuses] of 10.17 percent in real terms” (pp.

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<sup>1</sup>Calculated using the income/value estimate presented in Jensen and Murphy (1990) pp. 229-230, with  $b = 0.00002$ .

59-60).<sup>2</sup>

Managers may also be “punished” for poor share market performance through dismissal. Coughlan and Schmidt (1985), Gibbons and Murphy (1990), Warner, Watts and Wruck (1988) and Weisbach (1988) all find a statistically significant negative relationship between managerial turnover and stock returns. The size of this relationship, however, differs substantially among the studies. For example, Coughlan and Schmidt find that “an executive whose firm ranks in the bottom one percent of the distribution of abnormal stock returns is seven times as likely to leave the firm as the CEO of a firm in the top percentile” (p. 64-65). In contrast, Warner et. al. conclude that “the evidence indicates that management turnover is not highly sensitive to poor share performance” (p. 479). Jensen and Murphy (1990) consider the relation between total managerial wealth, including an adjustment for dismissal, and share performance. Overall, they estimate that CEO wealth changes by \$3.25 for every \$1000 change in shareholder wealth.

This research, in particular the results of Jensen and Murphy, raise the question of whether share-price based compensation is important in practice. The current empirical results, unfortunately, do not provide a definitive answer. Murphy (1985) concludes “that firm performance, as measured by shareholder’s realized return, is strongly and positively related to managerial remuneration” (p. 40).<sup>3</sup> In contrast, Jensen and Murphy (1990) claim that “the small observed pay-performance sensitivity seems inconsistent with the implications of formal principal-agent models” (p. 253). However, as Baker, Jensen and Murphy (1988) note, this latter conclusion has been criticised because principal-agent theory does not provide any guidance as to what the correct level of sensitivity should be.

Even if such guidance were provided by the theory, studies such as those mentioned above might tend to understate the degree of managerial incentives as they are only based on observed outcomes. These studies will tend to downgrade the importance of events that provide significant incentive effects but have only a low probability of occurring in equilibrium. One alternative approach to determine the importance of share-price based incentives in practice is to observe how the price of the relevant firm’s stock reacts to the introduction of a share-price based incentive scheme. Bhagat, Brickley and Lease (1985) find a significant, positive share-market reaction to the announcement of share-price based incentive schemes over and above

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<sup>2</sup>See also Antle and Smith (1986) on relative performance evaluation. For a brief overview of older empirical literature, see Ciscel and Carroll (1980).

<sup>3</sup>See also Jensen and Zimmerman (1985) and Joskow and Rose (1995).

that accounted for by tax benefits.<sup>4</sup>

While the empirical literature on share-price based incentive schemes appears inconclusive, it is important to consider the limitations to such schemes. Jensen and Murphy (1990) and Grundfest (1990) argue that political considerations interfere with the use of share-price based incentives.<sup>5</sup> The practical use of stock-based incentives may also be constrained by the ability of managers to “trade out of” those incentives in the share market.<sup>6</sup> Finally, the use of share-price based incentive schemes may be limited because of the problems covered in this survey. A fuller understanding of these theoretical constraints would help the design and interpretation of empirical studies.

The papers covered in this survey provide important insights into the practical limitations of share-price based incentives as well as the broader issue of the transmission of information between managers and investors and between managers of different firms. While the focus is on share-price based incentives, many of the models have broader implications for corporate behaviour.

## 2 Hidden Actions and Share-Price Based Incentives

All firms face the problem of motivating managers and others who control day-to-day operations to make decisions in the interests of shareholders. In general, the interests of managers will not coincide with the interests of their employers. A manager may receive (possibly non-pecuniary) benefits from certain of her activities (such as expense account lunches) or certain aspects of her firm (such as its size and public prominence) that may be of little benefit or even detrimental to firm value. Organisations must consider how to motivate these “agents” to act in line with the interests of the “principals”. *Hidden action* problems arise when shareholders cannot observe the actions of managers.<sup>7</sup> Principals must then try to create incentives for managers based upon observable and verifiable measures of performance. We refer to these as

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<sup>4</sup>See also Larcker (1983). Abowd (1990) attempts to test the efficacy of performance bonuses by looking at performance after such bonuses are paid.

<sup>5</sup>Both Joskow, Rose and Shepard (1993) and Joskow, Rose and Wolfram (1994) present empirical findings consistent with this argument.

<sup>6</sup>See Garvey (1993).

<sup>7</sup>In the literature, hidden action problems are sometimes referred to as moral hazard. Moral Hazard, however, can also arise when it is impossible to write an enforceable complete contract that specifies what the manager should do in every contingency.

*signals*.<sup>8</sup>

There is an extensive literature on how contracts should be designed to create these incentives at minimum cost.<sup>9</sup> Clearly, there is potentially an almost infinite number of observable phenomena on which the terms of a contract could in principle be based. Holmstrom (1979) shows that, given a contract which utilises a particular set of signals designed to induce some action, an additional signal is useful provided the original set of signals do not provide a sufficient statistic for the new signal with respect to the action. That is, the new signal is useful if it adds information. Unfortunately, the set of signals which satisfies this criterion may still be very large. This is particularly likely to be the case where there are many (unobservable) activities undertaken by the manager that affect firm value.

In reality, including more signals may be costly. A contract that is based on fewer signals may be easier to write, easier to monitor and easier to enforce. However, as Holmstrom and Milgrom (1991) show, there may be dangers to including some and omitting other signals. For example, suppose an imaginary economics department rewarded its junior faculty solely on the number of articles that they publish. Such a scheme may create an incentive for faculty to write many slapdash articles. If no signal of quality is available, it may be better not to include the incentives based on quantity at all.

An alternative to random omission is to find a few readily available signals that “aggregate” the information of many others. If an aggregate signal is a sufficient statistic for all its component parts then, by definition, there is no loss from using it and omitting the components. But in general, some information will be lost in the aggregation. We can think of a summary signal as being like an index—it is too much to hope for a single index number which is as informative as all the data that went into it. Indices are, however, less unwieldy than entire data banks.

One variable that immediately suggests itself for use as an aggregate signal is the firm’s share price. It is readily available and can be contracted upon. While the final outcome of a project may provide the most accurate signal of managerial efforts, basing a contract on this information may involve substantial delay. In the limit, contracts contingent on final values are impractical if the final value of the project is only disclosed when the firm is liquidated or after the manager has quit or retired. If the stock market is efficient, share prices will reflect large amounts of publicly available information about the firm and its activities. In particular, the share price

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<sup>8</sup>This is the term commonly used in the literature. It is important, however, to distinguish signals and the act of *signaling* by the manager. Signaling is discussed in section 3.

<sup>9</sup>For surveys of this literature see Hart and Holmstrom (1987) or Sappington (1991).

will be a good predictor of future earnings. If the pay of a transitory manager depends on the share price, we might think that this would reduce his incentive to sacrifice the firm's long-term performance in favour of short-term results. It is tempting (but, as we shall see, wrong) to jump to the conclusion that if their compensation is based on share prices then managers' interests can be aligned with shareholders.

Despite their superficial appeal as a signal on which to base contracts, share prices turn out not to be a very good aggregator of information to provide managerial incentives. Paul (1992)<sup>10</sup> applies the Holmstrom and Milgrom (1991) framework to analyse the effects of (short term) share-price based compensation. Consider a manager who can undertake a number of projects for his firm. The value of each project is stochastic and depends, in part, upon the manager's choice of actions, for example, his effort. In the short term, each project generates a signal  $y_i, i = 1, \dots, n$ , which provides a noisy indication of its final value. A contract designed to motivate (constrained) optimal effort levels from the manager will place more weight on a particular project's signal to the degree that:

- the project's marginal return from enhanced effort is greater,
- the manager's effort level for the project is more responsive to payments based on that project's signal, and
- the signal provides a precise measure of agent effort.

For a signal to provide a precise measure of the agent's effort requires that  $y_i$  is a good indicator of the project's final output and that this final output is itself a good indicator of managerial effort. Projects that intrinsically have highly variable returns will be assigned reduced weight in the manager's incentive scheme.

Compare this with how share prices aggregate the information contained in the signals,  $y_i, i = 1, \dots, n$ . Traders in the stock market are interested in estimating the present value of the firm. Therefore, the weighting of any signal in the share price depends, not on its influence on managerial behaviour, but on its predictive power for the future earnings of the firm. Given the manager's contract, the equilibrium effort level for each project is known by the investors, so they are not interested in the degree to which a signal is informative as to effort. Indeed, the signals that are most informative about future profits are (*ceteris paribus*) those that concern activities for which there is most residual uncertainty after effort levels have been determined. That is, those that (*ceteris paribus*) are least informative as to effort.

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<sup>10</sup>See also Bresnahan, Milgrom and Paul (1990) and Paul (1991).



Thus, share prices aggregate information with weights that are almost the opposite of the weighting of signals in the optimal incentive contract. The marginal value of effort in each project is irrelevant for the weight placed upon that project's signal in an efficient share price. Equally irrelevant is the responsiveness of effort in each project to corresponding payments. The most valuable signals are those that give the greatest information about projects with highly variable returns. As Paul puts it:

“[f]or the stock price (of an all-equity firm) to be an optimal aggregator of information for the incentive problem, it would have to measure the value-added of the manager, instead of the value of the firm's assets.”

A managerial contract with stock-price based compensation not only differs from the (constrained) optimal contract based on project signals, but may create perverse incentives for managers to devote excessive effort to projects with highly variable returns. Paul argues that this may explain the use of accounting earnings in managerial compensation schemes even though such data are embodied in the share price. Indeed, Joskow and Rose (1995) find that CEO compensation is influenced by both accounting profits and shareholder returns and that in proportionate terms the effect of the former is roughly double that of the latter.

The problem of using share prices as part of managerial compensation packages is not simply that they do not aggregate information as the optimal index for managerial efforts. The way in which the consumer price index is constructed can lead governments to design otherwise bizarre tax and interest rate policies to manipulate the index. Similarly, basing contracts upon share prices can create incentives for managers to try to manipulate the share price rather than maximise the value of the firm.

Narayanan (1985) and Stein (1989) present models in which managers take hidden actions to manipulate the share price at the expense of long-term earnings. In both models, the manager also has private information about the firm<sup>11</sup> and cares about share prices (perhaps because they enter her contract). Loosely following Stein (1989), consider a firm whose earnings are subject to permanent shocks. For example, assume that there are two periods,  $t \in \{1, 2\}$  and the base earnings in both periods are given by  $e_t = c + z$  where  $c$  is a constant and  $z$  is a normally distributed random variable with mean zero. Consider that, prior to learning the value of  $z$ , the manager can manipulate the earnings flow by borrowing from future earnings to boost

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<sup>11</sup>Strictly, Narayanan's manager has private information not about the firm but about her own ability. However, the model is formally equivalent to Stein's.

today's earnings. Such borrowing is undesirable for the long-term value of the firm. Thus, assume that the interest rate is zero, but if the manager borrows  $b$  today then tomorrow's cash flow is reduced by  $b + rb^2$ . The market then observes the distorted earnings at  $t = 1$  and sets the share price on the basis of expected earnings for  $t = 2$ .

If the manager cares about short-term share price as well as earnings, then no equilibrium will exist in which the manager does not manipulate cash flows to the detriment of the firm. That is, in equilibrium  $b > 0$ . To see this, let the manager's objective function be described by:

$$2(c + z) - rb^2 + \pi s$$

where the first two terms represent the firm's earnings given  $b$ ,  $s$  represents the  $t = 1$  share price, and  $\pi$  is the weight the manager places on the share price. If, in equilibrium,  $b$  is zero then  $s$  would equal the observed first period earnings—after observing the first period earnings the market would know the true value of second period earnings and price the share accordingly. However, given such a belief by the market, the manager would wish to set  $b$  to solve:

$$\max_b 2(c + z) - rb^2 + \pi(c + z + b)$$

The first order conditions for this problem imply that the manager will set  $b = \frac{\pi}{2r}$ . So long as  $\pi$  is positive and  $r$  is finite, it will always pay the manager to deviate and distort the firm's earnings profile.<sup>12</sup>

In general, the distortion created by compensation based on short-term share price will lead managers to favour projects which provide rapid indications of the long-term payoff. As Paul (1991) observes, this does not necessarily imply a distortion towards short or long-term projects, but rather towards projects which can be best evaluated by the market in the short term.

The problem can occur even if there is no moral hazard problem between shareholders and the manager. The problem may reappear between current and potential shareholders if managerial contracts are not observable. Suppose that current shareholders wish to maximise the short-term share-price either because they are liquidity constrained or because there is some random possibility of takeover. Then, the directors would want to write a contract which leads the manager to maximise the short-term share-price rather than the long-term value of the firm. While the directors would like the stock market to believe that they have directed the manager to

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<sup>12</sup>Shleifer and Vishny (1990) present a model where the manager chooses short term over long term projects to avoid potential mispricing of shares. Their model relies on a systematic stock market failure in the pricing of long term assets.

maximise firm value, this will never be an equilibrium contract as it would always pay the directors to deviate and impose share-price maximisation.

Hagerty, Ofer and Siegal (1992) consider how to design a contract with payments based both on a firm's short and long term performance that reduces the incentives for managers to divert cash flows to the present. Since the manager is risk averse, she prefers contracts whose payments vary little across states of the world; that is, those that have "low powered incentives". Shareholders can discourage managers from funneling cash flows from tomorrow to today, by writing contracts in which the variance of payments tomorrow is higher if the firm appears to do well today. Intuitively, if the manager succeeds today, the shareholders suspect her of "cheating" which may show up tomorrow. Consequently, the shareholders "punish" the manager more for failing tomorrow if she succeeds today. Hagerty, Ofer and Siegal compare this optimal contract structure with remunerating the manager not with current stock but with call options. They show that call options are more frequently included in managerial compensation packages when there are greater opportunities for managers to divert cash flows to the present.

### 3 Hidden Information and Firm Reputation

Both the share market and the managerial labour market are interested in estimating value. In the case of the share market, the emphasis is on evaluating the present value of a firm. In managerial labour markets the focus of attention is on the quality of the manager. Managers may have private information about either their own abilities or the value of their firm. If so, the relevant markets may try to infer that information from the managers' actions. Realising this, managers may try to manipulate their observable activities in order to create a favourable impression with the market.

In this section, we ignore informational asymmetries concerning the abilities of managers. These are extensively surveyed by Borland (1992) and Hirshleifer (1993). Instead, we concentrate on informational asymmetries between managers and the stock market concerning characteristics of the firm itself. In doing so, we take as given that managers generally know better than market traders what are the value-maximizing decisions in the day-to-day running of their firms.<sup>13</sup> We also assume that managers care about current share prices, perhaps (but not necessarily) because it is a factor in their remuneration package. In contrast to Section 2, we assume that manager's actions are publicly observable. The issues raised below arise because of

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<sup>13</sup>For problems that arise when the asymmetry is the other way, see Bresnahan, Milgrom and Paul (1990).

the manager's private information.

Three main forms of distortion arise from the interaction of privately informed managers and the stock market.

**Signaling.** Suppose that a manager wishes to communicate good news about a firm to the market in order to raise the share price. She may find that the only credible way to reveal this information is to undertake actions that incur otherwise unnecessary costs for the firm.

**The Lemons Principle.** Suppose that a manager would have to issue new stock to raise capital for a project. She knows that her firm has high value, but cannot credibly reveal this to the stock market. If she is unwilling to sell shares at the prevailing low price, she may forgo otherwise profitable projects.

**Information Neglect.** Suppose that a manager has private information which may conflict with the views of stock market traders about a decision facing the firm. If she is concerned with the firm's share price and cannot credibly reveal what she knows, she may prefer to conform to market opinion.

### 3.1 Signaling

Signaling models have found their way into almost all fields of information economics since their introduction by Spence (1973). The basic ingredients of all signaling models are:

- agents with different types—represented here by firms with good or bad prospects.
- a reason why good types want to separate themselves from bad types—here managers care about their current share price and this is higher for better firms.
- a means to signal type which is more costly for the low than for the high types. In the example below, good firms can signal their type to the stock market by choice of investment level.

The examples below consider both signaling and signal jamming. Following Truman (1986), Bebchuk and Stole (1993), and Bizjak, Brickley and Coles (1993), consider a firm choosing a level of investment,  $I$ , in period 1. Let period 2 profit,  $v$ , be a function of the firm's type, either  $G$  ("good") or  $B$  ("bad"), and the chosen level of investment. Initially, suppose that there are only two levels of investment,  $L$  ("low")

and  $M$  (“medium”), and that for any given level of investment, a good type earns higher profits than a bad type. In period 1, the stock market can observe the chosen level of investment but not the firm’s type, and evaluates the share price,  $E(v | I)$ , as the expected period 2 profit given its information. Suppose that the manager’s objective function is

$$\alpha E(v | I) + \beta v.$$

Suppose further, that the profit maximizing level of investment for a good type is  $M$  and for a bad type is  $L$ . Unfortunately, this will not always be an equilibrium outcome. If it were an equilibrium, then any firm that chose the medium level of investment would be assumed by the market to be a good type. Therefore, if a bad firm were to deviate by choosing the medium level of investment, it would command a period 1 share price  $v(G, M)$ , but would only earn  $v(B, M)$  period 2 profit. A non-deviant bad firm commands a share price equal to its actual period 2 profit of  $v(B, L)$ . Thus, if:

$$\alpha v(G, M) + \beta v(B, M) > (\alpha + \beta)v(B, L) \quad (1)$$

then the bad firms would have an incentive to mimic the good types, breaking the putative separating equilibrium. In this case, one plausible equilibrium outcome is for both types of firms to invest at level  $M$ .<sup>14</sup> This is socially inefficient since the bad firms over-invest.

The behaviour that breaks the (proposed) optimal separating equilibrium is sometimes referred to as “signal jamming”. This problem is more likely to occur, the greater is the weight managers place on today’s share price relative to tomorrow’s profit—in the example above the bigger is  $\alpha$  and the smaller is  $\beta$ . Bizjak, Brickley and Coles (1993) refer to this as the sensitivity ratio. They argue that the sensitivity ratio will be higher, the more managerial compensation depends on current share prices and the higher is the probability that the manager will quit the firm before period 2. They provide some empirical support for the hypothesis that managerial compensation packages are designed to have greater emphasis on long-term firm performance when there is greater informational asymmetry between managers and shareholders.

Next consider that there is a third level of investment available, denoted  $H$  (“high”). Let us retain the assumptions that bad firms’ optimal level of investment is  $L$ , good firms’ optimal level is  $M$ , and good firms achieve higher period 2 profit than bad firms at any given level of investment. There may now be an equilibrium

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<sup>14</sup>It is possible to construct other equilibria but none that are socially efficient.

with good firms choosing  $H$  and bad firms choosing  $L$ .<sup>15</sup> In particular, assume that inequality 1. holds. For simplicity, in this equilibrium, let the market believe that the firm is bad if it chooses  $M$ . By choosing the high investment level, good firms signal their type to the market, thus inducing a higher period 1 share price at the cost of lower period 2 profit. Conditions for this to be (weakly) worthwhile for the good firms are:

$$\alpha v(B, L) + \beta v(G, L) \leq (\alpha + \beta)v(G, H) \quad (2)$$

and

$$\alpha v(B, M) + \beta v(G, M) \leq (\alpha + \beta)v(G, H) \quad (3)$$

For it not to be worthwhile for bad firms to mimic good firms by choosing  $H$ , we require that:

$$\alpha v(G, H) + \beta v(B, H) \leq (\alpha + \beta)v(B, L). \quad (4)$$

The addition of the extra action enables the good firms to avoid signal jamming by the bad firms. Since it is no longer worthwhile for the bad firms to signal jam, they choose their optimal level of investment. Now, however, it is the investment choices of the good firms, made in order to signal, that are socially inefficient. As with all signaling models, inefficiency arises because it is costly for the good firms to distinguish themselves. Notice that, although we have followed the literature in labelling the activities as investment levels (here showing over investment in equilibrium), this is just one possible application. In particular, it is easy to construct a model with under investment, and more generally, any activity that has different benefits or costs depending on the firm's type may be used as a signal. Potential signaling devices include: dividend policy (Battacharya (1979)), the degree of self-financing for projects (Leland and Pyle (1977), Ross (1977)), or the type of projects actually undertaken.

Signaling behaviour can be quite subtle. For example, Hirshleifer and Chordia (1992) argue that good managers will generally prefer projects with early resolution of uncertainty to receive higher wages sooner. Similarly, managers of good firms may prefer early resolution if, for example, the firm's quality affects the cost of raising capital. The stock market might therefore interpret choice of projects with early resolution as a signal of high type. Given this, there may be an incentive for managers of bad firms to choose projects with early resolution to appear good at least in the short term. This, in turn, may lead good firms to choose even earlier resolution to separate themselves from the bad firms. Inefficiency here results from excessive expenditure on projects that resolve early or on means to advance resolution.<sup>16</sup> As Hirshleifer and

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<sup>15</sup>There may also be pooling and semi-separating equilibria but these are also socially inefficient.

<sup>16</sup>See also Thakor (1993).

Chordia point out, such expenditures are not necessarily those usually associated with “short-termism”. For example, certain R and D expenditures can accelerate the resolution of uncertainty about whether a future project will be a success. They observe that share prices usually rise with the announcement of increased R and D.

### 3.2 The Lemons Principle

Signal jamming is not the only reason why the inability of a firm credibly to reveal its true value to the share market may cause distortions. Myers and Majluf (1984) use a lemons model to show why asymmetric information about firm value may lead high-value firms to forgo profitable investment opportunities. Suppose that a manager who is considering a new equity issue cannot communicate her private information about the value of her firm. The price of the equity will be determined by the market’s belief about the firm’s value. To the degree that this price is below the true value of the firm, issuing new equity represents a dilution of the value to existing shareholders. In other words, if the manager knows that her firm has a value above the market price, she knows that any new shares will be sold too cheaply. For an equity financed project to be beneficial to existing shareholders, it must not merely have a positive present value, but its return must be high enough to outweigh any loss due to dilution. Thus it may not be in the interest of existing shareholders, to undertake otherwise profitable projects that involve equity funding.

To illustrate this problem, consider a firm that has previously engaged in some risky projects. The value of the firm at time  $t = 1$  as a result of these projects is either  $v_1$  or  $v_2$ ,  $v_1 > v_2$ . The manager of the firm knows the true value of the firm at  $t = 1$  but this information will not be revealed to the market until  $t = 2$ . The public, including the existing or “old” shareholders of the firm, have beliefs about the firm’s value. Let  $p$  be the probability given by the public to the firm being of value  $v_1$  and  $(1 - p)$  the probability that the firm has value  $v_2$ .

At time  $t = 1$ , a new project becomes available that has an upfront cost of  $c$  and returns  $(1 + \delta)c$  at  $t = 2$  for sure. Assume that interest rates are zero so that the project has a positive present value for all  $\delta > 0$ . Suppose that the firm must raise the funds for the project by issuing new shares that have equal claim on the *total* firm value as the existing shares. The market price of the new shares cannot depend on the true value of the firm but only on the market’s expectation of that value. Assume that all market investors are risk neutral. Thus, to raise the required funds, the manager must give the new investors a share of the expanded firm equivalent to  $c/\bar{v}$  where  $\bar{v} = pv_1 + (1 - p)v_2 + (1 + \delta)c$  is the expectation at  $t = 1$  of the firm’s value

at  $t = 2$ .

For the new project to be beneficial to the old shareholders of the firm, it must increase the value of their (diluted) share of the firm. If the firm's value at  $t = 1$  is  $v_1$ , then in the absence of the new project this wealth all belongs to the old stockholders. If the new project is funded then the value of the firm increases to  $v_1 + (1 + \delta)c$ , but the share of the expanded firm belonging to the old shareholders falls to  $1 - (c/\bar{v})$ . The new project only benefits the old shareholders if:

$$v_1 < \left(1 - \frac{c}{\bar{v}}\right)(v_1 + (1 + \delta)c).$$

Rearranging this inequality implies that the project only benefits old shareholders if:

$$v_1 < (1 + \delta)(\bar{v} - c). \quad (5)$$

The second term on the right hand side of this inequality reflects the dilution effect: the extent of the new funds required in relation to the expected value of the expanded firm. The smaller is this difference, the smaller is the share of the firm that remains under the original shareholders' ownership. The  $1 + \delta$  term reflects the return from the new project. This return has to be great enough to outweigh the dilution effect, if old shareholders are to gain from the project. Therefore a manager of a high-value firm who acts in the interest of old shareholders may not invest in the new project even though its net present value,  $\delta c$ , is positive.

The Myers and Majluf (1984) analysis has three immediate implications. First, socially desirable projects may not be undertaken. At heart this is a "lemons problem": buyers who are unable to determine the true value of a seller's goods will only be willing to pay a price based on expected value, which drives high-value sellers from the market. In the Myers and Majluf model it is a share in an existing firm which is being sold.

Secondly, the model implies that the type of funding available to a firm is important if there is an adverse selection problem. In particular, the Myers and Majluf problem disappears if the firm has access to internal or debt finance or if claims to the new project can be separated from claims to the return of the existing firm. More generally, the lemons problem implies that the financial structure of the firm is important for efficiency.<sup>17</sup>

Thakor (1990) argues that if the cost of external finance is high, as a result of either hidden action or hidden information problems, then firms may place a premium

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<sup>17</sup>Extensions of the work of Myers and Majluf that consider the optimal financial structure of the firm are surveyed by Harris and Raviv (1992). This issue has also been pursued by Hansen (1992).



on internal liquidity. This may lead firms that face a series of investment decisions to keep idle funds, to choose projects that pay off more quickly, and to centralize the allocation of capital within a firm.

Thirdly, while the above analysis involved the manager acting in the interests of existing shareholders at  $t = 1$ , such behaviour may be detrimental to shareholders at an earlier date. For example, consider that at  $t = 0$  an entrepreneur wanted to sell the firm through an initial public offering (IPO). If the distortions illustrated by Myers and Majluf are likely to arise at  $t = 1$  then this will lower the value of the firm at  $t = 0$  and reduce the IPO price to the detriment of the initial owner.

Dybvig and Zender (1991) consider the optimal managerial contract in this situation. They extend the Myers and Majluff model to allow at  $t = 0$  an entrepreneur both to start the firm's initial project and set a managerial contract that will continue over the whole life of the firm. She then sells the firm through an IPO. Dybvig and Zender show that the contract which maximises the value of the firm at the IPO will reward the manager according to the long-term value of the firm. The investment distortion identified above disappears in their framework and the irrelevancy of capital structure and dividend policy is reasserted. These results rest on the assumption that the manager's contract cannot be renegotiated after the IPO. If however, the initial shareholders prefer to renegotiate the contract and alter the manager's incentives and such renegotiation cannot be ruled out, then the Myers and Majluff problem will re-emerge.

### 3.3 Information Neglect

Problems arising from informational asymmetries between managers and the stock market need not depend on there being intrinsically good and bad firms. Generally, the stock market has opinions about what are the best decisions for a firm's manager to take. Often, managers have private information that make them better able to assess the consequences of each decision. Even if market traders know that it is better on average for managers to act on their private information, problems can arise if managers put great weight on current share prices, and cannot credibly reveal their information to the market. In particular, managers may be led to neglect their private information, choosing instead to follow the opinions of the stock market.

To see this, consider that a manager has a choice of two mutually exclusive actions today. Following Brandenburger and Polak (1992), call these actions  $L$  and  $R$ . Only one of the actions is "correct", yielding a payment of 1 to the firm tomorrow. Choosing the "wrong" action results in a payment of zero. Neither the manager nor the stock

market knows today which project is correct. Suppose, however, that the managers and the market's *ex ante* belief based on public information, is that  $R$  is more likely to be correct. Let this belief be denoted by  $\pi > 1/2$ , the probability that  $R$  is correct.

The manager receives additional private information about the relative merits of the two actions. This information need not be perfect, but enables him more fully to evaluate which action is likely to be correct. Let this private information have a probability  $q$  ( $q > 1/2$ ) of being accurate. For simplicity, if  $\rho$  denotes the state in which  $R$  is correct, and  $r$  denotes the situation where the manager's private information claims that  $R$  is correct, let the probability that the manager receives information  $r$  given  $\rho$ ,  $p(r | \rho) = q$ . Similarly, if  $\lambda$  denotes the state in which  $L$  is correct and  $l$  denotes that the manager's information claims that  $L$  is correct, then  $p(l | \lambda) = q$ .

If  $\pi > q$  then choosing  $R$  is more likely to be correct than choosing  $L$  even when the private signal claims  $L$  is correct. Thus if  $\pi > q$ , the profit maximizing strategy is for the manager's private signal to have no effect on her action. However, if  $\pi < q$  profit maximization always involves following the private signal. For concreteness, let  $\pi = 7/13$  and let  $q = 3/4$ . By Bayes' law, if the manager receives information  $r$  then the probability that  $R$  is correct is given by:

$$p(\rho | r) = \frac{p(r | \rho)\pi}{p(r | \rho)\pi + p(r | \lambda)(1 - \pi)} = \frac{7}{9}$$

Similarly:

$$p(\lambda | l) = \frac{18}{25}$$

As the payout from choosing the correct action is independent of that action, and both of these conditional probabilities exceed  $1/2$ , then the manager maximises the expected value of the firm by following her private information. The manager is more confident that his optimal action is correct after receiving the signal  $r$  than after the signal  $l$ . The reason, in this example, is that the signal  $r$  reinforces his prior beliefs whereas the signal  $l$  contradicts them. The *ex ante* expected value of the firm under this optimal strategy is  $3/4$ .

Now suppose, for simplicity, that the manager's objective is to maximise today's share price; that is, she puts zero weight on tomorrow's profit. Assume that the market can observe the manager's choice of action but not her private information. Then always following her private information will never be an equilibrium strategy for the manager. This is easily shown by contradiction. If the market believes that the manager is following her private information, then if it observes action  $R$  the

public will believe that the manager received information  $r$  and the share price will be  $p(\rho | r) = 7/9$ . That is, the share price will be the expected future profits given the public's beliefs about the strategy of the manager. Similarly, if the observed action is  $L$  the share price will be  $p(\lambda | l) = 18/25$ . Given these beliefs, if the manager wishes to maximise today's share price, it will pay her to deviate by choosing  $R$  regardless of her private information.

An equilibrium outcome is for the manager to disregard her private information and always choose  $R$ . This results in a sub-optimal probability of success of  $7/13$  which is also the equilibrium share price.<sup>18</sup> In this simple example, the inefficiency arises from the manager's wish to conform with the skewed priors of the market. More generally, the inefficiency arises because, given the informational asymmetry, maximising the market's expectation of tomorrow's profit (that is, today's share price) is not the same as maximising expected profit directly.

Notice that, although the motivation is different, there is considerable similarity in the formal structure of this simple information neglect model and the simple signal jamming model discussed above. If we labelled the firm whose manager receives signal  $r$  a "good" type and that with signal  $l$  a "bad" type, then the information neglect problem can be viewed as the inability of the "good" types to separate themselves. The underlying economics is different however. There is nothing intrinsically bad about firms receiving signal  $l$ ; it is just that this signal disagrees with the stock market's prior beliefs. Given the formal similarity, it is not surprising that the problem of information neglect can be alleviated in the same way as Bizjak, Brickley and Coles' signal jamming. That is, information neglect may be reduced by designing the manager's remuneration package to place greater weight on long term results.

## 4 Information Cascades

In all the above asymmetric information models, the problem arose because managers were concerned about current share prices; that is, with how the stock market reacted to and assessed their actions. Managers were induced to manipulate the information that is transmitted to the market. More generally, however, similar problems can occur whenever information is imperfectly transmitted between economic agents, even if managers act directly to maximise the value of the firm. Consider, for example, the problem we have identified as information neglect. Banerjee (1992), Bikchandani, Hirshleifer and Welch (1992) and Welch (1992) have shown that this problem

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<sup>18</sup>Again, we ignore other possible equilibrium outcomes except to note that they are also socially inefficient.

can occur even if managers completely ignore the stock market. Rather, information neglect arises because of externalities in the sequential use of information which is imperfectly transmitted between managers of different firms. If managers' choices are guided by their private information then other managers, who make related decisions later, can infer part of that information by observing which actions are chosen. Thus, using private information in one's (observable) choices confers an external benefit to those who follow. But, it may not be in a firm's private interest to use its private information fully. In particular, the publicly available information may outweigh private information leading a firm to disregard its own signals. The problem is particularly acute where public information includes the choices of earlier firms. In this case "herds" or "informational cascades" can develop: firms may choose to follow, suspecting that the herd knows something they do not, thus ignoring their own private information. These models are especially useful in explaining why many firms often seem to take the same (seemingly arbitrary) action.

To see how these models work, let us return to the example from the previous section of firms choosing  $L$  or  $R$ . Suppose now, however, that there are three firms, 1, 2 and 3, each facing the same decision one after the other. Assume that the same action is correct for all firms and results in a payoff of 1, while the other yields 0. Each firm receives a (conditionally) independent signal such that, using the same notation as before,  $q = p(r | \rho) = p(l | \lambda) = 3/4$ . As above, before any private signals are observed or actions taken, let the prior that the correct action is  $R$  be  $7/13$ . Assume that each firm aims to maximise expected profit.

Recall from the previous section that if the probability generated by public information that  $R$  is the correct action,  $\pi$ , is greater than  $1/2$  then it is optimal for a firm to follow its own signal (rather than unconditionally to choose  $R$ ) if and only if  $\pi \leq q$ . Similarly, if  $\pi \leq 1/2$  then it is optimal for a firm to follow its signal (rather than unconditionally to choose  $L$ ) if and only if  $q \geq (1 - \pi)$ . Therefore firm 1 will follow its signal. For firm 2, however, given that it knows that firm 1 follows its signal, observing firm 1's action adds to public information. Thus, for firm 2, prior to observing its own private information, the probability that  $R$  is the correct action can take either of two values,  $\pi(R)$  and  $\pi(L)$  where  $\pi(R)$  (respectively,  $\pi(L)$ ) is the probability that  $R$  is the correct action given that firm 1 has chosen  $R$  (resp.  $L$ ),

$$\pi(R) = p(\rho | R) = \frac{p(R | \rho)\pi}{p(R | \rho)\pi + p(R | \lambda)(1 - \pi)} = \frac{7}{9},$$

$$\pi(L) = p(\rho | L) = \frac{p(L | \rho)\pi}{p(L | \rho)\pi + p(L | \lambda)(1 - \pi)} = \frac{7}{25}.$$

Since  $3/4 > 1 - 7/25$ , firm 2 will follow its signal if it observes firm 1 choose  $L$ . But, since  $7/9 > 3/4$ , the expected profit maximising strategy for firm 2 is to choose  $R$  after seeing firm 1 choose  $R$  regardless of its signal. For firm 2 to follow firm 1 in this manner is referred to as “herd behaviour” or forming an “informational cascade”. Since firm 2’s signal is not reflected in its action in this case, it is lost to firm 3. Firm 3 will also “herd” following firms 1 and 2 if they both choose  $R$ . If firms 1 and 2 both choose  $L$  then firm 3 will maximise expected profit by also choosing  $L$  regardless of its signal. Only if firm 1 chooses  $L$  and firm 2  $R$  will firm 3 follow its own signal. In this case, it is as if it were firm 1 since its “prior” is back to  $7/13$ .<sup>19</sup>

Firm 2’s expected gain from not following its signal after observing that firm 1 chose  $R$  is given by:

$$\pi(R) - q = 7/9 - 3/4 = 1/36$$

where  $\pi$  is its probability of success from following firm 1 and  $q$  is its probability of success from following its signal. If firm 2 did follow its signal after firm 1 chose  $R$ , firm 3 would only follow its own signal if firm 2 chose  $L$ . The expected gain to firm 3 is given by:

$$qq(1 - \pi) - (1 - q)(1 - q)\pi = (9/16)(6/13) - (1/16)(7/13) = 47/208$$

Notice that  $qq(1 - \pi)$  is the probability of both firms 2 and 3 choosing  $L$  when  $L$  is the correct choice: the only event in which firm 3 gains when firm 2 follows its signal after firm 1 chose  $R$ . Similarly,  $(1 - q)(1 - q)\pi$  is the probability of both firms 2 and 3 choosing  $L$  when  $L$  is the incorrect choice: the only event in which firm 3 loses when firm 2 follows its signal after firm 1 chose  $R$ . Clearly, for these numbers it would be socially efficient for firm 2 to follow its signal. The external benefit outweighs the internal cost.

Although the numbers in this example are of course “cooked”, more generally the loss to firm 2 from not following its signal can be arbitrarily small while the more firms there are following firm 2, the larger are the external gains. If there is an infinite sequence of firms taking decisions then, in equilibrium, a cascade will develop with probability one. To see this, consider the probability that  $R$  is correct conditioned on the choices of the first  $n$  firms. The  $n + 1$ th firm will only follow its signal if this probability lies in the interval  $[(1 - q), q]$ . This can only result from one sequence of actions: that in which the firms alternate choices starting with the first firm choosing  $L$ .

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<sup>19</sup>Formally, we should specify an action for firm 3 after observing the pair  $(R, L)$ , but this never occurs in equilibrium.

Bikchandani, Hirshleifer and Welch (1992) point out that cascades can be very fragile in the sense that it only takes a tiny bit of information to break the equilibrium and result in a number of firms using their information. Another cascade will almost always form, but quite possibly on the “other side”. In our example, suppose that a herd of firms has formed each choosing  $R$ . Recall that each firm prefers to neglect its signal by the margin of  $1/36$ . Consider a public signal that has two states  $l$  and  $r$ , where  $p(l | \lambda) = 7/13$ : just enough to counteract the original prior. If the realisation of this relatively feeble signal is  $l$  then the next firm to move will weakly prefer to follow its own signal. If this and the next firm happen to have signals  $l$  themselves, then a new cascade will form but this time with each firm choosing  $L$ . Bikchandani, Hirshleifer and Welch use this idea to explain “fads” and point out that such fads are fragile whether or not the chosen action was “correct”. They show that cascades are especially fragile if the underlying “correct” action can change, even if this change occurs with small probability.

King (1995) shows how neglect may arise not just in the use of information but also in the collection of information. If it is costly for a manager to investigate which is the best out of a set of alternatives, then it may be profit maximising for that manager to avoid gathering information directly and rather to wait and “mimic” the choice of other firms. Such a spillover of information between firms will lead to sub-optimal levels of information collection and, in the extreme, herd-like behaviour.

The problem of informational cascades or herds can be exacerbated by the kind of factors identified in Sections 2 and 3. For example, Brandenburger and Polak (1992) extend the basic cascades model to show that, if managers aim to maximize current share prices then even the information of the first of a sequence of firms can be lost. Sharfstein and Stein (1990) provide a signal jamming example. They consider firms of two types: good firms who receive informative messages and bad firms whose private messages are completely uninformative.<sup>20</sup> Firms do not know their own type but would benefit from being thought of as good. Their model is driven by the assumption that informative messages are more highly correlated than uninformative messages. In this case, firms have an incentive to herd in order to appear informed.

## 5 Directions for Future Research

This paper has surveyed a range of issues relating to information, managerial incentives and share-price based contracts. We have emphasised the imperfect trans-

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<sup>20</sup>In fact, the Scharfstein and Stein model is about types of managers but it could be easily translated into this framework.

mission of information between managers and investors and between managers of different firms. Asymmetric information limits the ability of investors to overcome principal-agent problems through share-based incentives, and hinders socially efficient managerial decision making even when there are no principal-agent concerns.

One clear conclusion is that naïve incentives based on short-term share prices are likely to lead managers to take actions designed to manipulate those prices rather than actions that maximize the long-term value of their firms. However, considerable work still needs to be done at both a theoretical and an empirical level. For example, most of the analyses surveyed took the (possibly suboptimal) contract form as given. Some recent research derives the optimal contract in these contexts. Dybvig and Zender (1991), for example, consider the optimal contract in an extended Myers and Majluf (1984) framework. Bebchuk and Fershtman (1994) argue that allowing a manager to trade in her firm's shares (and hence inducing her to care about share prices) can alleviate the problem of risk-averse managers choosing overly conservative projects. The intuition is that allowing "insider trading" is like giving managers options that are more valuable when there is more share-price volatility. It would be interesting to know more generally under what circumstances share-price based incentives form part of an optimal scheme for managerial remuneration. To date, little work has been done on the practical implications of information neglect problems. An important exception is Welch (1992) who considers information cascades in initial public offerings. Information neglect appears to be a promising area for further theoretical and empirical applications.

Early empirical studies of share-based incentives, as noted in Section 1, have proved inconclusive. Future empirical research should take on board some of the theoretical lessons surveyed here. In particular, existing incentive schemes should be compared with the particular information problems that prevail for that firm. A start in this direction is offered, for example, by the papers of Bizjak, Brickley and Coles (1993) and Hagerty, Ofer and Siegal (1992) discussed above. More empirical research of this type would be welcome.

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