

# Commitment to Overinvest and Price Informativeness<sup>1</sup>

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# Commitment to Overinvest and Price Informativeness

## Abstract

A fundamental role of financial markets is to gather information on firms' investment opportunities, and so help guide investment decisions in the real sector. In this paper we study the incentives for information production when prices perform this allocational role. We argue that firms' overinvestment is sometimes necessary to induce speculators in financial markets to produce information. If firms always cancel planned investments following poor stock market response, the value of their shares will become insensitive to information on investment opportunities, so that speculators will be deterred from producing information. We discuss several commitment devices firms can use to facilitate information production. We show that the mechanism studied in the paper amplifies shocks to fundamentals across stages of the business cycle.

# 1 Introduction

A fundamental role of financial markets is to gather information on firms, and so help allocate resources to their most efficient uses. This occurs when traders in financial markets produce information about firms' prospects for their own speculative trading. The information gets into market prices, which guide investment decisions in the real sector either through managerial learning (a mechanism supported empirically by Chen, Goldstein, and Jiang (2005), and by Luo (2005)) or through firms' access to capital (a mechanism supported empirically by Baker, Stein, and Wurgler (2003)). The usual justification for the usefulness of information in financial markets for firms' investment decisions is that markets gather information from many different participants, who do not communicate with the firm outside the trading process (see Subrahmanyam and Titman (1999)). This idea goes back to Hayek (1945), who argues that markets are the most efficient system for information production and aggregation. The ability of financial markets to produce information that accurately predicts future events has also been demonstrated empirically. For example, the literature on prediction markets shows that markets provide better predictions than polls and other devices (see Wolfers and Zitzewitz (2004)). Roll (1984) shows that private information of citrus futures traders regarding weather conditions gets impounded into citrus futures' prices, so that prices improve even public predictions of the weather.

This paper explores the incentives for information production in a context where prices have this allocational role. Financial economics has studied how information gets reflected in market prices via the trading activities of speculators, who are motivated by the profits they make on their costly private information. Seminal papers include Grossman (1976), Grossman and Stiglitz (1980), Hellwig (1980), and the extensive market microstructure literature following Kyle (1985) and Glosten and Milgrom (1985). However, in this literature, the cash flows from risky assets are assumed to be exogenous, and so there is no possibility for informative prices to perform an allocational role and create economic value. We argue that the way in which a firm responds to stock price movements in its investment decisions has itself important implications for information production incentives. Specifically, when a firm chooses its investments optimally contingent on the information available in prices, there may be very little incentive for speculators to produce

information. If a firm wants to increase its value by inducing speculators to produce information, it may need to commit to an interim inefficient investment policy. We discuss various ways that this commitment could be achieved.

Our paper emphasizes the role of information produced by financial markets in firms' investment decisions, and focuses on this information alone. By doing this we do not try to deny the importance of alternative sources of information, such as banks or large shareholders, which have been extensively analyzed in the corporate finance literature (see Allen and Gale (2000), for an excellent review). Rather, we try to extend the analysis to a class of information providers, which was somewhat neglected in the corporate finance literature. Our paper relates to several other papers studying the role of information from financial markets in firms' investment decisions. These papers include: Leland (1992), Khanna, Slezak, and Bradley (1994), Dow and Gorton (1997), Subrahmanyam and Titman (1999), Dye and Sridhar (2002), Dow and Rahi (2003), Khanna and Sonti (2004), and Goldstein and Guembel (2005). Unlike these papers, our paper analyzes the incentives of speculators to produce information when prices perform an allocational role, and the actions firms may take to create such incentives.

The basic mechanism that causes too little information production in our model goes as follows. Assume a market where investment decisions are always optimal given the information in the price. In particular, previously announced investments are cancelled when, according to information reflected in prices in response to their announcement, they have negative NPVs. In such a market, the value of the securities becomes insensitive to the information about investments, as investments are often cancelled. Then, the information loses its speculative value, so that agents have no incentive to produce it in the first place. This makes prices uninformative, and destroys the useful process via which prices guide investment decisions. In the specific model we present in this paper, the information gathering process breaks down completely. More generally the logic of our argument suggests that the market produces too little information.<sup>1</sup> If a project is infrequently chosen the incentive to produce information about it will be reduced and this in turn will reduce the chance of the project being selected.

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<sup>1</sup>We discuss this point further in Section 6 below.

In order to prevent this breakdown of the information gathering process, firms have an incentive to commit ex ante to invest in cases when the information in the price suggests that the investment has a slightly negative NPV. This will make the value of firms' securities more sensitive to project-specific information, and may induce speculators to produce the information, making prices more informationally efficient. This course of action is interim inefficient, as it makes firms pursue investments in cases where they ought to be rejected based on all available public information, but it improves the ex-ante efficiency of investment decisions by letting information be produced and guide investment decisions in other cases. Overinvestment can be achieved with various commitment devices, and can be justified as a device that attempts to increase the informativeness of stock prices.

We study possible commitment devices in two different settings; both can be viewed as canonical representations of the relationships between firms' managers and shareholders. First, we consider a setting where the interests of firms' managers are completely aligned with the interests of shareholders. In this setting, a firm's manager makes the investment decision using all the information in the price and trying to maximize firm value. The manager has enough funds to finance the investment without relying on external resources. Due to the above considerations, the manager may wish to commit to pursue the investment when it has a slightly negative NPV. The manager can do this by setting a cancellation fee, i.e., a fee that needs to be paid in case the firm cancels the investment. Of course, the fee should not be too high. It needs to be set at a moderate level, so that the firm will have the ex-post incentive to pursue the investment when the price suggests it has a slightly negative NPV, but not when the price suggests its NPV is very negative. Such cancellation fees may be explicit or implicit. Explicit fees are especially common in mergers and acquisitions, where they are known as 'break-up fees.' This commitment can also be achieved by investing earlier than traditional real options theory would suggest, i.e. transforming an option to invest into an option to abandon.

Second, we consider a setting where there are strong agency conflicts between firms' shareholders and managers. Managers are 'empire builders': they want to invest as much as possible due to the private benefits they obtain from managing large investments (Jensen (1986)). In this setting,

shareholders will limit the amount of financial slack left inside firms in order to prevent managers from pursuing too many bad projects. Good projects, i.e., those that have a positive NPV based on all available public information, will be funded by capital markets after market prices reveal the positive information about them. Still, due to the considerations outlined above, shareholders will choose to leave moderate levels of financial slack inside the firm, so that marginally unattractive projects will also be funded. This is ex-post inefficient, but is ex-ante optimal because it makes the firms' securities more information-sensitive and hence induces financial market traders to produce the information that allows good projects to be identified. We use this argument, where financial slack serves as a commitment device to pursuing slightly negative NPV investments, to develop a theory of optimal financial slack.

Since commitment to overinvest serves to encourage information production, our model predicts a link between the presence of commitment and information variables. In one direction, firms with such commitment in place are expected to have more informative stock prices. This can be tested using measures of price informativeness, such as the probability of informed trading (PIN) and price non-synchronicity – both are used in the empirical study by Chen, Goldstein, and Jiang (2005). In the other direction, firms that can learn more from outsiders are more likely to try and encourage information production by committing to overinvest. This can be tested using the hypothesis of Luo (2005), that firms are likely to learn from the market when they face uncertainty mostly about demand and strategic parameters and less about technology parameters.

Finally, building on the analysis in the paper, we argue that our model has interesting implications for economic activities across different stages of the business cycle. In our model, the incentives of speculators in financial markets to gather information on firms' investment opportunities increase in the probability that firms will undertake those investments. This probability is low when economic fundamentals are weak, as then investments are expected to be less profitable. Since the information gathered by speculators contributes to the efficiency of investment decisions, and since it is sometimes crucial for investments to be undertaken (that is, when fundamentals are such that investments have negative NPVs based on prior information), the lack of information decreases the efficiency of investment decisions and the amount of investments undertaken in

states of bad economic fundamentals. Thus, the feedback from information in the price to firms' investment decisions amplifies the shocks to fundamentals, and makes the economy fluctuate more across stages of the business cycle. Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Suarez and Sussman (1997) present models where productivity shocks are amplified due to credit constraints. Our model offers an explanation based on the information gathered by stock-market speculators. This information effect can be viewed as a different explanation or as a source for the credit constraints discussed in existing literature.

The tension identified in our model is one between interim efficiency and ex ante incentives. This type of tension has previously been identified with regard to managerial incentives in a number of papers. Brander and Lewis (1986) and Fershtman and Judd (1987) show that firms in a Cournot competition will create incentives for managers to make interim non-efficient decisions that generate aggressive behavior, which is ex-ante optimal. Cremer (1995) shows that the principal's interim efficient decision may be too soft to provide optimal incentives ex ante, because the principal may not wish to fire a high ability manager, even though he performed poorly. This reduces incentives for the agent to exert effort ex ante. Thus, the principal may wish to commit to a tougher interim rule. Other papers have shown that the principal's interim efficient action may be too tough (e.g., Shleifer and Summers (1988), Burkart, Gromb and Panunzi (1997), Alamazan and Suarez (2003), and Kihlstrom and Wachter (2005)). In these papers, it may be ex ante optimal to retain a manager who should be sacked from the point of view of interim efficiency. In Rotemberg and Saloner (2000), top management commits to allow middle managers, who obtain private benefits from running their pet projects, to continue with marginally unprofitable projects in order to encourage them to initiate new projects. Guembel and White (2005) show that ex-ante monitoring incentives can be improved by an interim inefficient liquidation policy.

In contrast to these papers, we show that a similar tension may apply to ex ante incentives for financial market traders to acquire information for their speculative trading and the interim efficient investment decision by a firm. Our paper is distinctive in that the communication between firm and speculator takes place via the stock market price. In our model, the firm would like the speculator to produce information about a random variable, when normally the stock price would

not be sensitive to this random variable.<sup>2</sup> The firm therefore commits to making the stock price reflect the variable. This way, the firm can induce the trader to produce the desired information. The firm's investment policy is chosen with a view to making the securities market more complete. There are relevant states of the world for which there is no state security, unless the firm undertakes the investment. These states concern the value of a potential investment. If the firm does not make the investment, then the market is incomplete with respect to these states. But because the firm benefits from having a market for these securities it commits to making the investment and thereby makes the market more complete. Notice that it is impossible for a third party (such as a financial futures exchange) to create this state security because its value does not depend on public information.<sup>3</sup>

The remainder of the paper is organized as follows. In Section 2, we describe the basic model. Section 3 outlines firms' possible investment policies, and demonstrates the need to commit to an interim inefficient policy. Section 4 analyzes commitment devices in two separate canonical settings. In Section 5, we discuss implications for the business cycle. Section 6 provides discussion on robustness and other implications of the model. Section 7 concludes.

## 2 The Model

A firm has an investment opportunity which requires investment  $I$  and yields uncertain payoffs  $R \in \{R_l, R_h\}$  depending on the underlying state of the world,  $\omega \in \{l, h\}$ . The investment project is worth undertaking in the high state ( $h$ ), but not in the low state ( $l$ ). Each state is equally likely. For the main part of the analysis we assume that the project has ex ante negative net present value:

$$I > \bar{R} \equiv \frac{1}{2}(R_l + R_h). \quad (1)$$

We also assume that the project has a positive net present value, if the state can be identified in advance with probability  $1/2$  and the project is rejected when the bad state is forecast. This

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<sup>2</sup>Thus, our mechanism requires that investments are sometimes rejected, in which case information about their fundamentals does not affect price and/or firm value.

<sup>3</sup>One could imagine creating a futures contract whose value depends on the signals received by the speculators, but it would not be incentive compatible for them to reveal their signals truthfully.

means:

$$\frac{1}{4}(R_h - I) + \frac{1}{2}(\bar{R} - I) > 0. \quad (2)$$

The project can be thought of as containing an option to defer investment until more information is known about it. Then, assumptions (1) and (2) mean that the project's net present value is positive only once the real option is accounted for. We focus on this particular type of investment project, because it is the most interesting in terms of the interaction that it entails between investment policy and information production. We will analyze the general case in Section 5 where the ex ante project NPV can take any value.

We denote the value of the firm's assets in place (including any retained cash, etc.) as  $V_0$  (this is a fixed amount). Later in the paper (section 4.1), we will consider the possibility of the firm agreeing to pay a fee to a third party; in our application, it will be a potential takeover target, but one could also imagine other settings such as a managerial compensation fee. We need some notation to reflect this possibility, and in general one can imagine the fee might depend on a whole variety of variables such as the investment decision, the realized value of the project, and the stock market price of the firm's shares. Rather than listing all these variables, we will use the simple notation  $f$  to represent the expected fee, with subscripts for any conditioning variables (as in equation (3) below, for example). Until section 4.1, we recommend the reader to simply ignore this symbol.

There are two periods. In period one, the firm's equity is traded on financial markets. Then the firm either makes the investment or not (this may depend on the stock price). In period two, the investment opportunity matures; equity and all other financial claims are liquidated.

We now describe period one in more detail. The firm's equity is traded in a secondary financial market. We use the framework developed by Kyle (1985) to model trading and prices in this market. Specifically, the players in the market are: an informed speculator, uninformed liquidity traders, and a competitive market maker. Liquidity traders are equally likely to buy or sell, and their trade size is  $n$ . The informed speculator learns the true state  $\omega$  at cost  $c$ , and can trade contingent on his information. All orders are submitted to the market maker who sets the

price equal to the expected firm value contingent on the information contained in order flow. We assume that the market maker observes the set of orders, but not the identity of the trader(s) who submitted them. If the speculator is informed and trades, he will submit orders of size  $n$  in order to hide his trade behind the liquidity traders. It will be optimal for him to buy after receiving good news and to sell after receiving bad news. The market maker may then observe two buy orders, a buy and a sell order, or two sell orders.

- If he observes two buy orders (probability  $\frac{1}{4}$ ), he infers that the speculator traded on positive news and sets a high price, denoted by  $p_{bb}$ , that reflects this information.
- If he observes a buy and a sell order (probability  $\frac{1}{2}$ ), he cannot tell whether the speculator bought and the liquidity trader sold, or vice versa. He therefore sets a price  $p_{sb}$  that does not reveal the speculator's private information.
- Finally, if the market maker observes two sell orders, he infers that the speculator received negative news and therefore sold. He then sets a price  $p_{ss}$  that reflects the speculator's negative information.

The values of  $p_{bb}$ ,  $p_{sb}$ , and  $p_{ss}$  depend on the firm's equilibrium investment policy. This investment policy is endogenous and depends on prices and order flows. This point, which is central to our model, complicates the analysis relative to Kyle (1985), where the value of the firm was exogenous, and was not affected by the financial market.

If, in equilibrium, the speculator is not informed and hence, doesn't trade, then the order flow observed by the market maker is uninformative, and the price  $p_b = p_s$  depends on whether the firm's policy is to invest in this case.

We now consider the possibility of different investment policies, and their effect on prices. We focus on investment policies that can be made contingent on publicly available information (the stock price).

### 3 Investment Policies

#### 3.1 Unconditional Policies

##### 3.1.1 Always Invest

In an extreme case, the firm could always invest, regardless of the information revealed through the stock price. Assume for the time being that the speculator chooses to acquire private information (perhaps because information acquisition costs are small enough). If the market maker observes two buy orders, he will set the price equal to<sup>4</sup>

$$p_{bb} = R_h + V_0 - I - f_{bb}, \quad (3)$$

if he observes a buy order and a sell order, he will set the price equal to

$$p_{sb} = \bar{R} + V_0 - I - f_{sb}, \quad (4)$$

and if he observes two sell orders, he will set

$$p_{ss} = R_l + V_0 - I - f_{ss}. \quad (5)$$

Prices are efficient in the sense that they reflect the private information of the speculators, albeit with noise because their trades are confounded with the trades from the liquidity traders. Given our assumption (1) that the unconditional NPV is negative, this investment policy is obviously inefficient. It destroys value compared to the alternative of never investing. Also, conditional on the information revealed in the stock price, we can see that many bad projects are accepted: if prices are  $p_{sb}$  or  $p_{ss}$ , the project has negative NPV given the public information, but is accepted nevertheless.

It is also worth noting that unconditional investment could also arise if the informed trader chose not to acquire information. The price would then be<sup>5</sup>

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<sup>4</sup>Recall that  $f_{bb}$  represents the expected fee paid to third party, in case the firm has made a commitment of that sort. This fee plays only a very minor role in our analysis, except in section 4.1 below, but is included here for analytical completeness' sake.

<sup>5</sup>Strictly speaking, we should state explicitly that we have assumed  $f_b = f_s$  in this expression.

$$p_b = p_s = \bar{R} + V_0 - I - f_b. \quad (6)$$

### 3.1.2 Never Invest

In another extreme case, the firm could always reject the investment project, regardless of the information revealed through the stock price. In this case, the value of the firm is always going to be  $V_0$ , and this will also be the price of the stock set by the market maker.

## 3.2 Conditional Policies

We now consider policies where investment depends on public information (order flow and price).<sup>6</sup> There are two conditional investment policies of interest. The investment decision can either err on the side of sometimes rejecting good projects (type I error) or it can err in the other direction by sometimes accepting bad projects (type II error).<sup>7</sup>

A *type I conditional investment policy* is to invest only when the price reveals good information, rejecting when it is non-revealing or reveals bad information. In other words, it is a policy of erring on the side of over-rejection. The firm rejects unless it is certain of success.

A *type II conditional investment policy* is to invest except when the price reveals bad information (i.e., invest if it reveals good information or is nonrevealing). The two policies differ when the price is non-revealing. It is a policy of erring on the side of under-rejection. The firm invests unless certain of failure.

More generally, one may consider the possibility of randomizing over the investment decision. Doing so, however, would not alter our main conclusion derived below, namely that investing more

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<sup>6</sup>The first-best investment policy, given the speculator's private information, is to invest when he knows the project will succeed and reject the project when he knows it will fail. This policy is not available, because the financial markets can only observe the total order flow and the market price. These are imperfect signals of the private information because the speculator's order is confounded with the liquidity trader. A more relevant benchmark is to consider only investment policies that condition on the public information.

<sup>7</sup>We use the type I – type II terminology to build on the analogy with the terminology of hypothesis testing, where a type I means rejecting a true hypothesis, and a type II error means accepting a false hypothesis.

often than is interim efficient may increase ex ante firm value. We view a mixed investment strategy as hard, if not impossible to implement in practice and therefore, since our focus will be on the implementation of the investment policy, we do not provide a full analysis of this possibility here.

### 3.2.1 Type I Conditional Investment (Reject unless Certain)

Given our assumptions, the interim efficient investment policy would be type I, i.e., to invest when the stock price reveals the good state ( $p_{bb}$ ), and not invest otherwise ( $p_{sb}$  or  $p_{ss}$ ). If the firm does follow this policy, then a buy and sell order at the same time will lead to the project being rejected. Just like in the case of two sell orders, the share value will not be sensitive to the private information of the speculator about the fundamentals of the investment. The share price will reflect this information only in the case of two buy orders:

$$p_{bb} = R_h + V_0 - I - f_{bb}, \quad (7)$$

$$p_{sb} = V_0 - f_{sb}, \quad (8)$$

$$p_{ss} = V_0 - f_{ss}. \quad (9)$$

As we now show, this will, in turn, have a drastic effect on the firm's investment.

**Proposition 1 (Feasibility of type I investment policy)** *Suppose the firm does not invest except when there are two buy orders. In equilibrium, the speculator then does not acquire costly information, and the firm therefore never invests.*

**Proof.** Suppose the speculator does acquire information in equilibrium. If there are two buy orders, the market maker knows that the state of the world is good and sets a price that reveals the state exactly. Therefore, in this state of the world, the speculator makes no profit. The same argument applies to the case of two sell orders. If there are two orders of opposite sign, the interim efficient investment policy is not to invest by the assumption  $I > \bar{R}$ . The firm's liquidation value is therefore independent of the state of the world, and again the speculator cannot profit. This implies that the speculator would choose not to acquire information. Then, the price will never reveal positive news, and the firm will never invest. ■

To see how this effect operates, assume on the contrary that the speculator does acquire information, and then buys on good news and sells on bad news. We will go through each of the three different possibilities for the total order flow and price.

First, in the case of two buy orders, there is no uncertainty about the project, which will return  $R_h$ . Because the price fully reveals the information, the speculator makes no profit. The asset value is sensitive to the private information, but the private information is already fully reflected in the price. Second, if there are two sell orders, there is again no uncertainty about the project, and the speculator makes no profit on his information. Third, if there are two opposite orders, the speculator has information that is not reflected in the order flow or in the price. This is the source of profit in traditional market microstructure models. Here, however, the speculator is unable to profit from his information when the information is not revealed. This is because in this case, the project is rejected, and the value of the firm does not depend on the project's realized return. The asset value is no longer sensitive to the private information, so there is no money to be made from predicting the project's profitability.

Note that this result does not depend on the specific design of the security in which the speculator can trade. Any security whose value depends on the value of the firm will share a crucial property with the equity claim studied here: the value of the security is only sensitive to the value of the investment project, if the project is actually undertaken by the firm. If the firm rejects the project, its value (and therefore the value of any security written on it) will be insensitive to that information. Moreover, it may be impossible in most relevant cases to issue a separate security that reflects the value of an investment project regardless of whether or not it is actually undertaken. For example, it is hard to imagine that the value of synergies in a potential acquisition could ever be known unless the acquisition actually takes place.

### **3.2.2 Type II Conditional Investment (Accept unless Certain)**

Suppose that the speculator acquires and trades on information, and that the firm follows the type II investment policy: it always invests except when the price reveals that the future state of the world is bad. In other words, the firm invests when the price is  $p_{sb}$ . Now the informed speculator

can make a profit on his information.

Consider the three possible values for the stock price. If the price is  $p_{bb}$ , the firm will take the project, and the project will return  $R_h$  for sure. The price will be

$$p_{bb} = R_h - I + V_0 - f_{bb}. \quad (10)$$

If the price is  $p_{ss}$  the firm will reject the project and so

$$p_{ss} = V_0 - f_{ss}. \quad (11)$$

The interesting case is when the price is  $p_{sb}$ , since, after observing the price, there still remains uncertainty about the future project value. Then,

$$p_{sb} = \bar{R} - I + V_0 - f_{sb}. \quad (12)$$

Note that these price formulas do not rule out the possibility that new external financing,  $\max\{0, I - V_0\}$ , is raised to fund the investment, since any money raised in an efficient market has zero NPV. Let the final value of the existing equity be  $V_h$  or  $V_l$ , depending on the success or failure of the project. These two values will normally differ from each other ( $V_h > V_l$ ),<sup>8</sup> although their exact values will depend on the form of financing (debt, seasoned equity, etc.) and on the value of  $f$ . Standard market efficiency requires

$$p_{sb} = \frac{1}{2}(V_h + V_l). \quad (13)$$

The informed trader's trading profits, when he knows the state is good but the price is non-revealing at  $p_{sb}$ , are

$$n(V_h - p_{sb}) = \frac{n}{2}(V_h - V_l).$$

Similarly, if the state is bad and the price is non-revealing, the speculator has a short position and trading profits are

$$n(-V_l + p_{sb}) = \frac{n}{2}(V_h - V_l).$$

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<sup>8</sup>We rule out extreme cases that lead to the original equity holder's payoff being decreasing in firm value. This extreme could only be achieved by a security such a structured note whose payoff is more than 100% sensitive to the project payoff, i.e. effectively the firm would be selling more than 100% of the project's equity.

For example, if riskless debt is issued to finance the project, or if no external finance is required, his trading profits are  $\frac{n}{2}(R_h - R_l)$ .

If we average across the three possible stock prices,  $p_{bb}$  and  $p_{ss}$  each have probability  $\frac{1}{4}$  and  $p_{sb}$  has probability  $\frac{1}{2}$ , then expected trading profits for the speculator are:

$$\frac{n}{4}(V_h - V_l) \tag{14}$$

If this exceeds  $c$ , then the speculator will be willing to produce information and the stock price will be partially revealing. The investment policy is not interim efficient (conditional on the price), but, precisely because of this, it does reward the speculator for producing the information that can guide investment.

### 3.3 Overinvesting is Optimal

So far, we have taken as given the firm's investment policy. This investment policy, together with the speculator's information production cost, determines whether the speculator will choose to become informed and trade. Note that the firm does not bear the cost of the speculator's trading profits; these are borne by the liquidity traders. We can now summarize the properties of the four investment policies considered.<sup>9</sup>

1. Unconditional investment: Information about investment prospects is produced if the cost is small enough, but, by assumption (1), the investment policy is dominated by all other investment policies considered.
2. Type I conditional investment (invest only on good news): This investment policy would be interim efficient, but is not feasible, because the speculator does not acquire information if the firm follows this policy.
3. Type II conditional investment (invest unless bad news): This investment policy is not interim efficient, but, by assumption (2), it is better than the two unconditional policies. This policy is also feasible so long as the information production costs are small enough.

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<sup>9</sup>We restrict attention to investment policies that are monotonic in the order flow. It can be easily shown that other investment policies will not be optimal.

4. Never invest: This policy is better than unconditional investment, but not as good as the two conditional investment policies.

We now consider the firm's optimal investment policy in the reduced form game in which  $V_h$  and  $V_l$  are given. We will later endogenize the firm's choice of  $V_h$  and  $V_l$ .

**Proposition 2** *When  $c \leq \frac{\alpha}{4}(V_h - V_l)$  then the type II policy is the only feasible conditional investment policy. Given assumptions (1) and (2), the type II policy is also preferred over the two unconditional investment policies.*

**Proof.** Follows directly from the discussion above. ■

Given that the type I investment policy is never feasible, and that unconditional investment is dominated (by assumption (1)), the optimal policy must be either type II conditional investment, or never investing. Given assumption (2), the firm will choose the type II conditional investment. Of course, for this investment policy to be feasible, the cost of information production has to be sufficiently low, so that the speculator will acquire information and trade on it.

Choosing the type II policy entails a trade off. It improves the ex-ante efficiency of the investment decision, but leads to interim inefficient decisions, as projects are accepted too often than optimal. More importantly, the firm needs to have a device in place that enables commitment to an interim inefficient investment rule.<sup>10</sup> We now turn to discuss such commitment devices.

## 4 Commitment to the Investment Rule

The type of commitment device used by the firm depends on the way the firm's investment decision is affected by its stock price. Generally, there are two main mechanisms that can generate a feedback effect from stock prices to real investments. First, the firm's management may learn from

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<sup>10</sup>A firm may also be able to commit to an interim inefficient investment policy in the context of a repeated game where it may try to establish a reputation for ex ante optimal overinvestment. An analysis of this game lies outside the scope of this paper. Moreover, the mechanism of reputation building may be of limited relevance in the context studied here, which exhibits short lived agents (the manager) as well as multiple agents (the speculators) whose ability to co-ordinate on and inflict potentially time inconsistent punishment strategies is probably small.

financial markets about the prospects of the investment project. That is to say, financial markets may sometimes have information about aspects of an investment project that the managers do not have. This could be relevant in a setting where managers act to maximize shareholder value and want to learn more information from financial markets that will help them make better investment decisions. This mechanism has been supported empirically by Chen, Goldstein, and Jiang (2005) and by Luo (2005), and has been discussed theoretically in various papers, including Dow and Gorton (1997) and Subrahmanyam and Titman (1999).

Second, the firm's stock price may affect its access to external capital, for example, because potential lenders learn from the price about the prospects of the firm's investments, and use this information to decide whether to finance the firm's investments or not. This mechanism has been supported empirically by Baker, Stein and Wurgler (2003). This could be relevant in a setting where managers may pursue different objectives than maximizing shareholder wealth and shareholders may want to improve resource allocation by limiting the free cash flow available to managers, and thus controlling the managers' investment decisions. In this setting, control is likely to be imperfect, so that the interim efficient decisions will not necessarily be enforced.

#### 4.1 Managerial Learning

Suppose now that the firm's manager acts to maximize shareholder wealth and that he has no private information about the available investment project. Suppose also that the firm has sufficient internal funds to undertake the project whenever it wishes to do so. This means that the manager will choose the investment project so as to implement the interim efficient decision. From our previous discussion it follows that the financial market would not produce any information in this case and the (interim efficient) type I conditional investment policy therefore becomes infeasible.

One way to achieve the necessary degree of commitment to invest can be the introduction of a fee that the firm pays if it announces an investment and then does not undertake it, for example a break-up fee in a merger agreement.<sup>11</sup> When the bidding firm is committed to paying a fee  $F$

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<sup>11</sup>Often, break-up fees refer to fees payable by the target in the event of another bidder taking it over. Here, we refer to fees payable by the bidder in case it decides to cancel. Such fees have also become common in recent years. For example, in the HP-Compaq takeover, the merger agreement stipulated that either party would be liable to pay

it may go ahead with the merger rather than rejecting it even when the financial markets do not react favorably to the announcement. In principle the firm may be able to make the fee payment contingent on the stock price realization after the merger announcement. This may, however, not be a viable option since the firm can probably manipulate its own stock price, for example by changing its earnings forecasts. This may make it less credible that the firm will actually have to honor its payment. We therefore assume that the break-up fee can only be made contingent on whether or not the merger is consummated.<sup>12</sup>

The next proposition characterizes the optimal fee, and shows that it should be set at an intermediate level, so that it causes investment when the price is not revealing, but not when it is revealing that the state of the world is low.

**Proposition 3** *If  $c \leq \frac{\alpha}{4}(R_h - R_l)$  and  $\frac{1}{4}(R_h - I) + \frac{3}{4}(\bar{R} - I) \geq 0$  then it is optimal for the firm to commit to a fee  $F = I - \bar{R}$  when it rejects the investment project. Otherwise it is optimal for the firm never to invest.*

**Proof.** For a fee to cause the investment to occur when the price is non-revealing, we need

$$\bar{R} - I \geq -F. \tag{15}$$

Moreover, the fee has a dead-weight cost because it has to be paid even when the firm abandons the merger in response to negative order flow. Therefore it will be set as small as possible, while maintaining condition (15). The types of projects for which it would now be optimal to commit to such a fee must have a slightly higher NPV, because they have to generate enough cash to compensate for the ex ante cost of paying the fee:

$$\frac{1}{4}(R_h - I) + \frac{3}{4}(\bar{R} - I) \geq 0. \tag{16}$$

Given that the firm accepts the project when the price is  $p_{sb}$ , we know that  $V_h = R_h - I + V_0$  and

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compensation of US\$675 million if it were responsible for the failure of the transaction.

<sup>12</sup>If a fee can be made contingent on the stock price our analysis would go through in much the same way, except that the commitment fee would not carry an ex ante cost, because in equilibrium it would never be paid. This is because the firm would write a contract in a way that it would only have to pay when the price is non-revealing.

$V_l = R_l - I + V_0$ . Thus, based on (14), the speculator will collect information as long as:

$$c \leq \frac{n}{4}(R_h - R_l). \quad (17)$$

■

More broadly, firms are likely to suffer reputational costs (rather than explicit break-up fees) or be sued when they cancel previously announced projects (see: Luo (2005)). Our analysis suggests that these reputational costs could have a positive side effect of increasing firms' commitments to their projects and encouraging financial markets to produce information about those projects. It is a contrarian view to the prevailing wisdom in finance that an immediate response to shareholder concerns is always better for firm value. A direct empirical implication of our model is that firms that have more commitment power should also have a more informative stock price.

Another form of commitment can be to invest in projects too early if some of the investment outlay is a sunk cost. This transforms an option to wait into an option to abandon. Abandoning the project later entails a loss of a fraction of the initial investment. A firm may therefore choose to abandon the investment only after observing negative order flow, but not when order flow is non-revealing. Sinking some funds into the investment works like a break-up fee. When the financial market sees that the firm has committed to the project it will be willing to produce information about the project's value, because the firm's securities will be more sensitive to this information.

Traditional real options theory assumes that the information arrival is exogenous and derives optimal exercise policies under that assumption. Specifically, one of the main predictions of real options theory is that investment should be delayed, because waiting for more information improves the investment decision. Our analysis shows that the exercise policy itself may affect information production incentives and therefore the amount of information available. In particular, we show that investing earlier can increase the amount of information available. This offsets the incentives to wait.

## 4.2 Financial Slack

The agency cost of free cash flow is a standard concept in corporate finance (Jensen (1986)). Managers may prefer to re-invest corporate earnings even when this is not in the shareholders'

interests. A stylized representation of this is to assume that managers' only objective is to invest as much as possible. We now suppose that managers act this way, and study how shareholders can set the level of financial slack to control them: by setting dividend payout policy or leverage, shareholders can control free cash and hence investment policy (as suggested by Jensen (1986)).

If shareholders want the firm to invest when the stock price is  $p_{sb}$  they can design the financial structure of the firm in such a way as to leave enough internal cash to allow investment in this case (i.e., internal cash plus cash raised is at least  $I$ ), but not enough to enable investment in the worst case when the price is  $p_{ss}$ . This is type-II conditional investment. On the other hand, if they wish, shareholders can keep internal cash low so as to restrict the firm's ability to raise external finance in any circumstances.

Let  $E$  denote the initial cash holdings in the firm. In order to go ahead with the investment project the firm needs to raise external finance  $\max\{0, I - E\}$ . If  $I - E > 0$ , the firm can attempt to raise external finance from a set of uninformed, passive investors.<sup>13</sup> The investors learn from the market price and can make their decision to supply capital contingent on that price. External finance can be raised in the form of debt, equity or any other claim. Note that the amount of funding the market is willing to supply depends on its expectation that the project will succeed given the order flow and market price. The money raised must offer a competitive return (assumed zero) to the external finance providers. The repayment to the external finance providers can be made contingent on the final project value, and because finance is raised after the stock price is observed, the repayment terms can also be made dependent on the stock price.

Let the repayment to the external finance providers be  $X_l$  in the bad state and  $X_h$  in the good state. In the case of riskless debt, we have  $X_l = X_h = I - E$ , and where no external funding is required,  $X_l = X_h = 0$ . Notice that if external financing is raised, the investors will get a competitive expected return. Thus, when the price is  $p_{sb}$ ,  $\frac{1}{2}(X_l + X_h) = I - E$ .

We first show that when internal cash is too low, the firm will never invest.

**Proposition 4** *For  $E < I - \bar{R}$ , the firm is unable to raise external finance and never undertakes*

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<sup>13</sup>We assume that the speculator, after receiving information, is unable or unwilling to fund the entire project. This could be due to wealth constraints or risk aversion.

the investment project.

**Proof.** Suppose the speculator acquires information and trades on it. The investors' individual rationality constraint requires an expected repayment in the middle state (after price  $p_{sb}$ ) equal to the amount of capital raised:  $\frac{1}{2}(X_l + X_h) = I - E$ . The maximum amount of repayment that the firm can promise to the providers of external finance in this state is  $\frac{1}{2}(X_l + X_h) \leq \bar{R}$ . This requires that  $\bar{R} \geq I - E$ ; hence for  $E < I - \bar{R}$  the firm is not able to raise external finance when the price is  $p_{sb}$ . When the price is  $p_{bb}$ , the firm is able to raise enough capital to undertake the project, because by assumption  $R_h > I$  and therefore the investors' individual rationality constraint can be satisfied. At price  $p_{ss}$  the firm is unable to raise finance because  $I - R_l > I - \bar{R}$ . Hence, the firm follows the interim efficient investment policy (type I conditional investment). From Proposition 1, however, we know that the speculator does not acquire information if the firm follows this investment rule. Hence, stock prices do not reflect information and capital raising has to be uncontingent. By assumption the unconditional NPV of the project is negative and, also by assumption,  $E < I - \bar{R}$ . It will therefore not be possible to raise uncontingent finance. ■

The intuition behind this result is as follows. At  $p_{sb}$ , the project's expected payoff (from the viewpoint of the external finance providers, who condition on price but have no private information) is the unconditional expectation  $\bar{R}$ . By hypothesis, this is less than the financing requirement  $I - E$ . So the firm will be unable to fund the project at price  $p_{sb}$ , which implies that the price cannot be informative in the first place: if the price were  $p_{bb}$ , financing might be possible, but this price cannot occur. So the project is never financed.

We can now complete the characterization of the equilibrium, and give the optimal level of retained earnings. The shareholders' objective is to choose how much cash  $E$  to leave in the firm, to maximize their wealth inclusive of the value of the firm. By choosing  $E$ , they effectively determine the amount of financial slack in the firm and hence the firm's investment policy.

**Proposition 5** *If  $c \leq \frac{\pi}{4}(R_h - R_l)$ , the shareholders will choose retained earnings  $E \in [I - \bar{R} + \frac{2c}{\pi}, I - R_l)$ . The speculator will produce information and the investment policy chosen is type II conditional investment. If  $c > \frac{\pi}{4}(R_h - R_l)$ , the shareholders will choose retained earnings  $E < I - \bar{R}$  and the firm never invests.*

**Proof.** We know shareholders will prefer type II conditional investment and will choose it if possible, i.e., if information production costs are small enough. First, consider the constraints imposed by the requirement that the speculator has an incentive to acquire information. From equation (14), the speculator's trading profits are:

$$\begin{aligned}
& \frac{n}{4}(V_h - V_l) \\
= & \frac{n}{4}[(R_h - X_h + V_0 - I) - (R_l - X_l + V_0 - I)] \\
= & \frac{n}{4}[(R_h - R_l) - (X_h - X_l)]
\end{aligned} \tag{18}$$

This has to be greater than  $c$ . So, the smaller  $X_h - X_l$ , the higher the speculator's trading profits.  $X_h - X_l$  can be minimized by paying the maximum possible amount to the providers of capital when the project returns  $R_l$ , i.e.,  $X_l = R_l$ . Substituting  $X_l = R_l$  yields an upper bound on  $X_h$ :  $X_h \leq R_h - 4\frac{c}{n}$ . Moreover, the investors' individual rationality constraint requires  $\frac{1}{2}(X_h + X_l) = I - E$ . Substituting this and  $X_l = R_l$  into  $X_h \leq R_h - 4\frac{c}{n}$  yields the lower bound  $E \geq I - \bar{R} + \frac{2c}{n}$ . Of course,  $E$  will be set below  $I - R_l$  to prevent investment when the price is  $p_{ss}$ . Finally, when  $c > \frac{n}{4}(R_h - R_l)$ , there is no way to implement Type II conditional investment policy and enable the speculator to make a profit, as the lower bound and upper bound of  $E$  converge. ■

Note that the minimum amount of retained earnings that is compatible with moderate over-investment ( $I - \bar{R} + \frac{2c}{n}$ ) is larger than the financing requirement in the middle state  $p_{sb}$  ( $I - \bar{R}$ ). If retained earnings were at the minimum level  $I - \bar{R}$ , the external capital providers would have to be made residual claimants on the new project's cash flows in order to satisfy their individual rationality constraints: all cash generated by the firm would need to be paid out to them. As a result the firm's original shares would exhibit no exposure to the project's cash flows and the speculator could not profit from trading in them. When retained earnings are a little higher, the shares would be exposed to some of the project's cash flows, but not enough to allow the speculator to make enough profit from trade on costly information. To allow more profitable trade, retained earnings have to exceed the financing requirement  $I - \bar{R}$  by an amount ( $\frac{2c}{n}$ ) so that the speculator who trades in the firm's shares gains enough exposure to project risk. Speculation then generates more profit than the cost of information acquisition.

If shareholders, instead, chose retained earnings  $E$  in the intermediate range  $E \in [I - \bar{R}, I - \bar{R} + \frac{2c}{n})$ , the manager would always invest. The informed trader would not produce information. The capital markets would supply capital  $I - E$  and, on average, receive the same in return.<sup>14</sup> However, this investment policy is worse for the shareholders than never investing, and so this level of retained earnings is suboptimal.

When the cost of information acquisition becomes high relative to the amount of noise trade ( $c > \frac{n}{4}(R_h - R_l)$ ), then retained earnings would have to be so high that the firm could finance the project even in the very bad state  $p_{ss}$ . At that point it is better for the firm to reduce retained earnings to a level where investment is never possible.

Our result that firms will optimally choose to have internal cash is related to Myers and Majluf (1984), who also get a similar result. Interestingly, the underlying reason in our model is almost opposite to the one in Myers and Majluf (1984). While in their model, firms know more about their projects than outsiders and keep internal cash to avoid the adverse-selection costs of external finance, in our model internal cash is optimal when outsiders have exclusive information about the fundamentals of firms' investments.

Finally, while we concentrated here on internal cash as a commitment device for overinvestment, one can think of a line of credit as an alternative device. Shareholders can provide managers with a line of credit that enables them to raise a certain amount of cash independently of the realization of the stock price. This will have the same effect as internal cash.

## 5 Implications for the Business Cycle

So far, we have focused on a specific type of investment project by assuming that (1) unconditional investment carries a negative net present value (Condition (1)), but (2) that the project has a positive net present value, if the bad state can be identified in advance with probability 1/2 and the project is rejected in that case (Condition (2)). In practice, the expected ex ante profitability of the project is likely to change across different stages of the business cycle. In a boom it is

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<sup>14</sup>The contract could specify payment  $X_l = R_l$  and  $X_h = 2(I - E) - R_l$ , which averages to  $I - E$  and satisfies  $X_s \leq R_s$  for  $s = l, h$ .

more likely that firms can find projects that are worthwhile even when no further information is known about them. In that case condition (1) would be violated. In a bust it is more likely that available projects are not profitable ex ante, even if some bad projects can be abandoned when more information becomes available about them. Here, condition (2) would be violated. We will now analyze how such changes in ex ante profitability associated with changes in the business cycle affect the firm's investment behavior.

### 5.1 Project Profitability in a Boom, Intermediate and Bust Period

There are three parameters that affect the expected profitability of the investment project:  $R_h$ ,  $R_l$ , and  $I$ . To ease the exposition, we fix  $R_l$  and  $I$ , and let  $R_h$  vary across the business cycle. Higher levels of  $R_h$  represent high expected profitability and thus a boom in the economy, while lower levels are associated with a bust. Throughout the analysis, we maintain the assumption that  $R_l < I$  (i.e., investment is not desirable when the project has a low realization), and that  $R_h > I$  (i.e., investment is desirable when the project has a high realization). Thus, we let  $R_h$  vary anywhere above  $I$ .

Doing so allows us to distinguish between three cases, depending on whether or not (1) and/ or (2) hold. These conditions can be restated in terms of bounds on  $R_h$ . Thus, condition (1), that the project has ex ante negative net present value, can be restated as:

$$R_h < 2I - R_l \equiv R_h^{**}. \quad (19)$$

Similarly, condition (2), that the project has a positive net present value if the bad state can be identified in advance with probability 1/2 and the project is rejected in that case, can be restated as:

$$R_h > \frac{3}{2}I - \frac{1}{2}R_l \equiv R_h^*, \quad (20)$$

where  $R_h^{**} > R_h^*$  is implied by  $I > R_l$ .

Based on these thresholds of  $R_h$ , we will define three ranges of expected profitability, depending on whether (a)  $R_h \geq R_h^{**}$ , (b)  $R_h^{**} > R_h > R_h^*$ , or (c)  $R_h^* \geq R_h$ . We thus move from case (a) where the economy is in a boom through an intermediate stage (b) to the bust (c). We now turn to characterize the firm's investments and profits in each of these three ranges.

**(a) Boom:**  $R_h \geq R_h^{**}$ . The interim efficient investment policy is Type II conditional investment, that is, to invest unless the price reveals that the future state of the world is bad. This is because, in this range of parameters, the ex ante net present value of the project is positive (Condition (1) does not hold), so when the price does not reveal any new information about the fundamentals, it is efficient to invest. Just like before, the type II conditional investment policy is compatible with information production by the speculator. Negative information will therefore be available with probability one half if the state is bad and lead to project rejection. The ex ante probability that investment will take place is then 0.75 and average profits are  $\frac{1}{2}(R_h - I) + \frac{1}{4}(R_l - I)$ .

**(b) Intermediate Profitability:**  $R_h^{**} > R_h > R_h^*$ . This is the range we focused on in the previous sections of the paper. In this range, the interim efficient investment policy is Type I conditional investment, that is, to invest only when the price reveals good information. This is because the ex ante net present value of the project is negative (Condition (1) holds). The problem, however, as explained in previous sections, is that the Type I conditional investment policy is not feasible. Since Condition (2) holds, the firm may find it beneficial to commit, via one of the mechanisms described thus far in the paper, to the Type II conditional investment policy, so that it always invests unless the price reveals that the project had a low realization. Depending on the commitment mechanism, additional conditions may be required for the firm to actually choose to commit.

Overall, assuming that the additional conditions hold when expected profitability is intermediate, the firm chooses to commit to the Type II conditional investment policy.<sup>15</sup> This investment policy is not interim efficient. It exhibits more investments than the interim efficient investment policy. Specifically, the ex ante probability of investment is 0.75 vs. 0.25 in the interim efficient policy (which is Type I conditional investment policy). Of course, average profits from the investment under the chosen investment policy ( $\frac{1}{2}(R_h - I) + \frac{1}{4}(R_l - I)$ ) are lower than those under the interim efficient policy ( $\frac{1}{4}(R_h - I)$ ). In addition, it should be noted that the commitment device used in this range of parameters will generate extra costs, and thus reduce average profits below  $\frac{1}{2}(R_h - I) + \frac{1}{4}(R_l - I)$ .

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<sup>15</sup>If the firm does not commit, it will never invest.

**(c) Bust:**  $R_h < R_h^*$ . The ex ante net present value of the project is negative, and the interim efficient investment policy is Type I conditional investment. Again, however, this is not a feasible investment policy. Moreover, in this range, since condition (2) does not hold, the project has a negative net present value even if the bad state can be identified in advance with probability 1/2 and the project is rejected in that case. Thus, commitment to Type II conditional investment policy is not desirable, no matter what the relevant commitment mechanism is. Thus, when the economy is in a bust, with no commitment in place, the speculator will not collect information about the project, and the firm will never invest. Obviously, this represents less investments and lower profits (the profit in this range is always 0) than what could be achieved if information was collected and the interim efficient investment policy had been pursued.

## 5.2 Comparing across Stages of the Business Cycle

Our model generates starkly different implications for firm profits as well as investment efficiency and frequency across different stages of the business cycle (boom, intermediate, bust). These implications, which are summarized in Table 1, may constitute testable empirical predictions of our model.

Before we turn to describe the different implications, it should be noted that the fundamental reason why investment behavior and efficiency change across different stages of the cycle in our model is that the amount of information produced by speculators changes. In order to understand how the information effects identified in our model have a changing impact depending on the state of the economy, we need to consider a benchmark that is unaffected by these specific effects. This is necessary in order to tell whether, say, a reduction in investment and firm profits in a bust is merely attributable to a worsening of the economic environment or whether it is exacerbated by the information effects that are the focus of our paper. We therefore choose as a benchmark the situation in which the amount of information the firm has does not change over the business cycle. This would be the case if the cost of information acquisition for the speculator is zero, and we focus on the resulting stock market equilibrium in which the speculator trades on his information regardless of the investment policy chosen by the firm. In this case the firm would always choose

the interim efficient investment policy. This has immediate implications for actual investment efficiency in our model compared to the benchmark.

Stage of the cycle	Definition	Categories for Comparison			
		Efficiency	Investment Frequency	Average Profits	Commitment
Boom	$R_h > R_h^{**}$	Efficient Investment	0.75	$\frac{1}{2}(R_h - I) + \frac{1}{4}(R_l - I)$	-
Intermediate	$R_h^{**} > R_h > R_h^*$	Overinvestment	0.75	$\frac{1}{2}(R_h - I) + \frac{1}{4}(R_l - I)$	+
Bust	$R_h < R_h^*$	Underinvestment	0	0	-

Table 1: Comparison across Stages of the Business Cycle

Columns 1 and 2 of Table 1 summarize the efficiency and frequency of investments predicted by our model for different stages of the business cycle. Figure 1 provides a graphic illustration. In the figure, the thick solid line represents the benchmark, i.e., the interim efficient policy, while the thick dotted line represents the actual equilibrium policy. Figure 2 follows the format of Figure 1 and illustrates the expected profits across stages of the business cycle under the efficient plan and the actual equilibrium plan. The profits are also summarized in Column 3 of Table 1.

When information acquisition is costly, the firm follows the interim efficient investment policy during a boom but not otherwise. Therefore, the firm's investment decisions and its expected profits when the economy is in a boom are exactly the same as in the benchmark.

This changes when we move to the intermediate state described in case (b). In order to ensure that speculators produce information, the firm commits to an interim inefficient policy of overinvestment. Thus, the amount of investment in the economy does not drop as much as it should when the economy moves from a boom to an intermediate state (see Figure 1). Resources are allocated inefficiently and this reduces overall profits in the economy (see Figure 2). Profits are lower than in the benchmark because speculators only produce information if the firm overinvests. Hence, moving from a boom to the intermediate state of the economy entails that investment

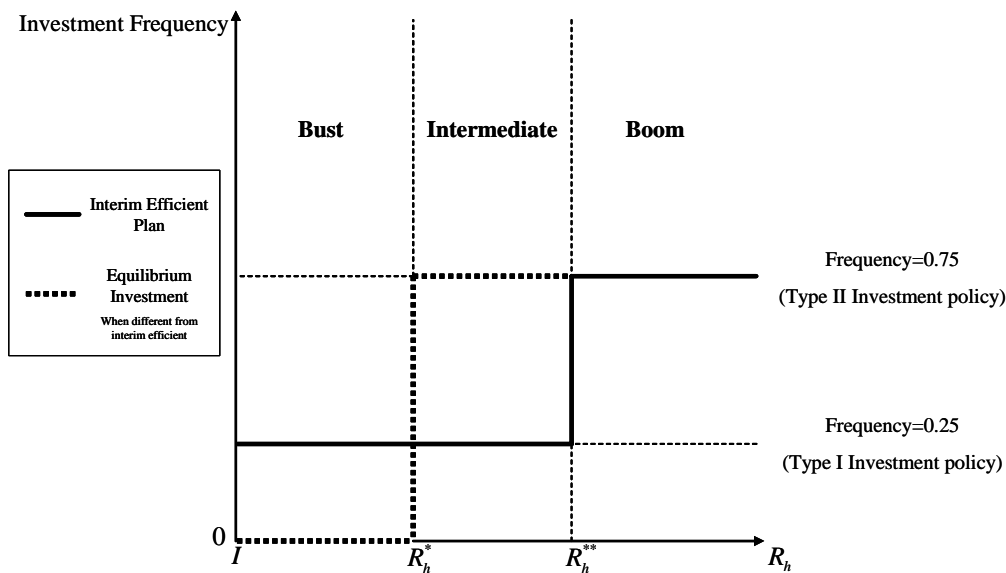


Figure 1: Investment Frequency across Stages of the Business Cycle

remains higher than in the benchmark, but profits fall below the benchmark level.

When the economy weakens further and moves into the bust range (c), then we have a sudden collapse of investment. This is because the firm no longer finds it worthwhile to commit to overinvest. As a result, speculators stop producing information and the investment is never made because there is not enough information to identify the good projects. The equilibrium investment policy reflects underinvestment relative to the benchmark, which causes profits to be lower than in the benchmark.

An important implication of our approach is that investment levels fluctuate more widely across peak and trough of a cycle than can be explained when information production is not endogenous. This is of course one of the central puzzles in business cycle theory: why does investment fluctuate much more strongly than consumption during a business cycle? If we think about consumption fluctuations as the driver for the profitability of investment projects, then our benchmark shows by how much investment would fluctuate purely on the basis of accommodating the reduction in the NPV of investments. We show that investment can be expected to fluctuate more strongly than that due to information effects. When the economy is in a trough there is little information

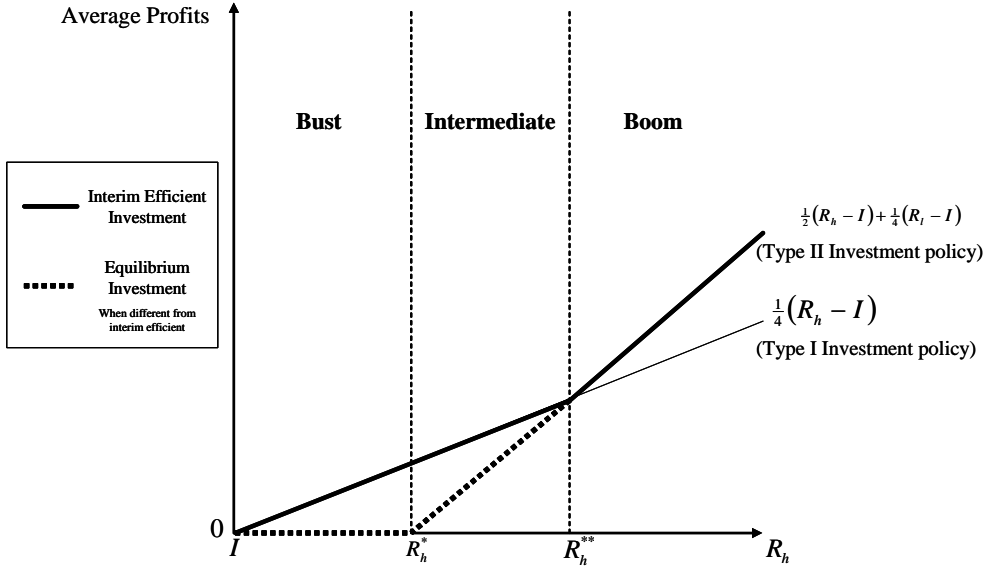


Figure 2: Profitability across Stages of the Business Cycle

available and firms therefore invest less than in the benchmark. When the economy moves to a better stage of the cycle, the amount of investment in the benchmark does not change. However, in our model, investment increases sharply, because firms not only start investing, they even overinvest so as to allow better production of information.

Another important implication of our approach is that, as fundamentals deteriorate, the endogeneity of information production decreases firms profits beyond the direct effect of changing fundamentals. This can be seen in Figure 2, where the profits are shown to be below the efficient benchmark in the bust and intermediate stage. The idea is that information production is more profitable when the probability that investments will be undertaken is higher. This probability increases in the fundamentals of the economy, which means that speculators are more willing to produce information when the state of the world is good. Since information enables firms to make better investment decisions, this amplifies the effect that fundamentals have on profits.

Finally, as shown in Column 4 of Table 1, our model predicts that commitment to investment via one of the mechanisms discussed in the previous sections (break-up fee, financial slack, etc.) will occur only when the expected profitability is intermediate. It will not occur in a boom or in

a bust. This is because during a boom, expected profitability is so high that there is no need to commit: investing when the price reveals no information is simply interim efficient. During a bust, expected profitability is so low that commitment is ex ante inefficient: the cost of investing when the price reveals no information is too high to justify commitment. Thus, commitment will occur only for intermediate values of  $R_h$ . This is another testable prediction of our model.

### 5.3 Relation to the Business-Cycle Literature

Investment fluctuations over the business cycle have been linked empirically and theoretically to capital market imperfections (see for example, Bernanke and Gertler (1989), Greenwald and Stiglitz (1993), Kiyotaki and Moore (1997), and Suarez and Sussman (1997)). It is known that firms' access to capital worsens in downturns of the business cycle. One reason that has been put forward for this is that during bust periods a firm's collateral is less valuable and therefore it has more restricted access to external finance.<sup>16</sup>

Since we provide a framework in which the stock price may feed back into a firm's investment decisions via access to external finance, our paper is clearly closely related to the above literature. However, we identify a very different mechanism for worsening access to capital. In particular, in our setting a firm's access to external finance is reduced because the information problem worsens when economic prospects are weak. During bust periods speculators make less money from producing and trading on information about investments that are unlikely to go ahead anyway. External providers of capital are then no longer willing to finance projects, because they know very little about their prospects.

In our view, it is very natural to think about changing access to external capital as arising from changes in the information environment - after all, information problems are one of the fundamental reasons for firms' limited access to external capital. To our knowledge, the model proposed in this paper is the first that links changes in the economic outlook to endogenous changes in the information environment, access to external capital and investment behavior.

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<sup>16</sup>In quite a different approach Dow, Gorton, and Krishnamurthy (2005) show that productivity shocks are amplified due to the control exerted by shareholders on firms' managers.

## 6 Discussion

In this section, we discuss some broader aspects of the results and possible extensions.

### 6.1 Robustness

The model we have presented assumed a simple structure for the financial market, where the speculator has a discrete choice between producing information and not producing information, and where noise trading is drawn from a binomial distribution. This structure simplified the analysis by generating the result that if the firm follows the interim efficient investment rule, no information is produced and the firm never invests. More generally, the speculator could choose an effort level (signal precision) for his information production and noise trading may be drawn from a more general class of distributions allowing for an order flow that is never fully revealing. In this more general setting, one would expect interim efficient investment to result in too little information production. The firm could still benefit by committing to overinvestment.

Suppose the firm's investment policy is represented by a function  $f$ :

$$I = f(v) \tag{21}$$

where  $I$  is investment and  $v$  is (signed) order flow.<sup>17</sup> When the information received from the stock market is sufficiently negative, the interim efficient investment level will be zero. Thus, there is a cut-off level  $v^-$  such that  $f(v) = 0$  for  $v \leq v^-$ . The firm value is then independent of  $v$  for all realizations that lead to zero investment.

Since  $v$  is publicly available information, it is clear that the speculator can never make a trading profit in those states that lead to zero investment. In other words when  $v$  leads to an inference that makes the firm reject the investment, the firm value is exactly equal to the stock price:  $p = V(I = 0)$ . Given the speculator's trading strategy, we can then determine a probability with

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<sup>17</sup>Note that it might seem natural to write investment as a function of stock price, or as a function of stock price and order flow. We cannot write it as a function of stock price alone because it might be that two different order flows result in the same stock price and plausibly, the firm can observe order flow too. Hence, we must show the dependence of  $I$  on order flow. Also, there is no need to show separate dependence on stock price because order flow determines the price.

which order flow results in zero investment and therefore zero trading profits:  $prob(v \leq v^-)$ . The firm can reduce the likelihood of this event by choosing a lower cut-off level for investment  $v^* < v^-$ . This increases the speculator's expected trading profits and therefore the incentives for information production. Moreover, if the firm does not change its investment policy in any other respect, the trading profits available in the case of  $v > v^-$  remain unchanged. Of course, the speculator may adjust his own trading strategy in response to a new investment policy. But doing so can never reduce his trading profits, so the conclusions regarding the speculator's incentives for information production are robust.

## 6.2 IPOs

Our analysis focuses on the usefulness of trade in a secondary market in terms of possible improvements to a firm's investment decisions. An obvious question that arises in this context is when private firms would like to go public so as to be able to take advantage of the information produced and aggregated in market prices. Subrahmanyam and Titman (1999) explore this question with a focus on how financial market development affects and is affected by the decision to go public. We can use our model to shed further light on the question of when in the economic cycle companies may wish to go public. The discussion in Section 5 made clear that firms benefit more from the market mechanism as a provider of information when the firm is relatively likely to have a worthwhile project. Otherwise, a financial market will not be a good provider of information about investment prospects. This suggests that firms should be more eager to go public when the available projects have better ex ante prospects.

This is consistent with the empirical evidence on cluster periods in IPO activity (e.g., Ibbotson and Ritter (1995), Jenkinson and Ljungqvist (2000)). When investment prospects are more favorable, IPO volume tends to be dramatically higher than during periods of poorer investment prospects. One obvious alternative explanation for the phenomenon would be that firms' financing requirements are simply lower when prospects are poorer and therefore do not take their company public in those periods. However, the observed variability in IPO activity far exceeds variability in overall investment and financing requirements therefore do not appear to explain adequately

the observed fluctuations in IPO volume (see Lowry (2003)). Our model thus provides a novel explanation for the strong relationship between IPO volume and economic prospects.

### **6.3 Corporate Governance**

If managers want to overinvest, weaker control by shareholders will lead to more investment. Hence, to get overinvestment, we need weak governance. In countries where the stock market is strongly established as the norm for large firms, stock market ownership generally entails highly dispersed ownership and weaker shareholder control than for private equity. One of the advantages of the stock market system is held to be the information aggregation properties of the financial markets, and it has been argued that weaker shareholder control is the price that must be paid to achieve these informational benefits. However, our model suggests there may be a complementarity between weaker shareholder control and improved informational efficiency. Weaker shareholder control leads to greater investment levels, which increases the cash-flow relevance of information and hence increases information production.

If dispersed shareholders cannot control managerial actions directly, takeovers provide an alternative control mechanism. In our model anti-takeover measures, instead of being value-reducing, could increase managerial discretion to invest and hence increase cash flow relevance of information, and enhance the value of the firm. Anti-takeover defense mechanisms (poison pills, relocation to Delaware, etc.) are known to have a negative share price impact. This is not puzzling in itself, as it may reflect suboptimal actions by management that is already entrenched. However, even in cases where the mechanism requires shareholder approval, there is still a negative impact. In our model, this could be explained if the management knows in advance whether the firm is likely to have strongly positive NPV projects in the future, or projects that are ex ante negative NPV. A firm with strongly positive NPV projects will not need to take interim inefficient investment decisions in order to generate sufficient cash-flow relevance for the information. It won't need anti-takeover defenses because it won't be subject to takeover threat. On the other hand, in the other case, adopting takeover defenses could be a way to commit to interim moderate overinvestment and increase ex-ante firm value. Hence, announcing the proposed anti-takeover measures could have a

negative impact on share price, because it reveals that the firm has relatively poor projects in the pipeline, but the shareholders might approve the measures because they are ex-ante optimal for a firm in that position.

## 6.4 Managerial Incentives

We assumed in this paper that managers are motivated exclusively by private benefits of running large projects and therefore overinvestment always occurs if there is financial slack. This assumption is common in the literature (Jensen (1986)) and often justified by the observation that in practice managers appear to earn higher wages and increased non-monetary benefits (office size, corporate jets etc.) when they run larger firms. However, these perks are presumably endogenous which begs the question why firms reward empire building behavior.

In our model the optimal compensation scheme for a manager who is not driven by empire building motives per se, would clearly involve some reward for overinvestment. Intuitively, the optimal compensation scheme would involve a performance based component so as to avoid overinvestment in very bad projects (presumably there are always enough unprofitable projects available for the manager to burn the firm's free cash flow). At the same time a contract that was purely based on performance would mean that the manager would voluntarily refrain from the moderate amount of overinvestment we have shown to be in the firm's interest. The optimal contract would therefore be based on both, performance and firm size. One empirical prediction would be that publicly traded firms should include a bigger component of size based compensation, while privately held firms should base pay purely on performance.

## 6.5 Managerial Biases

Another way to generate overinvestment is to hire managers who are biased about the prospects of their firms' investments, and who think that the investments are more likely to succeed than they really are. Such managers will likely go ahead with investments when the market price suggests they have slightly negative NPV. This is because they misinterpret the market signal due to their biased perception. The link between managers' overconfidence and investment distortions has been

documented by Malmendier and Tate (2005).

## 7 Concluding Remarks

The information gathered by speculators in financial markets is important in guiding investment decisions in the real sector. In this paper, we showed that firms might need to commit to overinvest in order to provide speculators with incentives to gather information on their investment opportunities. We discussed several commitment devices firms can use for this purpose, pertaining to different assumptions regarding the relationships between firms' shareholders and managers. In a setting where the managers' interests are fully aligned with those of shareholders, managers may commit to overinvest by setting a cancellation fee – a fee that needs to be paid out in case the investment project is cancelled. Managers can also incur some costs on the investment project, making the abandonment costly, and effectively transferring an option to invest into an option to abandon. In a setting where managers want to build empires and invest as much as possible, shareholders will typically limit the cash available to managers to prevent too many bad projects from being undertaken. Still, they may optimally choose to leave some retained cash in the firm, in order to ensure that some overinvestment will take place. We believe our model can rationalize some other corporate phenomena as commitment devices to overinvest. Finally, our model can capture the empirically observed excess fluctuations in investment across the business cycle. We argue that the reduction in the availability of positive NPV projects reduces the incentives for speculators to produce and trade on information. Stock prices therefore end up containing less information about investment prospects which worsens firms' access to external capital.

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