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To believe or not to believe[1]

Utpal Bhattacharya[a,*], Murugappa Krishnan[b]

[a] *Kelley School of Business, Indiana University, Bloomington, IN 47405, USA*
[b] *Carlson School of Management, University of Minnesota, Minneapolis, MN 55455, USA*

Abstract

This paper explains how the actions of skeptical traders can make manipulable earnings reports informative. Our model consists of a price-maximizing manager who chooses a cheap talk report, a profit-maximizing trader who may then seek costly information, and competitive market makers. Since the manager can influence the trader's information acquisition decision, the manager may choose to reveal even bad news to decrease the impact of order flows on prices. The paper provides foundations for treating positive and negative earnings surprises as good news and bad news respectively, even when external auditing cannot constrain opportunistic managers. Testable implications are derived. © 1999 Elsevier Science B.V. All rights reserved.

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* Corresponding author. Tel.: +1 812 855 3413; fax: +1 812 855 5875; e-mail: ubhattac@indiana.edu.

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1. Introduction

Corporate managers do not ignore their own interests when they make reports to financial markets. Yet the evidence suggests that their reports are informative; one of the best-documented empirical regularities in accounting (see Lev, 1989) is the positive association between manipulable earnings and stock prices. This raises an interesting issue. Why are such manipulable reports relied upon by other agents? Why do managers report bad news, despite the fact that they would like share prices to be as high as possible? How does manipulability affect informativeness? If earnings numbers are manipulable, why is a positive earnings surprise considered good news?

In a dynamic setting, two answers have been proposed: managerial reputation (Benabou and Laroque, 1992) and legal liabilities (the SEC's Rule 10-b(5) threatens substantial penalties when bad news eventually comes out after initial optimistic reports, and there is a sharp drop in share prices).[2] We identify a different resolution of moral hazard focusing on a suspicion effect. We model a one-shot game in which a Sender (manager) is allowed a single reporting choice so, by construction, all dynamic effects are ruled out. Yet the Sender may make his report informative in equilibrium in order to minimize suspicion among Receivers (traders), and their suspicion-induced reliance on alternative sources of information. A key feature of our model is that the indirect penalty for lying by the Sender works its way through the independent actions of other Receivers (price-setting market makers who see the order flows).

We first set up a benchmark explanation which assumes that corporate earnings reports are dominated by items that are hard data. An example of such hard data is the item 'cash and cash equivalents', which is easily audited. If corporate disclosures are only about hard data, traders in capital markets would find it useless to spend money to seek another opinion. This is because all opinions, including the manager's disclosure, are alike. Further, if we make an additional assumption that there exists a positive audit probability and the manager is severely punished if he is caught lying, the manager will choose to tell the truth. This threat of punishment is credible because of the hardness of the information: first, the cost of auditing hard data is small and, second, if the case goes to court, a jury could easily reach a consensus about what a manager should have reported because the dispute is about hard data.[3] To summarize, according to this Hard Data hypothesis, the trader does not seek another

[2] Interestingly, Baginski et al. (1994) document that bad news is revealed even with respect to forward-looking announcements, for which safe harbor rules that provide immunity from lawsuits exist.

[3] We implicitly assume, as in Hart and Moore (1988), that there always exists a well-behaved court, which serves to rule out pathological possibilities that could arise otherwise (as in *Alice in Wonderland* where, upon a whim, the Queen could scream 'Sentence before verdict' and 'Off with his head').

opinion because all opinions are alike, and the manager does not lie because the threat of punishment for lying is severe and credible.

Our explanation, the *soft data* hypothesis, assumes that corporate earnings reports are dominated by items that are soft data. Examples of such items would include goodwill, inventories, receivables, losses or gains from disposal of a business segment.[4] These are items about which consensus among measurers is difficult to achieve, and there is considerable scope for *honest* disagreement. Even defining misrepresentation is not easy when the honest judgments of different individuals are not perfectly correlated. In other words, corporate disclosures are 'cheap talk': costless (i.e., no out-of-pocket costs), non-binding (i.e., does not restrict strategic choices), and unverifiable (i.e., to a court) information. Managers can misrepresent with impunity. Traders can find the option to seek another opinion valuable.[5]

The primary contribution of this paper is to show that under the Soft Data hypothesis, though a share price maximizing manager can manipulate a report with impunity, she may *choose* not to do so for a non-null set of parameter values.

The intuition for this result is as follows. For parameter values in this region, the trader's optimal strategy *after* seeing the manager's report is to seek an additional opinion only when he sees a good report. We interpret this as 'suspicion'. The market maker knows this, and he therefore puts weight on order flows only when the report is good. The manager knows this too, and so she refrains from giving good reports when she privately knows that the prospects of the firm are bad, because that would trigger search by the trader, the subsequent discovery of the bad prospects, subsequent sell orders, and very low prices. Suspicion in financial markets, therefore, may be responsible for informativeness in unverifiable reports.

What are the conditions under which this equilibrium exists? The first condition is that search costs are not too high (otherwise, the manager's report

[4] The possibility that an accounting report may be dominated by either hard data or soft data is discussed in Solomons (1989, p. 91), and goes back at least to Ijiri (1975) who states on p. 36: 'The lack of room for disputes over a measure may be expressed as the *hardness* of the measure. A 'hard' measure is one constructed in such a way that it is difficult for people to disagree. A 'soft' measure is one that can easily be pushed in one direction or the other. For example, cash balance is a hard measure, while goodwill is a soft measure'.

[5] While auditors and Generally Accepted Accounting Principles (GAAP) can eliminate bizarre accounting treatments in financial reports, it is clear that there are important sources of manipulability even within the constraints of GAAP and an audit. These include, but are not limited to, the characterization of extraordinary items, restructuring charges, and various accounting numbers that rely on estimates (like depreciation, inventory, effects of discontinued operations). Recent developments like the FAS 115, which emphasizes management intention and allows the use of market values in some cases to determine accounting numbers, expand the scope for manipulation even further. For example, the balance sheet number for marketable securities and any associated holding gain or loss can be altered simply by changing stated managerial intention from 'buy and hold to maturity' to 'trading securities'.

will not affect the trader's search decision, because the trader will never search) or too low (otherwise, the manager's report will not affect the trader's search decision, because the trader will always search). The second condition resolves the seeming contradiction between the manager's indirect penalty for lying (prices are more responsive to order flows after good reports than they are after bad reports) and the trader's incentive to search only in the good report state (expected gross profits from search are higher after good reports than after bad reports).[6] This second condition is that future payoffs of the security be sufficiently positively skewed.[7] If this second condition holds, the beliefs of the trader are coarser after the good report than after the bad report, and so his expected gross profits from search are higher after good reports than after bad reports. As the allowable search cost is bounded above by the former gross profit and bounded below by the latter gross profit, he searches only when the report is good. So prices are more responsive to order flows after good reports than they are after bad reports.

Some noise is also needed to prevent full revelation and thus ensure the existence of a 'suspicion equilibrium' – noise trading is needed to provide camouflage for informed traders, and communication noise in the interpretation of a firm's financial statements is needed to provide camouflage for truth-telling managers.

The asymmetry of returns implied by the Soft Data hypothesis leads to testable implications. The first implication is that since prices are the lowest under good reports and selling pressures (this is the penalty for lying), periods with bad news should have average abnormal returns that are *higher* than those from periods with good news but selling pressure. The second implication is that prices are more sensitive to order flows after good reports than they are after bad reports.

Our research has links with three strands of the previous literature on disclosures. The first body of work asks why managers would choose to tell the truth in a world where disclosures are voluntary but *verifiable*. This literature analyzes the inferences the market obtains from silences, and how managers can influence those inferences by their disclosures (see, for example, Grossman, 1981; Milgrom, 1981; Shin, 1994). Our paper, by contrast, analyzes the managerial motives for truthful disclosure in situations where disclosure is mandatory but unverifiable. An example of such a mandatory disclosure is the periodic earnings disclosures required for listed firms.

[6] The seeming contradiction arises because, in a model where asset payoffs have a symmetric distribution, if the trader finds it profitable to search in the good report state, when prices are more responsive to order flows than in the bad report state, that is when spreads are higher and the market *expects* the trader to search, then he would find it even more profitable to search in the bad report state, when spreads are lower and he is *not* expected to search. So an equilibrium in which the trader searches only when the report is good cannot be sustained. It is for this reason that the assumption of symmetry has to be dropped, and skewness of payoffs plays a critical role.

[7] The positive skewness needed for our 'suspicion equilibrium', as we will see from the calibration exercise done on a sample of 1259 firms in Section 5, is not unreasonable.

The second body of work that our research is linked to is the 'cheap talk' literature. Our model can be regarded as a variation of the two-player non-cooperative information transmission game of Crawford and Sobel (1982). In our model, the manager is a Sender; market makers, Receivers; and the trader, both a Receiver and a Sender. Farrell and Gibbons (1989) have also considered the problem of one Sender communicating via cheap talk to two Receivers, and have shown that the presence of the second Receiver can discipline the Sender's relationship with the first. In our setting, which is intended to capture the essence of an imperfectly competitive financial market, this occurs with one Receiver (the trader) also becoming a Sender (via order flows) to a market maker.

The third body of work that our research is linked to is the 'mechanism design' literature. This literature is generally set within a contractual framework, and it is concerned with mechanisms that can be employed by a utility maximizing first-mover to influence subsequent movers to reveal their information truthfully (see, for example, Townsend, 1979). What differentiates our framework from the above literature is that our objective is to explain why the first mover (the manager) gives an informative report. The second, and more important difference, is to explain how information revelation can occur in a non-contractual setting. Disclosures are modeled as cheap talk, and there exists no principal who designs an enforceable contract for the manager that gives the manager an incentive to reveal information. Despite this, managers voluntarily reveal information even in a world where there are no explicit contractual incentives for them to do so (no compensation schemes, no direct and credible punishment for lying). In our paper, the incentives for information revelation are implicit: they are caused by prices that are set by market makers who correctly believe that traders have an incentive to investigate when they are suspicious.

The plan of the rest of the paper is as follows. We introduce the model in Section 2. In Section 3 we discuss the hard data hypothesis. Section 4 analyzes the soft data hypothesis. Section 5 illustrates our intuition with a numerical example, the parameters of which are calibrated from actual 5 day abnormal returns following earnings announcements. Section 6 concludes. All proofs are in the appendix.

2. A trinomial model of a Glosten–Milgrom (1985) market

Details of the model that we develop are inspired by the extensive form introduced in Glosten–Milgrom (1985).[8] The principal departure we make is in

[8] Krishnan (1992) uses a binary framework to show the equivalence between Glosten–Milgrom (1985) and Kyle (1985), given identical parametric assumptions. So our conclusions do not depend critically on the particular details of the Glosten–Milgrom (1985) extensive form.

the introduction of a strategic manager who chooses a message based on her private information.

2.1. Assumptions

There is one share, yielding a risky terminal value $\tilde{v} = v, v \in \{a-1, a, a+1+n\}$, where a, $n \geqslant 0$. Each state is equiprobable.[9] The parameter n governs skewness and, as we will see later is crucial for the existence of our 'suspicion' equilibrium. The parameter a scales returns. It plays no role in the theory, but is important in enabling us to calibrate our model to plausible real-world returns.

There is a manager who is not allowed to trade in the firm's shares. She has perfect information about the future value of her firm's shares. She has to give a report about the state of her firm's prospects, and this could be good or bad. Note that the dimension of the message space is less than the dimension of the payoff space. Formally, she chooses a 'book value', $\tilde{b} = b, b \in \{B, G\}$, after discovering the future prospects of her firm. As in much of corporate finance, her objective is to maximize expected share price. Mixed strategies are allowed. To preclude full revelation, we assume that there is some 'communication noise', so that the perceived 'report', $\tilde{r} = r, r \in \{B, G\}$ could be different from – though is informative about – the manager's 'book': $\text{prob}(\tilde{r} = G|\tilde{b} = G) = \text{prob}(\tilde{r} = B|\tilde{b} = B) = t \in (1/2, 1)$.

In other words, there are current shareholders (not explicitly recognized) who employ the manager to maximize the expected share price, with agency problems, if any, resolved by the optimal contract between current shareholders and the manager. While a more general analysis would recognize the possibility of managerial moral hazard along several dimensions, we abstract from all issues other than the unverifiable nature of corporate reports to focus exclusively on moral hazard pertaining to corporate disclosures.

Both the message space restriction and communication noise are important, as we will see later, in ensuring existence of an informative equilibrium with cheap talk. In the context of corporate earnings disclosures to a financial market, these assumptions are a simple way to capture the effect of accounting rules.[10] Communication noise may arise because of imperfections in the accounting process, or the variety of ways in which even generally accepted accounting principles are interpreted. Actual corporate reports are fairly

[9] An earlier version of the paper allowed a more general discrete probability distribution. As that increased the number of parameters without adding any insight, we chose to use this simpler specification.

[10] Even in other economic settings, the richness of the set of states of the world relative to the imprecise language available to describe these states, would suggest that a message space restriction and communication noise are reasonable assumptions. See also Jordan and Xu (1998) for a discussion of accounting rules and message space restrictions.

complex documents, and the fact that numerous securities analysts are employed to decipher such reports suggests that the presence of noise in the communication process is plausible.[11] As a matter of fact, if there was no noise and no scope for individual interpretation, we would not have a vibrant financial press with its multitude of opinions. The publicly observable report $\tilde{r}$ should be interpreted as the external auditor's opinion of the firm's books.

Several previous papers (for example, see Diamond (1985), Caballé (1992), and references therein) have considered the communication noise parameter, t, to be the disclosure policy variable. We recognize that the choice of a precision parameter does capture some aspects of actual corporate disclosure policy: whether or not to list on the stock exchange, how many analysts to maintain a regular relationship with, etc. However, in a setting with moral hazard (see, for example, Benabou and Laroque, 1992), the typical concern is whether there is some element of *bias* in corporate reports: are managers trying to paint a rosy picture? To focus on this bias, we assume that t is exogenous in this paper.

Define

$$\alpha \equiv \text{prob(book value, } b = G \mid \text{manager's private signal, } v = a + 1 + n),$$

$$\gamma \equiv \text{prob(book value, } b = G \mid \text{manager's private signal, } v = a),$$

$$\beta \equiv \text{prob(book value, } b = B \mid \text{manager's private signal, } v = a - 1).$$

The manager's disclosure strategy is a triple, (α, γ, β). An 'uninformative' strategy entails $\alpha = \gamma = 1 - \beta$, whereas an 'informative' strategy is everything else.

There is a single risk-neutral strategic trader who has no initial private information. After observing the public report $\tilde{r} = r$, this trader can acquire, at a cost c, additional private information about the value $\tilde{v}$. This information cost could be interpreted as the time and money spent doing further investigations by consulting an in-house expert or an outside expert. For simplicity, we assume that this expert provides perfect information, and we denote this by r_e. The information set of the trader will therefore consist of the manager's report and the outcome of incremental information acquisition, if any.

At this stage it is useful to introduce some notation to describe the trader's incremental information acquisition strategies. An incremental information acquisition strategy, I^i, indicates whether or not the trader will acquire additional information, after observing $\tilde{r} = r$. There are $2^2 = 4$ such pure strategies.

[11] A story in the *Wall Street Journal* (7 April 1993) about IBM nicely captures this notion of 'communication noise'. We quote: 'Footnotes in IBM's annual reports disclose that, in 1984, it adopted more liberal accounting for its huge investments in equipment and for its retirement plan. The changes – a bit like removing a car's shock absorbers – enabled IBM to push the cost of its investments into the future. While similar to moves at many other companies, they may have increased IBM's profits *more than many investors realize*'. (our italics)

Define these as

$I^1 \equiv$ trader never acquires additional information,

$I^2 \equiv$ trader always acquires additional information,

$I^3 \equiv$ trader acquires additional information only if $\tilde{r} = G$,

$I^4 \equiv$ trader acquires additional information only if $\tilde{r} = B$.

If this strategic trader has decided to search, he will choose not to participate in trading if the value of the firm his search has discovered lies within the market maker's quotes, and he will choose to participate in trading if the value of the firm his search has discovered lies outside the market maker's quotes. In the former case, his order is denoted by $x \in \{\phi\}$, and in the latter case, his order is denoted by $x \in \{-1, 1\}$. The restriction on order size is similar to Glosten–Milgrom (1985).

Nature picks one trader, out of the entire population of traders who would like to trade (potential traders consist of liquidity traders and the above strategic trader), to come to the trading window. The probability of the strategic trader to be picked, if he has decided to participate, is q. If the strategic trader has decided not to participate, the probability of a liquidity motivated trade is unity. If the trader at the window is a liquidity trader, he is equally likely to give order $x = +1$ or $x = -1$. If the trader at the window is a strategic trader, his order could be $x = +1$ or $x = -1$, and this choice would depend on his information set and the prices he will obtain from the market maker. The logic for liquidity noise is now standard (see, for example, Grossman and Stiglitz, 1980; Milgrom and Stokey, 1982). Without it, the informed trader's willingness to trade would fully reveal his private information, and there would be no incentive to trade.

Market makers set the price at which they would be willing to sell one unit and the price at which they would be willing to buy one unit. Competition among risk-neutral market makers is assumed to lead to zero expected profits conditional on all public information. As the market maker's information consists of the manager's report and the order flow, we denote prices by $P(\tilde{r}, \tilde{x})$, where $r \in \{B, G\}$ and $x \in \{-1, +1\}$.

The time structure of the model is described in Table 1.

2.2. Characterization of equilibrium

We are now in a position to define equilibrium. The manager's reporting strategy R is a mapping from $\tilde{v}$ to his disclosure strategy (α, γ, β).

$$R\colon \{a-1, a, a+1+n\} \to [0, 1].$$

The report $\tilde{r}$ is a noisy transformation of the manager's book value $\tilde{b}$. The strategic trader's trading strategy X is a mapping from the public report $\tilde{r}$, and expert opinion $\tilde{r}_e$ (this would be null if there is no additional search) to demand

Table 1
Time structure of the model

Stage	Event
$t = 1$	Nature chooses the value of a firm, $\tilde{v}$. It could be $a - 1$, a or $a + 1 + n$. Each state is equiprobable
$t = 2$	Manager observes $\tilde{v}$. She then chooses a book value, $\tilde{b} = b, b \in \{B, G\}$. If $\alpha \equiv$ prob($b = G$ | manager's private signal $= a + 1 + n$), $\gamma \equiv$ prob ($b = G$ | manager's private signal $= a$) and $\beta \equiv$ prob ($b = B$ | manager's private signal $= a - 1$), then the disclosure strategy is a triple (α, γ, β)
$t = 3$	Public observes an accountant's report $\tilde{r}$, which is a noisy transformation of $\tilde{b}$. prob($r = G$ | $b = G$) = prob($r = B$ | $b = B$) = $t > 0.5$
$t = 4$	Based on $\tilde{r}$, a strategic trader decides on whether to acquire costly incremental information. An expenditure of c gets him perfect information, r_e, about the true realized value of v
$t = 5$	Market maker sets prices conditional on the manager's report and order flows. They make zero conditional (on all public information–manager's report and order flows) expected profits, and set prices accordingly
$t = 6$	Nature picks one trader, out of the entire population of traders who would like to trade (potential traders consist of liquidity traders and the above strategic trader), to come to the trading window. The probability of the strategic trader to be picked, if he has decided to participate, is q. If the strategic trader has decided not to participate – and he will not participate if the value of the firm his search has discovered lies within the price quotes of the market maker – the probability of a liquidity motivated trade is unity
$t = 7$	If trader at window is a liquidity trader, he is equally likely to give order $x = +1$ or $x = -1$. If trader at window is a strategic trader, his order could be $x = +1$ or $x = -1$, and this choice would depend on his information set and the prices set by the market maker
$t = 8$	v is revealed to all. Portfolios are consumed. The world ends

x (this would be null if he decides not to participate):

$$X\colon \{B, G\} x \{\phi, a - 1, a, a + 1 + n\} \rightarrow \{\phi, -1, 1\}.$$

The gross profits of the informed trader are given by $\tilde{\pi} = (\tilde{v} - \tilde{p})\tilde{x}$, where the price $\tilde{p}$ is chosen by the market maker conditional on the manager's report, $\tilde{r}$, and the order flow, $\tilde{x}$. Let the market maker's price-setting strategy be denoted as $\tilde{p} = P(\tilde{r}, \tilde{x})$.

A subgame perfect equilibrium is a 4-tuple (X, I^i, R, P) satisfying the following conditions:

(a) *Trader's optimization*: We first find the trader's optimal order placement strategy, X, as a function of his search strategy, I^i. The order placement strategy would be optimal if, for any $\tilde{r} = r$, expert opinion, $\tilde{r}_e = r_e$, and any alternate trading strategy X', we have

$$E(\tilde{\pi}(X(I^i(r), r, r_e), R(\tilde{v}), P(r, x))) \geqslant E(\tilde{\pi}(X'(I^i(r), r, r_e), R(\tilde{v}), P(r, x))). \tag{2.1}$$

Having obtained the optimal order placement strategy as a function of his search strategy, we now find the optimal search strategy, I^i. The search strategy would be optimal if, for any alternate search strategy I^j we have

$$E(\tilde{\pi}(X(I^i(r), r, \tilde{r}_e), R(\tilde{v}), P(r, x))) \geqslant E(\tilde{\pi}(X(I^j(r), r, \tilde{r}_e), R(\tilde{v}), P(r, x))). \tag{2.2}$$

Requiring that this strategy is optimal after $\tilde{r} = r$ is observed serves to impose credibility of the search threat. In other words, it ensures that the search and order strategies are subgame perfect.

(b) *Manager's optimization*: For any private signal, v, and for any alternate disclosure policy R', R would be an optimal reporting strategy if

$$E(\tilde{P}(R(v), X(I^i(\tilde{r}), \tilde{r}, \tilde{r}_e))) \geqslant E(\tilde{P}(R'(v), X(I^i(\tilde{r}), \tilde{r}, \tilde{r}_e))). \tag{2.3}$$

Note that the manager's strategy is credible (it is optimal after the realization of his private signal).

(c) *Market efficiency*: The pricing rule P satisfies

$$\tilde{p} = P(R(\tilde{v}), X(I^i(\tilde{r}), \tilde{r}, \tilde{r}_e)) = E(\tilde{v} \mid \tilde{r}, \tilde{x}). \tag{2.4}$$

3. Benchmark case: The hard data hypothesis

In this section of the paper we set out our null hypothesis. According to this hypothesis, corporate disclosures are only about hard data. If this is true, the trader in this case would not spend money to seek a second opinion if he believes that the manager is giving an informative report. This is because all opinions, including the interpretation of the manager's disclosure, are alike. Why, then, should the manager give an informative report? As discussed before, the manager gives an informative report because of a credible threat of severe punishment for deviating.

Thus, the computation and analysis of equilibrium in this case become simple. The only viable strategy for the manager is the 'informative' one and for the trader the 'no search' strategy. Further, since the trader is not searching, his expected profits are zero, and this is independent of his order. We assume that he buys when he hears a good report and sells when he hears a bad report.

Proposition 3.1. *Assuming that 'Good' and 'Bad' are both associated with non-null subsets of values that v can take, and that 'Good' is assigned to higher values,* *equilibrium prices have the property that*

(i) $P(r, x)$ *is independent of* x, *for every* r, *and*

(ii) $P(G, x) > P(B, x)$, *for every* x.

Proof. Part (i) is obvious, because as the trader does not search, there is no information in order flows. Further, since managers disclose what they know, part (ii) follows.

More generally, when the trader has some initial endowment of private information, prices will depend on order flows. It would still be the case, however, that for *any* order flow, prices would be increasing in the report. In contrast, with soft data and the suspicion it gives rise to, prices may not be increasing in the report. As the next section will show, this can generate the penalty for lying.

4. Suspicion case: The soft data hypothesis

In the benchmark case, in which the corporate report is only about hard data, the only viable strategy for the manager is the informative one. With unverifiable soft data, both informative and uninformative equilibria may exist. There are eight candidates for equilibrium (arising from four trader search strategies times two classes – informative and uninformative – of manager disclosure strategies). We will prove in this paper that only three candidates survive as equilibria: the first two involve the manager giving uninformative reports, the trader using I^1 (never search) or I^2 (always search); the third involves the manager giving an informative report (here $\alpha^* = \gamma^* = 1$ and $\beta^* \in (0, 1)$) and the trader adopting strategy I^3 (search only when report is good). This last equilibrium articulates our notion of suspicion. Given that the manager wants share prices to be as high as possible, and that in equilibrium he announces a good book value when he gets good signals ($v = a + 1 + n$ or a) and *mixes* when he gets a bad signal ($v = a - 1$), it is natural to define suspicion as being aroused only when the report is good. We call this the 'suspicion' equilibrium.

We begin our analysis by stating the following lemma.

Lemma 4.1. *An informative equilibrium* (*i.e., an equilibrium where the manager's report is informative*) *cannot exist when the trader is never searching* (I^1) *or is always searching* (I^2).

Proof. See Appendix. □

The proof is by contradiction. Its intuition is as follows. If the trader never searches and the report is informative, its realization would not affect the trader but would positively affect the market makers' price, thereby making it optimal for the manager to deviate to always reporting 'good'. This is a contradiction. On the other hand, if the trader always searches, an informative report would still never affect the trader but would again positively affect the price set by the market makers, thereby making it optimal for the manager to deviate to always reporting 'good'. A contradiction again. So a report cannot be informative under I^1 (never search) or under I^2 (always search).

Uninformative equilibria (i.e., equilibria where the manager's report is not informative) may exist for these particular search strategies.

Proposition 4.2. *Two uninformative equilibria exist for certain parameter values. They involve search costs so high that the trader is never searching* (I^1), *or so low that the trader is always searching* (I^2).

Proof. See Appendix. □

If the manager's reports are assumed to have no information content, the market maker's prices will not be dependent on the report. If this is the case, the manager's reporting strategy would not affect prices. The manager, hence, has no incentive to deviate. I^1 (never search) will be credible if the costs of search are high, and I^2 (always search) will be credible if the costs of search are low. The appendix gives a precise bound on these costs in terms of the primitive parameters of the model.

This indicates why with the 'search when suspicious' strategy, an informative equilibrium might hold. In this case, the likelihood with which the trader engages in additional search and the resulting order flow of the trader can both be influenced by the manager's disclosure.

We now examine I^3 (search only when report is good) or I^4 (search only when report is bad).

Lemma 4.3. *An uninformative equilibrium does not exist if the trader adopts* I^3 (*search only when report is good*) *or* I^4 (*search only when report is bad*).

Proof. See Appendix. □

The intuition behind this proof is as follows. If the manager's report is assumed to be uninformative, then prices would depend only on the order flow. Specifically, we would get $P(\text{Good}, +1) > P(\text{Bad}) > P(\text{Good}, -1)$ if the trader adopts search strategy I^3 (search only when report is good), and $P(\text{Bad}, +1) > P(\text{Good}) > P(\text{Bad}, -1)$ if the trader adopts search strategy I^4 (search only when report is bad). Thus, from the trader's perspective, the prices he is faced with are less adverse when market makers expect him not to search than they are when he is expected to search. So if he finds it profitable to search when expected to search, he will find it even more profitable to search when not expected to, and so will deviate from the candidate equilibrium strategy.

We now state the main proposition in this paper.

Proposition 4.4. *An informative equilibrium exists for a non-null set of primitive parameter values. Here* (*a*) *the prices offered by the market maker satisfy expressions* (*A*.22) *and* (*A*.23) *in the appendix and* (*b*) *there exists a non-empty interval,* ($\underline{c}$, $\bar{c}$), *where* $\underline{c}$ *and* $\bar{c}$ *are, respectively, the lower and upper bound on the cost of search. These bounds are defined in terms of primitive parameters by expression* (*A*.24) *in the appendix.*

The equilibrium is characterized by

(a) *Trader's strategies*:

(i) *Search strategy is* I^3(*search only when the report is good*).

(ii) *Order strategy*: *X*:

$$(\tilde{r} = \text{Bad}) \rightarrow \; -1, (\tilde{r} = \text{Good}) \rightarrow \begin{cases} 1, & \text{if } \tilde{r}_{\mathrm{e}} = a + 1 + n, \\ \phi, & \text{if } \tilde{r}_{\mathrm{e}} = a, \\ -1, & \text{if } \tilde{r}_{\mathrm{e}} = a - 1. \end{cases}$$

(b) *Manager's reporting strategy*: *R*: $\alpha^* = \gamma^* = 1$, *and* $\beta^* \in (0, 1)$. β^* *solves expression* (*A*.22) *in Appendix*.

(c) *The pricing rule* $P(\tilde{r}, \tilde{x})$ *is as follows*:

$$P(\tilde{r} = \text{Good}, \tilde{x} = 1) = a + \frac{(1+n)(1+q) - (1-q)\dfrac{(t(1-\beta^*) + \beta^*(1-t))}{t}}{(2+q) + (1-q)\dfrac{(t(1-\beta^*) + \beta^*(1-t))}{t}} > a, \tag{4.1}$$

$$P(\tilde{r} = \text{Bad}, \tilde{x}) = a + \frac{(1+n) - \dfrac{(t\beta^* + (1-\beta^*)(1-t))}{1-t}}{2 + \dfrac{(t\beta^* + (1-\beta^*)(1-t))}{1-t}} \quad \forall x, \tag{4.2}$$

$$P(\tilde{r} = \text{Good}, \tilde{x} = -1) = a + \frac{(1+n)(1-q) - (1+q)\dfrac{(t(1-\beta^*) + \beta^*(1-t))}{t}}{(2-q) + (1+q)\dfrac{(t(1-\beta^*) + \beta^*(1-t))}{t}} < a. \tag{4.3}$$

Proof. See Appendix. □

If the trader searches, he buys if he discovers $v = a + 1 + n$ and sells when he discovers $v = a - 1$. When the trader discovers that $v = a$, he refuses to participate because the prices bracket a.

Can we similarly obtain an informative equilibrium if the trader searches only when $r =$ Bad, that is under search strategy I^4? In the appendix we show that the informative equilibrium with I^4 that we obtain is exactly equivalent to the above. The manager still chooses a pure strategy when she knows $v = a + 1 + n$ or $v = a$ and mixes when she knows $v = a - 1$, except she now states $\tilde{b} = B$ in the former states with probability one and states $\tilde{b} = G$ in the latter state with probability β. In other words, the labels are reversed. Given common knowledge of the vocabulary being used, it is clearly inappropriate to distinguish between these equilibria.

We show in the appendix that a necessary condition for expression (A.22) to hold is that the lowest price set by the market maker occurs when the report is good but the order flow is negative. This is our next result.

Proposition 4.5. *In an informative equilibrium,* $P(G, +1) > P(B, x) > P(G, -1)$.

Proof. See Appendix. □

So price is the highest for good news and trader buys, and is the lowest for good news but trader sells. This is because when the news is good, the market maker correctly assesses that there is a significantly higher probability that the trader at the window is a person who has engaged in costly information acquisition, and so the market maker puts greater weight on the order flow.

The ordering of prices in Proposition 4.5 makes clear why a stock price maximizing manager does not have an incentive to deviate from the equilibrium informative strategy. Suppose she wants to decrease β (the probability that the manager chooses a bad book value when she gets a bad signal, $v = a - 1$). While this will increase the probability of the occurrence of a good report, it will also increase the likelihood of the trader's search, who will choose $x = -1$ when he discovers the bad state. This will sharply increase the likelihood of obtaining the lowest price, $P(\text{Good}, -1)$. This penalty for misrepresentation more than offsets the gain the manager will get if $P(G, +1)$ obtains (this price will result if the trader at the window is a liquidity trader who gives an $x = +1$ order).

In the next section we show that there are reasonable parameter values for which the informative equilibrium exists. Since the inequalities specified in the conditions for equilibrium hold strictly in this example, it follows that the suspicion equilibrium would continue to hold even for small perturbations of the primitive parameter values.

5. A calibrated example

Given a manager's earnings announcement every quarter in the real world, our model is best interpreted as a model of cumulative abnormal returns in an 'earnings announcement window'. The market maker's price quotes in our model should not be interpreted literally as bid-ask quotes, but as the anticipated trading price at the end of the 'event window'. This means that $P(G, +1)$ should not be regarded as the ask quote that prevails immediately after a good news announcement, but as the *anticipated trading price* at the end of a 3-day or 5-day announcement window (these have been the most common definitions of windows in empirical work based on earnings announcements) in which good news has been announced, and in which buying pressure or positive order flow has been experienced. Similarly $P(G, -1)$ should be interpreted as the anticipated trading price at the end of a 3-day or a 5-day announcement window in which good news has been announced, but selling pressure or negative order flow has been experienced. Finally, $P(B)$ should be interpreted as the average anticipated trading price at the end of a 3-day or a 5-day announcement window in which bad news has been announced.

We obtained a sample of 1259 firms, each of which had data for fifteen quarters of 5-day returns after an earnings announcement.[12] We then computed, for each firm, the mean and the skewness of cumulative abnormal returns (CAR) in this 5-day event window. We then analyzed the cross-sectional statistics of these firm-specific metrics. The mean of the mean was indistinguishable from zero; the skewness ranged from a high of 0.67 to a low of -0.71, with a mean of 0.009.[13]

We now assign values to the parameters of our model to match the above statistics. Specifically, we select values such that (i) the price before the announcement looks like a real-world stock price level (say \$40.00), (ii) the mean of possible post-announcement returns is zero and (iii) the skewness of possible post-announcement returns is 0.009.

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[12] We thank Srini Sankaraguruswamy for help with this sample, and refer the reader to Sankaraguruswamy (1996) for more details about the data. In particular, his definition of CAR also adjusts for changes in beta in the return period. Since the sample contains only NYSE and AMEX firms, it may be regarded as 'conservative' relative to what we would expect from a sample that also contained NASDAQ firms, since NASDAQ has more small-cap and high-tech stocks.

[13] The skewness metric used here is computed as the $(\min + \max - 2 \times \text{mean})/(\max - \min)$, and not as the third moment about the mean. The reason we do this is because the former measure is a better indicator of asymmetry than the latter measure (see p. 76 in Mood et al. (1974), and p. 88 in Kendall and Stuart (1976) for a general discussion on this point, and Krishnan et al. (1996) for a specific discussion with respect to skewness of earnings.) An example due to Haberman (1996) illustrates this point clearly. A discrete random variable, X, takes on values in $\{-2, 1, 4\}$ with corresponding probabilities $\{10/27, 16/27, 1/27\}$. The third moment about its mean is zero, though the distribution is clearly asymmetric. The min-max measure yields 1/3, suggesting correctly that the distribution is right-tailed.

A possible concern regarding the use of this measure is that it requires the support to be bounded for the min and the max to be defined. It is true that boundedness is needed, but since what the bounds are is unrestricted, we can approximate even an unbounded distribution (such as the normal) to any desired degree of accuracy.

Make $a = 37$ and $n = 9$. So payoffs are equally likely to be 36, 37 or 47. The unconditional mean is 40, which is the share price before the announcement. Make $t = 0.99$ (this ensures only a 1% communication noise), and $q = 0.99$ (this ensures only 1% noise trading). Then equilibrium prices, using the formulas given in Proposition 4.4, are: $P(G, +1) = 43.636$, $P(B, x) = 36.472\ \forall x$, and $P(G, -1) = 36.436$. Further, $\alpha^* = \gamma^* = 1$ and $\beta^* = 0.229$(β^* solves expression (A.22) in the Appendix). So the return for good news and buying pressure is 9.09%, the return for bad news is -8.82%, and the return for good news and selling pressure is -8.91%. Notice that, given the above equilibrium strategies, they are not equally likely. A simple calculation shows that the mean of the returns is zero and the skewness is 0.00941. So our statistics match real-world statistics; the calibration is complete.

In our calibrated example, when the manager gets signals $v = a + 1 + n = 47$ or $v = a = 37$, she chooses a good book value, and when she obtains a signal $v = a - 1 = 36$, she chooses a good book value with a 77.1% probability (i.e., she tells the truth only 22.9% of the time). Notice that the price when both order flows and the report indicate bad news, $P(B, -1)$, exceeds the price when only order flows indicate bad news, $P(G, -1)$. This satisfies Proposition 4.5, which follows from expression (A.22) in Appendix. In a sense, this is the penalty for the manager if she gives an uninformative report. Notice also that $P(G, -1) < a = 37$, which is expression (A.23) in the Appendix.

The cost of seeking an additional opinion, c, must be between 0.861 per share and 1.322 per share for the strategy I^3 (search only when the report is good) to be subgame perfect. This is expression (A.24) in the appendix. This implies that the gross expected profit from searching in the good report state is 1.322 and the gross expected profit from searching in the bad report state is 0.861. Hence, the trader searches in the good report state because he makes a positive net expected profit from searching in that state (if he did not search, his net expected profit would be zero if he did not participate and negative if he did participate), and he does not search in the bad report state because he makes a zero net expected profit by not searching but participating in that state (if he did search, his net expected profit would be negative).

These numbers arise because when the bad report state occurs, the posterior probability for the trader that $v = a - 1 = 36$ (where he makes a low profit of 0.472 if he searches) is a high 92.14%, and the posterior probability for the trader that $v = a = 37$ (where, if he searches, he makes a profit of 0.528) is 3.93%, and the posterior probability for the trader that $v = a + 1 + n = 47$ (where, if he searches, he makes a high profit of 10.528) is a very low 3.93%. On the other hand, when the good report state occurs, the posterior probability for the trader that $v = a - 1 = 36$ (where he makes a profit of 0.436 if he searches) is 27.8%, and the posterior probability for the trader that $v = a = 37$ (where he makes a loss if he searches and participates, and so he does not participate) is 36.07%, and the posterior probability for the trader that $v = a + 1 + n = 47$ (where, if he searches, he makes a profit of 3.364) is a not so low 36.07%. In other words, if the manager is mixing his strategies as given above, it follows that the trader has a higher incentive to search in the good news report state than in the bad news report state. This is because the differential information advantage of an informed trader vis-a-vis a market maker is much less when the report is bad (bad reports come almost surely from bad states) than when the report is good (good reports can come from any state).

For this example, we would also have an uninformative equilibrium if $c > 4.621$ (here the trader will never search, I^1), and an uninformative equilibrium if $c < 1.235$ (here the trader will always search, I^2).

Expression (A.22) ensures incentive compatibility of the manager. The equality in expression (A.22) is satisfied, as the above example shows, by a non-null set of parameters in (q, t, a, n)-space. Numerical simulations suggest that expression (A.22) is satisfied for large q. It cannot, of course, be arbitrarily close to one. To see why, note that as q approaches unity, the trader loses the ability to camouflage his trades with liquidity trades. So he becomes less willing to invest in costly private information. But if he never acquires private information, we know from Lemma 4.1 that there cannot be an informative equilibrium. On the other hand, q cannot be small either. To see this, note that as q becomes smaller, order flows have little influence on the price and the manager's report has a greater influence on the price. So the manager has an incentive to deviate in the bad state, given a candidate informative equilibrium.

Expression (A.23) requires that $P(G, -1) < a$. This restriction is needed for our particular 'suspicion equilibrium'. The intuition for this restriction is as follows. If $P(G, -1)$ is not less than a, then all the market maker's offered prices are greater than or equal to a. This implies that the trader after searching will always sell if he discovers $v = a - 1$ or $v = a$. Hence, if the manager is indifferent to what he discloses when $v = a - 1$, he will also be indifferent when $v = a$. In that case, $\gamma = \beta \in (0, 1)$. So the manager will deviate from $\gamma = 1$.

Expression (A.24) ensures incentive compatibility of the trader. The restriction on the cost parameter c is satisfied by a non-null set of values (see example above). This restriction can be interpreted very easily: for very low cost parameters, the trader will always acquire additional information; for very high cost parameters, he will never acquire additional information. Only for costs in an intermediate range is the 'search only when suspicious' strategy optimal.

When $r =$ Bad, the trader is not expected to search. If he does not search, his information is the same as that of the market maker and, hence, his expected profits are zero. If he deviates to searching, he will have more information than the market maker and, hence, his gross expected profits would be positive. Expression (A.24) ensures that the cost of search is high enough to make his net expected profit (net of search cost) to be negative in this state; therefore, he does not deviate in this state. However, when $r =$ Good (the state where the trader is expected to search), expression (A.24) ensures that this cost of search is low enough for him to make more profit when he searches than when he does not search. So he does not deviate. In short, expression (A.24) could be simply interpreted to mean that search costs and the market maker's prices are such that there are no gains to search at $r =$ Bad, but there are gains to search at $r =$ Good.

Numerical simulations suggest that the incentive compatibility condition for the trader – expression (A.24) – is satisfied for large t. It cannot, of course, be arbitrarily close to one, the situation where there is no communication noise. To see why, assume that without communication noise there is a Nash equilibrium in which the manager gave an informative report. If the bad report occurred, it would only have come from a bad book value, and a bad book value is sometimes chosen by the manager only if $v = a - 1$. Thus, in our setting, $P(B, x)$ would be $a - 1$, which is the minimum price possible. As the prices offered in the good report states are higher, the manager would always deviate. Hence, some communication noise is essential for our equilibrium to survive. Note that in our example, $t = 0.99$, which tells us that we do not require a lot of communication noise to obtain an informative equilibrium. On the other hand, t cannot be small either. To see this, note that as communication noise in the report increases, (i.e., t becomes smaller), the differential information advantage of an informed trader vis-á-vis a market maker increases. More importantly, the profits that the trader makes by searching when he is not expected to search (in the bad report state) becomes greater than the profits the trader makes by searching when he is expected to search (in the good report state), and so the trader deviates.

It is important to note here that there is a tension between the two incentive compatibility conditions. Simple intuition would suggest that the profits that the trader expects by searching when he is expected to search should be less than the profits that the trader expects by searching when he is not expected to search. This would suggest that if search costs are low enough to ensure gains to searching when $r =$ Good, there are more gains to searching when $r =$ Bad. We thus see that the necessary condition for the manager's incentive compatibility condition to be met – prices are more responsive to order flows after good news than they are after bad news – is precisely what makes it more difficult for the trader's incentive compatibility condition to be met – expected profits from search are higher after good news than after bad news.

This tension is resolved by the following intuition. For the trader to search only when the report is good, all we need is that the beliefs of the traders be coarser in the good news state than in the bad news state. This is generated by two reasons in the model. First, the manager's *optimal* disclosure strategy endogenously assures this. Ignoring the clouding effect of communication noise (which is assumed to be of much smaller order, and is only 1% in our example), it is apparent that since the manager mixes only in the $v = a - 1$ state, a bad report can most likely come from the $v = a - 1$ state, whereas a good report can come from any of the states. So there is less informational content in a good report than in a bad report. Second, since a good report could be coming from any state, making n large makes the good report even less informative.

To summarize, the important conditions needed to ensure the existence of a 'suspicion equilibrium' are two: search costs that are bounded below and above, and positive skewness in payoffs. Some noise is also needed to prevent full revelation and thus ensure the existence of a 'suspicion equilibrium'-noise trading is needed to provide camouflage for informed traders, and communication noise in the interpretation of a firm's financial statements is needed to provide camouflage to truth-telling managers.

6. Concluding remarks

The theory in this paper was motivated by a well-documented empirical regularity: accounting earnings surprises and abnormal stock returns are positively correlated, implying thereby that accounting earnings reports have information content. We asked why earnings surprises constitute news despite their possible manipulability, a question that has received little attention in the literature. Is it because manipulable components are small, so that earnings are essentially hard data, or is it because despite being soft data and unverifiable, managers find it advantageous to make earnings reports informative?

This paper argues that the Soft Data Hypothesis is a plausible one. When accounting earnings reports are about soft data, stock price maximizing managers have an incentive to report optimistically, and so profit maximizing traders might benefit from seeking a second opinion. This expression of suspicion may actually alleviate the moral hazard problem associated with corporate disclosures. We show that an informative equilibrium can exist if returns are positively skewed, and if the trader's cost of search, the level of communication noise, and the level of order flow noise are all in an intermediate region.

Unlike the previous literature which assumes that disclosures are verifiable and that Senders of a message cannot lie, we focus on the role of the Receiver. We show that, given unverifiable information, suspicion-induced actions of a Receiver (trader) may serve to penalize the Sender (manager) for misrepresentation. A special feature of our model is that this penalty works its way through the actions of rational third parties, markets makers, who set prices. Also, since the Sender's only choice is a one-shot message, she has no way of acquiring a reputation. The Receiver's suspicion is, however, sufficient to alleviate moral hazard. Thus, the suspicion effect can be valuable in overcoming moral hazard even when the reputation effect cannot. In other words, the existence of alternate sources of information in a modern financial market can discipline managers into making their disclosures informative, even if they are myopic and even if the direct cost of lying is zero.

Our Soft Data hypothesis leads to testable restrictions on abnormal returns during an event window following earnings announcements. If our hypothesis is correct, periods with bad news should have average abnormal returns that are *higher* than those from periods with good news but selling pressure. Second, prices should be more sensitive to order flows after positive earnings surprises than after negative earnings surprises. Given the availability of transaction data, this property can be exploited in designing an empirical procedure for discriminating between the Soft Data and the Hard Data hypotheses.

Appendix A.

The trader always buys if he discovers $v = a + n + 1$ and always sells when he discovers $v = a - 1$. When he discovers that $v = a$, he will buy, sell or refuse to participate depending on whether the market maker's price quotes are less than a, greater than a, or bracket a. The information contained in order flows would be different in each of these cases, and so will the prices. The variables ψ and δ, defined below, accordingly take on different values for each of the cases.

$$\psi \equiv \begin{cases} 0, & \text{if } P(G, +1) > a > P(G, -1), \\ -q, & \text{if } P(G, -1) \geqslant a, \\ +q, & \text{if } P(G, +1) \leqslant a, \end{cases}$$

$$\delta \equiv \begin{cases} 0, & \text{if } P(B, +1) > a > P(B, -1), \\ -q, & \text{if } P(B, -1) \geqslant a, \\ +q, & \text{if } P(B, +1) \leqslant a. \end{cases}$$

Now define the following: $\alpha_t \equiv \alpha t + (1-\alpha)(1-t)$, $\gamma_t \equiv \gamma t + (1-\gamma)(1-t)$ and $\beta_t \equiv \beta t + (1-\beta)(1-t)$. We are now in a position to obtain the prices set by the market maker for various conjectures of the manager's message strategies and the trader's search strategies. This is obtained from the market efficiency condition.

$$\begin{aligned} P(\tilde{r}, \tilde{x}) &= E(\tilde{v} \mid \tilde{r} = r, \tilde{x} = x) \\ &= (a + 1 + n)\text{prob}(v = a + 1 + n \mid r, x) + a\,\text{prob}(v = a \mid r, x) \\ &\quad + (a-1)\text{prob}(v = a - 1 \mid r, x) \\ &= a + (1+n)\text{prob}(v = a + 1 + n \mid r, x) \\ &\quad - \text{prob}(v = a - 1 \mid r, x) \\ &= a + \frac{(1+n)\text{prob}(v = a + 1 + n, r, x) - \text{prob}(v = a - 1, r, x)}{\text{prob}(r, x)} \end{aligned}$$

This gives us Table 2.

Table 2
Prices set by the market maker

Search strategy of trader	Reporting strategy of manager	$P(B,-1)-a$	$P(G,-1)-a$	$P(B,+1)-a$	$P(G,+1)-a$
I^1	Inf	$[(1+n)(1-\alpha_t)-\beta_t]/[(1-\alpha_t)+(1-\gamma_t)+\beta_t]$	$[(1+n)\alpha_t-(1-\beta_t)]/[\alpha_t+\gamma_t+(1-\beta_t)]$	$[(1+n)(1-\alpha_t)-\beta_t]/[(1-\alpha_t)+(1-\gamma_t)+\beta_t]$	$[(1+n)\alpha_t-(1-\beta_t)]/[\alpha_t+\gamma_t+(1-\beta_t)]$
	Uninf	$0.33n$	$0.33n$	$0.33n$	$0.33n$
I^2	Inf	$[(1+n)(1-q)(1-\alpha_t)-(1+q)]\beta_t]/[(1-q)(1-\alpha_t)+(1-\delta)(1-\gamma_t)+(1+q)\beta_t]$	$[(1+n)(1-q)\alpha_t-(1+q)(1-\beta_t)]/[(1-q)\alpha_t+(1-\psi)\gamma_t+(1+q)(1-\beta_t)]$	$[(1+n)(1+q)(1-\alpha_t)-(1-q)\beta_t]/[(1+q)(1-\alpha_t)+(1+\delta)(1-\gamma_t)+(1-q)\beta_t]$	$[(1+n)(1+q)\alpha_t-(1-q)(1-\beta_t)]/[(1+q)\alpha_t+(1+\psi)\gamma_t+(1-q)(1-\beta_t)]$
	Uninf	$[(1+n)(1-q)-(1+q)]/[(1-q)+(1-\delta)+(1+q)]$	$[(1+n)(1-q)-(1+q)]/[(1-q)+(1-\psi)+(1+q)]$	$[(1+n)(1+q)-(1-q)]/[(1+q)+(1+\delta)+(1-q)$	$[(1+n)(1+q)-(1-q)]/[(1+q)+(1+\psi)+(1-q)]$
I^3	Inf	$[(1+n)(1-\alpha_t)-\beta_t]/[(1-\alpha_t)+(1-\gamma_t)+\beta_t]$	$[(1+n)(1-q)\alpha_t-(1+q)(1-\beta_t)]/[(1-q)\alpha_t+(1-\psi)\gamma_t+(1+q)(1-\beta_t)]$	$[(1+n)(1-\alpha_t)-\beta_t]/[(1-\alpha_t)+(1-\gamma_t)+\beta_t]$	$[(1+n)(1+q)\alpha_t-(1-q)(1-\beta_t)]/[(1+q)\alpha_t+(1+\psi)\gamma_t+(1-q)(1-\beta_t)]$
	Uninf	$0.33n$	$[(1+n)(1-q)-(1+q)]/[(1-q)+(1-\psi)+(1+q)]$	$0.33n$	$(1+n)(1+q)-(1-q)]/[(1+q)+(1+\psi)+(1-q)]$
I^4	Inf	$[(1+n)(1-q)(1-\alpha_t)-(1+q)]\beta_t]/[(1-q)(1-\alpha_t)+(1-\delta)(1-\gamma_t)+(1+q)\beta_t]$	$[(1+n)\alpha_t-(1-\beta_t)]/[\alpha_t+\gamma_t+(1-\beta_t)]$	$[(1+n)(1+q)(1-\alpha_t)-(1-q)\beta_t]/[(1+q)(1-\alpha_t)+(1+\delta)(1-\gamma_t)+(1-q)\beta_t]$	$[(1+n)\alpha_t-(1-\beta_t)]/[\alpha_t+\gamma_t+(1-\beta_t)]$
	Uninf	$[(1+n)(1-q)-(1+q)]/[(1-q)+(1-\delta)+(1+q)]$	$0.33n$	$[(1+n)(1+q)-(1-q)]/[(1+q)+(1+\delta)+(1-q)$	$0.33n$

Now define the following conditional expectations of the trader (conditional on report), but before search: $\pi \equiv E(v \mid r = \text{Bad}, \alpha, \gamma, \beta)$ and $\phi \equiv E(v \mid r = \text{Good}, \alpha, \gamma, \beta)$. Then the conditional expected profit for the strategic trader is given in Table 3.

The market maker's price quotes used in Table 3 have been obtained from Table 2.

Proof of Lemma 4.1 (*Non-existence of informative equilibria under I^1 or I^2*). We will show that an informative equilibrium cannot exist when the trader is never searching or when he is always searching. Note that in both these cases the order flow is independent of the report. So, without loss of generality, one can assume that a disclosure is informative if good reports lead to higher prices for a given order flow.

The Case of I^1 (*never search*): As order flows have no information content, $P(G,-1) = P(G,+1) \equiv P(G)$ and $P(B,-1) = P(B,+1) \equiv P(B)$. Suppose the report is informative. This implies that $P(G) > P(B)$. Notice that when $v = a - 1, a$ or $a + 1 + n$, the expected price obtained by the manager if he reports $b = B$ is

$$(1-t)P(G) + tP(B) \tag{A.1}$$

and if he reports $b = G$ is

$$tP(G) + (1-t)P(B). \tag{A.2}$$

As $t > 0.5 > (1-t)$ and $P(G) > P(B)$, expression (A.2) > expression (A.1), and so the manager will always report $b = G$. A contradiction. So the report cannot be informative. $\square$

The Case of I^2 (*always search*): Suppose the report is informative. This implies that $P(G,+1) > P(B,+1)$ and $P(G,-1) > P(B,-1)$. When $v = a - 1$, the expected price obtained by the manager if he reports $b = B$ is

$$\begin{aligned}&(1-t)\{qP(G,-1) + 0.5(1-q)(P(G,+1) + P(G,-1))\} + t\{qP(B,-1)\\ &\quad + 0.5(1-q)(P(B,+1) + P(B,-1))\}\end{aligned} \tag{A.3}$$

and if he reports $b = G$ is

$$\begin{aligned}&t\{qP(G,-1) + 0.5(1-q)(P(G,+1) + P(G,-1))\} + (1-t)\{qP(B,-1)\\ &\quad + 0.5(1-q)(P(B,+1) + P(B,-1))\}.\end{aligned} \tag{A.4}$$

Subtract expression (A.3) from expression (A.4) to obtain

$$\begin{aligned}&(2t-1)[q\{P(G,-1) - P(B,-1)\} + 0.5(1-q)\{(P(G,-1) - P(B,-1))\\ &\quad + (P(G,+1) - P(B,+1))\}].\end{aligned} \tag{A.5}$$

Table 3
Expected profits of the trader

Manager's report, r	Trader's order, x	Expected profits of trader after search, but before nature picks trader to go to window			Expected profits of trader if he does not search, but before nature picks trader to go to window
		$v=a+1+n$	$v=a$	$v=a-1$	
Bad	Not participate	0	0	0	0
	-1	$-q(a+1+n-P(B,-1))$	$-q(a-P(B,-1))$	$-q(a-1-P(B,-1))$	$-q(\pi-P(B,-1))$
	$+1$	$q(a+1+n-P(B,+1))$	$q(a-P(B,+1))$	$q(a-1-P(B,+1))$	$q(\pi-P(B,+1))$
Good	Not participate	0	0	0	0
	-1	$-q(a+1+n-P(G,-1))$	$-q(a-P(G,-1))$	$-q(a-1-P(G,-1))$	$-q(\phi-P(G,-1))$
	$+1$	$q(a+1+n-P(G,+1))$	$q(a-P(G,+1))$	$q(a-1-P(G,+1))$	$q(\phi-P(G,+1))$

When $v = a + n + 1$, the expected price obtained by the manager if he reports $b = B$ is

$$(1-t)\{qP(G,+1) + 0.5(1-q)(P(G,+1) + P(G,-1))\} + t\{qP(B,+1) + 0.5(1-q)(P(B,+1) + P(B,-1))\} \tag{A.6}$$

and if he reports $b = G$ is

$$t\{qP(G,+1) + 0.5(1-q)(P(G,+1) + P(G,-1))\} + (1-t)\{qP(B,+1) + 0.5(1-q)(P(B,+1) + P(B,-1))\}. \tag{A.7}$$

Subtract expression (A.6) from expression (A.7) to obtain

$$(2t-1)[q\{P(G,+1) - P(B,+1)\} + 0.5(1-q)\{(P(G,-1) - P(B,-1)) + (P(G,+1) - P(B,+1))\}]. \tag{A.8}$$

When the manager gets signal $v = a$, if he chooses a bad book, his expected price is

$$(1-t)\{0.5q\theta(P(G,+1) - P(G,-1)) + 0.5(P(G,+1) + P(G,-1))\} + t\{0.5q\xi(P(B,+1) - P(B,-1)) + 0.5(P(B,+1) + P(B,-1))\} \tag{A.9}$$

and if he chooses a good book, his expected price is

$$t\{0.5q\theta(P(G,+1) - P(G,-1)) + 0.5(P(G,+1) + P(G,-1))\} + (1-t)\{0.5q\xi(P(B,+1) - P(B,-1)) + 0.5(P(B,+1) + P(B,-1))\} \tag{A.10}$$

where θ and ξ are defined below:

$$\theta \equiv \begin{cases} 0 & \text{if } P(G,+1) > a > P(G,-1), \\ -1 & \text{if } P(G,-1) \geqslant a, \\ +1 & \text{if } P(G,+1) \leqslant a. \end{cases}$$

$$\xi \equiv \begin{cases} 0 & \text{if } P(B,+1) > a > P(B,-1), \\ -1 & \text{if } P(B,-1) \geqslant a, \\ +1 & \text{if } P(B,+1) \leqslant a. \end{cases}$$

Subtract expression (A.9) from expression (A.10) to obtain

$$(2t-1)[\{0.5q\theta(P(G,+1) - P(G,-1)) + 0.5(P(G,+1) + P(G,-1))\} - \{0.5q\xi(P(B,+1) - P(B,-1)) + 0.5(P(B,+1) + P(B,-1))\} \tag{A.11}$$

As $P(G,+1) > P(B,+1)$ and $P(G,-1) > P(B,-1)$, expressions (A.5), (A.8) and (A.11) are positive. So the manager will always report $b = G$. A contradiction. So the report cannot be informative. □

Proof of Proposition 4.2 (*Existence of uninformative equilibrium*). We will now prove that if I^1(never search) or I^2(always search) is utilized by the trader, an uninformative equilibrium can exist for certain parameter values.

First part: *manager does not deviate*: Notice that under I^1 or I^2, prices are independent of the report for uninformative disclosures, which means that the manager's disclosure strategy has no effect on prices. So the manager will not deviate.

Second part: *trader does not deviate*: We will next show that – for certain parameter regions – given an uninformative report and given that the prices are being set assuming uninformative report and I^1, the trader does not deviate from I^1. We will then do the same for the case of I^2.

The case of I^1 (*never search*): Given the market maker's price quotes for this case (Table 2 tells us that all the prices are the same here – denote this by P), the gross expected profits of the trader if he decides to search is the same in each report state and equals $q\{0.33[a+1+n-P]+0.33\mid a-P\mid+0.33(P-(a-1))\}$, where $P=a+0.33n$. The gross expected profits of the trader if he decides not to search is zero. So the trader will not deviate if $c>q\{0.33[a+1+n-P]+0.33\mid a-P\mid+0.33(P-(a-1))\}$, where $P=a+0.33n$. □

The case of I^2 (*always search*): Here $P(+1)=a+[(1+n)(1+q)-(1-q)]/[(1+q)+(1+\eta)+(1-q)]$ and $P(-1)=a+[(1+n)(1-q)-(1+q)]/[(1-q)+(1-\eta)+(1+q)]$, where

$$\eta\equiv\begin{cases}0 & \text{if } P(+1)>0>P(-1),\\ -q & \text{if } P(-1)\geqslant 0,\\ q & \text{if } P(+1)\leqslant 0.\end{cases}$$

It is easy to show that $P(+1)>P(-1)$. The gross expected profits of the trader if he decides to search is the same state in any report state – since reports are uninformative – and equals $q\{0.33[(a+1+n)-P(+1)]+0.33\mu+0.33[P(-1)-(a-1)]\}$ where

$$\mu\equiv\begin{cases}0 & \text{if } P(+1)>a>P(-1),\\ P(-1)-a & \text{if } P(-1)\geqslant a,\\ a-P(+1) & \text{if } P(+1)\leqslant a.\end{cases}$$

The gross expected profits of the trader if he decides not to search is zero. So the trader will not deviate if $c<q\{0.33[(a+1+n)-P(+1)]+0.33\mu+0.33[P(-1)-(a-1)]\}$. □

Proof of Lemma 4.3 (*Nonexistence of uninformative equilibrium that involves* I^3 *or* I^4)

The case of I^3 (*search only when report is good*): From Table 2, when the report is uninformative, we obtain that

$$P(B) = a + 0.33n,$$

$$P(G, +1) = a + [(1+n)(1+q) - (1-q)]/[(1+q) + (1+\psi) + (1-q)] > P(B),$$

$$P(G, -1) = a + [(1+n)(1-q) - (1+q)]/[(1-q) + (1+\psi) + (1+q)] < P(B),$$

where ψ has been defined before. Now if the trader searches in the good report state his net expected profit is

$$q\{0.33[a + 1 + n - P(G, +1)] + 0.33\sigma + 0.33[(P(G, -1) - (a-1)]\} - c, \tag{A.12}$$

where

$$\sigma \equiv \begin{cases} 0 & \text{if } P(G,+1) > a > P(G,-1), \\ P(G,-1) - a & \text{if } P(G,-1) \geqslant a, \\ a - P(G,+1) & \text{if } P(G,+1) \leqslant a. \end{cases}$$

If he searches in the bad report state his net expected profit is

$$q\{0.33[a + n + 1 - P(B)] + 0.33\,|\,a - P(B)\,| + 0.33[P(B) - (a-1)]\} - c. \tag{A.13}$$

It is easy to check that expression (A.13) > expression (A.12) under all circumstances. So if trader searches when $r = G$, he will also search when $r = B$. This is a deviation. □

The case of I^4 (*search only when report is bad*): The proof is identical to the above proof with relabelling (change G to B and B to G). □

Proof of Proposition 4.4 (*Existence of "suspicion" equilibrium*): We will now prove the main proposition of our paper: an informative equilibrium can exist when the trader is searching only when $r = G$. We do this by identifying the condition required on parameters for the manager to follow an informative strategy (expressions (A.22) and (A.23)), and the condition required on parameters for the trader to follow I^3 (expression (A.24)).

First part: (*manager does not deviate*): We will show that if expressions (A.22) and (A.23) on parameters hold, given I^3, the manager will not deviate from $\alpha = \gamma = 1$ and $\beta \in (0, 1)$.

When the manager gets signal $v = a + 1 + n$, if he chooses a bad book, his expected price is

$$(1 - t)\{qP(G, +1) + 0.5(1 - q)(P(G, +1) + P(G, -1))\} + tP(B) \tag{A.14}$$

and if he chooses a good book, his expected price is

$$t\{qP(G, +1) + 0.5(1 - q)(P(G, +1) + P(G, -1))\} + (1 - t)P(B). \tag{A.15}$$

When the manager gets signal $v = a$, if he chooses a bad book, his expected price is

$$(1 - t)\{0.5q\theta(P(G, +1) - P(G, -1)) + 0.5(P(G, +1) + P(G, -1))\} + tP(B) \tag{A.16}$$

and if he chooses a good book, his expected price is

$$t\{0.5q\theta(P(G, +1) - P(G, -1)) + 0.5(P(G, +1) + P(G, -1))\} + (1 - t)P(B) \tag{A.17}$$

where θ has been defined before.

So manager does not deviate from $\alpha = 1$, if expression (A.15) $\geqslant$ expression (A.14), which implies that

$$qP(G, +1) + 0.5(1 - q)(P(G, +1) + P(G, -1)) \geqslant P(B) \tag{A.18}$$

and manager does not deviate from $\gamma = 1$, if expression (A.17) $\geqslant$ expression (A.16), which implies that

$$0.5q\theta(P(G, +1) - P(G, -1)) + 0.5(P(G, +1) + P(G, -1)) \geqslant P(B). \tag{A.19}$$

When the manager gets signal $v = a - 1$, if he chooses a bad book value, his expected price is

$$(1 - t)\{qP(G, -1) + 0.5(1 - q)(P(G, +1) + P(G, -1))\} + tP(B), \tag{A.20}$$

and if he chooses a good book value, his expected price is

$$t\{qP(G, -1) + 0.5(1 - q)(P(G, +1) + P(G, -1))\} + (1 - t)P(B). \tag{A.21}$$

So manager does not deviate from $\beta \in (0, 1)$ if expression (A.20) = expression (A.21). This implies that

$$P(B) = qP(G, -1) + 0.5(1 - q)(P(G, +1) + P(G, -1)) \tag{A.22}$$

Comments on expression (*A*.22)

(i) Since $P(G, +1) > P(G, -1)$ from Table 2, if expression (A.22) holds, it implies that $qP(G, +1) + 0.5(1 - q)(P(G, +1) + P(G, -1)) > qP(G, -1) +$

$0.5\ (1-q)(P(G,+1)+P(G,-1)) = P(B)$ which in turn implies that expression (A.18) holds only as an inequality. So $\alpha = 1$.

(ii) If expression (A.22) holds, it implies that

$$\begin{aligned} P(B) &= qP(G,-1) + 0.5(1-q)(P(G,+1)+P(G,-1)) \\ &= 0.5q\ (P(G,-1)-P(G,+1)) + 0.5(P(G,+1)+P(G,-1)). \end{aligned}$$

Given the definition of θ above, and given that $P(G,+1) > P(G,-1)$, it is apparent that when $\theta = 0$ or 1,

$$\begin{aligned} &0.5q\theta(P(G,+1)-P(G,-1)) + 0.5(P(G,+1)+P(G,-1)) \\ &\quad > 0.5q\ (P(G,-1)-P(G,+1)) + 0.5(P(G,+1)+P(G,-1)) = P(B); \end{aligned}$$

and when $\theta = -1$,

$$\begin{aligned} &0.5q\theta(P(G,+1)-P(G,-1)) + 0.5(P(G,+1)+P(G,-1)) \\ &\quad = 0.5q\ (P(G,-1)-P(G,+1)) + 0.5(P(G,+1)+P(G,-1)) = P(B). \end{aligned}$$

This implies, from expression (A.19), that if $\theta = 0$ or 1, the manager has no incentive to deviate from $\gamma = 1$. However, if $\theta = -1$, the manager is indifferent. To preclude this situation, we require an additional restriction: $\theta \neq -1$. This means

$$P(G,-1) < a \tag{A.23}$$

(iii) $\beta = 1$ if expression (A.20) > expression (A.21). However, we found in our numerical analysis that if expression (A.20) > expression (A.21), Expression (A.24) (the trader's condition) was violated.

(iv) *Proof of Proposition* 4.5 (*Ordering of prices*). A necessary condition for expression (A.22) to hold is that $P(B) > P(G,-1)$. Suppose not. Then $0.5(P(G,+1)+P(G,-1)) > P(B)$, and so $qP(G,-1) + 0.5(1-q)(P(G,+1)+P(G,-1)) > P(B)$. This violates expression (A.22). This gives us the following ordering of prices: $P(G,+1) > P(B) > P(G,-1)$. □

(v) A necessary condition for expression (A.22) to hold is that there exists some communication noise. If $t = 1$, then $P(B) = -1 < P(G,-1)$. This violates (iv).

(vi) If we do a similar analysis for the case of I^4, we find that

$$\begin{aligned} \alpha &= 1 && \text{if } qP(B,+1) + 0.5(1-q)(P(B,+1)+P(G,-1)) < P(G), \\ \alpha &\in (0,1) && \text{if } qP(B,+1) + 0.5(1-q)(P(B,+1)+P(G,-1)) = P(G), \\ \alpha &= 0 && \text{if } qP(B,+1) + 0.5(1-q)(P(B,+1)+P(G,-1)) > P(G), \end{aligned}$$

and

$$\begin{aligned} \gamma &= 1 && \text{if } 0.5q\xi(P(B,+1)-P(B,-1)) + 0.5(P(B,+1)+P(B,-1)) < P(G), \\ \gamma &\in (0,1) && \text{if } 0.5q\xi(P(B,+1)-P(B,-1)) + 0.5(P(B,+1)+P(B,-1)) = P(G), \\ \gamma &= 0 && \text{if } 0.5q\xi(P(B,+1)-P(B,-1)) + 0.5(P(B,+1)+P(B,-1)) > P(G) \end{aligned}$$

and

$$\begin{aligned}
&\beta = 1 && \text{if } P(G) < qP(B,-1) + 0.5(1-q)\,(P(B,+1) + P(B,-1)),\\
&\beta \in (0,1) && \text{if } P(G) = qP(B,-1) + 0.5(1-q)\,(P(B,+1) + P(B,-1)),\\
&\beta = 0 && \text{if } P(G) > qP(B,-1) + 0.5(1-q)\,(P(B,+1) + P(B,-1)).
\end{aligned}$$

Comparing this to the analysis done for the I^3 case, we notice that the inequality signs are flipped and the following relabelling has occurred: 'good book' to 'bad book' and vice versa. Hence, the analysis is identical.

Second part: (*trader does not deviate*): We will show that if a particular condition on parameters holds (expression (A.24)), the trader does not deviate from I^3.

From Table 3, the gross profit from searching when the report is bad is

$$q[0.33(1-t)\{a+1+n-P(B)\} + 0.33(1-t)\{|a-P(B)|\} \\ + 0.33\beta_t\{(P(B)-(a-1)\}]/[0.67(1-t) + 0.33\beta_t]$$

whereas the gross profit from searching when the report is good is

$$q[0.33t\{a+n+1-P(G,+1)\} + 0.33\sigma + 0.33(1-\beta_t)\{P(G,-1) \\ -(a-1)\}/[0.67t + 0.33(1-\beta_t)]$$

where β_t and σ had been defined before.

As the profit from not searching is zero, the trader will not deviate from I^3 if

$$\begin{aligned}
&q[0.33t\{a+n+1-P(G,+1)\} + 0.33\sigma + 0.33(1-\beta_t)\{P(G,-1)\\
&\quad -(a-1)\}/[0.67t + 0.33(1-\beta_t)]\\
&> c\\
&> q[0.33(1-t)\{a+1+n-P(B)\} + 0.33(1-t)\{|a-P(B)|\}\\
&\quad + 0.33\beta_t(P(B)-(a-1)]/[0.67(1-t) + 0.33\beta_t] \qquad \text{(A.24)}
\end{aligned}$$

□

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