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Stock recommendation of an analyst who trades on own account

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This article analyzes the provision of information acquisition and truthful reporting incentives to a financial analyst who can privately trade on own account. In a binary message and state space, I show that the analyst's reward scheme essentially provides him with a portfolio endowment traded in the market. Regardless of the true signal, the analyst issues the report that corresponds to the portfolio endowment with maximum market value, given security prices. The analyst's information acquisition incentive is driven only by private portfolio considerations: he acquires information only if he will be holding a large enough position in the stock he covers.

1. Introduction

■ An important function of security analysts in financial brokerage firms is to provide unbiased information to investors. Following the poor performance of the stock market in general and of the analysts' recommendations, the credibility of analysts came under attack by the popular business press.[1] The debate mainly focused on internal pressure that the analysts face in their own firms particularly with respect to increasing investment banking business. This objective calls for pleasing underwriting clients by issuing optimistic reports. A conflict of interest arises because brokerage clients (investors) want unbiased research, but investment banking clients (issuers or underwriters) want optimistic research: the analyst may feel pressure to boost or maintain the stock price by issuing positive recommendations.[2]

According to Boni and Womack (2002), a much less emphasized but equally important issue concerning the credibility of the analysts' recommendations is the personal investments of the analysts in the stocks they cover. Schack (2001, p. 60) also emphasizes this point: "Wall Street

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[1] Newspaper headlines such as "Shoot All the Analysts" (*Financial Times*) and "Can We Trust Wall Street Again?" (*Fortune* magazine) expressed a popular concern on analyst credibility. Alarmed by the growing media attention, in the summer of 2001 the U.S. Congress held hearings, titled "Analyzing the Analysts," to find remedies for the credibility problem.

[2] In 2002, the SEC approved new NASD (National Association for Security Dealers) rules which mandate separation of research and investment banking and prohibit the compensation of analysts from specific investment banking deals.

research analysts increasingly are accused of ditching their objectivity to please underwriting clients. But largely overlooked in all of the complaints has been perhaps the most fundamental conflict of interest for all Wall Street analysts—owning the stock of companies they cover. It is not illegal; nor by Wall Street's standards is it unethical. In fact, it is a common industry practice." Whether analysts should be allowed to trade in the stocks they cover is a controversial issue. The opponents of analyst trading argue that the whole practice is unethical, because the analysts have a clear incentive to manipulate the stock price with false recommendations if they can trade on own account. Some practitioners, however, are in favor of analysts' stock ownership, arguing that credibility would be enhanced if the analysts are allowed to "put their money where their mouth is." Despite its importance, the theoretical literature on the credibility of analyst recommendations has largely overlooked the implications of analysts' personal trades.

This article examines how a stock analyst's ability to privately trade on own account affects his information acquisition and reporting incentives. I describe a model where an analyst is hired by a principal (an investor or an investment bank) to provide information on a risky security return. The analyst has to pay a cost to acquire a private information signal. A high (low) signal indicates that the high (low) return is more likely. Given this signal or based on no private information at all, the analyst issues a report, high or low, to the principal. Subsequent to the report, the analyst privately trades the risky security along with a safe security. The analyst has no *a priori* bias in choosing his report. Furthermore, the analyst is assumed to be competitive: his reporting and private portfolio choices take the risky security prices as given. This competitiveness assumption rules out any incentives to misreport solely to manipulate the stock price and introduces analyst trading perhaps in the most innocuous way. In this setting, I analyze the principal's problem of providing costly information acquisition and truthful reporting incentives by tying the analyst's reward scheme to his report and to the realization of the risky security return.

In the benchmark case when the analyst *cannot* trade, the truthful reporting constraints are not binding: if the analyst can be made to acquire information *ex ante*, he strictly prefers to report the signal truthfully *ex post*. The principal can provide information acquisition incentives only by a reward scheme that makes the analyst strictly prefer to report the true signal *ex post*. This *ex post* rent from making informed reports provides the *ex ante* incentive for costly information acquisition: the information acquisition incentives are based on "reporting performance." The optimal contract rewards the analyst if his report proves to be accurate.

The optimal contracting analysis when the analyst can privately trade on own account yields the following results.

- The principal cannot make the analyst strictly prefer to report the true signal. If the analyst acquires information, he truthfully reveals it only when indifferent between the two reports. Furthermore, the analyst's information acquisition incentives are driven only by private portfolio considerations. The analyst acquires information only if he will be holding a large enough position in the risky security, but not because he is *ex post* strictly better off from reporting the true signal.
- Because the principal can provide information acquisition incentives only by inducing the analyst to hold a large enough risky security position, the analyst's trading ability is a bigger problem, if the analyst is too risk-averse. An excessively risk-averse analyst tends to hold very little exposure to the risky security, and providing information acquisition incentives can be prohibitively costly. If the analyst is sufficiently risk tolerant, however, the principal may be better off from the analyst's ability to trade: the analyst may have *a priori* incentives of his own to acquire information and use it in his private portfolio decision.
- When the analyst privately trades, a compensation scheme that rewards the accuracy of the analyst's report performs no better than a flat-wage scheme in terms of providing costly information acquisition and truthful reporting incentives.

These results indicate that the superiority of reward schemes based on the analyst's reporting performance depends crucially on the trading opportunities available to the analyst. More strict trading restrictions on analysts may result in more frequent use of explicit schemes that reward reporting performance. Furthermore, if trading restrictions on analysts are lax, it is better to hire a relatively more risk-tolerant analyst who tends to put his money in the security he covers rather than a more risk-averse analyst who tends to hold little exposure to the risky security in his private portfolio.

To characterize the reporting incentives when the analyst privately trades, the analysis builds on the following observation, which holds for any reward scheme in a binary message and state space. For a given report, the analyst's reward scheme essentially provides him with a portfolio endowment traded in the market. In other words, for any given report, there is a portfolio of safe and risky securities such that this portfolio and the analyst's reward scheme generate the same payoff. By choosing a report, the analyst essentially chooses between different portfolio endowments. This observation implies that regardless of the true signal, the analyst chooses the report that corresponds to the portfolio endowment with the maximum market value. This reporting strategy is optimal, because the analyst can subsequently sell this portfolio as part of his private trades at this market value, and use the proceeds as additional wealth to allocate in an optimal portfolio according to the true signal. Regardless of the true signal, the analyst therefore chooses the report that maximizes his wealth endowment and allocates this maximized wealth in an optimal private portfolio given the true signal.

The article generalizes the above observation to a general message and state space and presents a "separation of the reporting strategy from private information" result. The separation result applies to any reward scheme where for any given possible report, the part of the reward scheme that depends on the report corresponds to a portfolio endowment of safe and risky securities traded in the market. This property of the reward scheme creates reporting incentives that do not use the private information signal: for every signal, the analyst makes the report that corresponds to the portfolio endowment with the maximum market value, given the security prices. This result indicates that reward schemes that create similar payoff structures as the financial claims that the analysts can trade in the market can be inadequate in ensuring credible recommendations. Such schemes can fail to induce any information revelation even if they are designed purely to reward the analyst's performance. I provide an example of this result with a performance-based scheme which is known to achieve truthful reporting in the absence of analyst trades. This scheme fails completely to induce any information revelation when the analyst privately trades: regardless of the true signal, its precision, and the analyst's preferences, the analyst always issues a report equal to the prevailing risky security price.

□ **Related literature.** As mentioned, the theoretical literature that examines incentive problems between financial analysts and their clients has largely overlooked the possibility that analysts may also trade on their own account. One exception is Biais and Germain (2002), who consider a model where a portfolio manager has conflicting interests with his client because the manager trades on own account. In their setting, however, the portfolio manager uses his information to select a portfolio on behalf of the client. Because their manager does not disclose any information to the client, they do not address the credibility of the recommendations. Instead, they focus on whether the manager creates a portfolio that maximizes the client's welfare.[3]

Benabou and Laroque (1992) and Morgan and Stocken (2003) also address an analyst's incentives to misreport his information. Different than my article, the analysts in these papers are primarily concerned with the price impact of their recommendations. Morgan and Stocken (2003) consider the issue of analyst credibility when the investors are uncertain about the pressure that the analyst faces to boost the stock price. The analyst may be biased to issue a favorable report

[3] Admati and Pfleiderer (1986, 1990) study the problem of an information seller in a noisy rational expectations framework. In Brennan and Chordia (1993), a brokerage firm sells financial market information by charging a commission fee. These papers assume that the seller has the information *ex ante* and reports it truthfully *ex post*, and that the seller does not trade himself.

to win business for the investment banking branch of his company. They address precisely the misalignment of the analyst's incentives due to the ties with the investment banking business. To focus on the responsiveness of stock prices to analyst recommendations, they purposely rule out the possibility that the analyst may trade on own account. Instead, I focus on the implications of the analyst's private trades for information acquisition and reporting incentives in an optimal contracting setting where the stock price does not depend on the analyst's recommendation. My analysis complements theirs by addressing the relatively less emphasized source of conflict identified by Boni and Womack (2002) and Schack (2001), namely the analyst's private trades.[4]

Benabou and Laroque (1992) analyze the reporting incentives of a privately informed agent (like a market guru, a journalist or a corporate insider) who can trade on own account without being detected. Their informed agent can influence and manipulate the stock price through public announcements. They show that with noisy private information, an informed agent can manipulate prices repeatedly by false reports, as the market cannot tell whether he is dishonest or just wrong. In Benabou and Laroque (1992), misreporting incentives arise to manipulate prices, whereas in this article, the analyst is competitive and takes the stock price as given in choosing his report and his trades.

Another related strand of literature considers situations where the analysts are concerned with convincing investors of their forecasting expertise. In Trueman (1994), the analysts have different forecasting abilities unobservable to the market. They choose their reports with the objective of maximizing the clients' posterior probability that the analyst has high-forecasting ability. Trueman shows that analysts with precise signals report truthfully, whereas low-ability analysts with less precise signals mimic the high types. Ottaviani and Sorensen (2006) formulate a cheap-talk framework where an expert with private information is concerned about being perceived to have accurate information. They show that experts can credibly reveal only part of their information. Those papers consider reputation-driven reporting environments and do not allow the analyst/expert to trade on own account.

Finally, this article is related to the optimal contracting literature that focuses on the incentives of financial experts. Allen (1990) also considers the reliability of a financial expert's disclosure to his clients and derives a mechanism that ensures truthfulness. Unlike this article, however, Allen's expert can commit to trade in a manner perfectly observable to his clients and actually uses this trading ability to ensure the clients that he is indeed informed.[5] Kihlstrom (1988) analyzes a delegated portfolio management problem where an investor designs an optimal contract that ensures that the agent/manager expends costly effort to receive precise information and then chooses a portfolio in the investor's best interest. Unlike this article, however, the agent/portfolio manager does not trade on own account by assumption.[6]

The plan of the article is as follows. The next section lays out the model and describes the optimal contracting problem. Section 3 analyzes the case when the analyst cannot trade. Section 4 considers the principal's problem of providing information acquisition and truthful reporting incentives when the analyst privately trades. Section 5 provides a general separation of the reporting strategy from the true signal result. Section 6 concludes. The Appendix collects the proofs which are not presented in the text.

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[4] The idea that the analyst's private trades can undermine incentives is also somewhat similar to the recent literature that studies agency settings where the agent can engage in unobservable side contracts to undermine the effort incentives in his compensation scheme. For recent examples of such agency models, see Bisin and Guaitoli (2004) and Kahn and Mookherjee (1998).

[5] For each possible disclosure of the information signal, Allen's informed agent can commit to invest in a prespecified observable portfolio to ensure truthful revelation of information.

[6] In their seminal article, Demski and Sappington (1987) consider a general problem where a principal designs a contract to motivate the expert to acquire information and use it in the best interest of the principal. Different than my article, they assume that communication between the expert and the principal is prohibitively costly. Furthermore, their expert does not trade on own account.

2. The model

■ The model considers a security analyst (agent) who can provide information on a risky security return by issuing a report to his client (principal). The details of the setup are explained below.

The security market. Consider a financial market where two securities are traded: a safe security (normalize its gross return to 1) and a risky security. A portfolio is described by a pair $(x, y) \in \mathbb{R}^2$, where x and y are the shares of the safe and risky securities, respectively. The liquidation value of a portfolio (x, y) is given by $x + \theta y$, where θ is the stochastic final value of the risky security. Assume that θ can take two values, $\theta \in \{\theta_h, \theta_l\}$ with $\theta_h > \theta_l$. The prior distribution of θ is summarized by the *ex ante* probability $\Pr(\theta_h) = \alpha \in (0, 1)$.

Costly information acquisition. At date 0, the principal (an investor or an investment bank) hires the security analyst to acquire information on the risky security return.[7] Upon expending a private cost, the analyst can observe a private signal s correlated with θ . The information signal can take two values, $s \in \{h, l\}$, where h and l refer to high and low signals, respectively. The signal is noisy. Let ϕ denote the signal's precision defined as $\phi \equiv \Pr(h \mid \theta_h) = \Pr(l \mid \theta_l) \in (\frac{1}{2}, 1)$. For ease of reference, also let σ_h and $\sigma_l \equiv 1 - \sigma_h$ describe the prior distribution of s where $\sigma_h \equiv Pr(s = h) = \alpha\phi + (1 - \alpha)(1 - \phi)$.

Reporting and portfolio choice. Whether the analyst acquires information or not, the particular information signals he receives are not observable and *ex post* verifiable by the principal. Therefore, the analyst is not constrained in any way to report his private signal truthfully, if he has one. Given the signal realization s (if information is acquired) or based on no information at all, the analyst makes a report $m \in \{h, l\}$ to the principal prior to trading.[8] Subsequent to issuing a report to the principal, the analyst chooses a private portfolio (F, d) on own account. This portfolio choice is also unobservable to the principal.[9]

Security prices. It is relatively well understood that an analyst who can trade on own account and who can also affect security prices by his recommendation may have an incentive to produce favorable reports to maintain or boost the value of the securities in his portfolio.[10] As a point of departure from the existing literature and also to weaken the incentives to misreport, I abstract away from the effect of the recommendation on the risky security price. In particular, I assume that the analyst is a competitive price taker in the securities market, and his reporting and private portfolio choices have no price impact. Each share of the risky security trades at a price p in the market where $\theta_l < p < \theta_h$. I normalize the share price of the safe security to 1. Accordingly, a portfolio (x, y) trades in the market at a price $x + py$.

Preferences and the analyst's compensation. The analyst values consumption of final wealth and incurs a disutility from acquiring information. The analyst's utility is specified as $u(\omega) - c$, where ω is the final wealth and $c > 0$ is the cost of information acquisition, measured in utility terms without loss of generality. The utility function $u(.)$ is twice differentiable, strictly increasing, and strictly concave.

To keep the model simple, I do not explicitly model how the principal uses the information provided to her by the analyst. The principal's objective is to induce information acquisition and truthful revelation at a minimum expected monetary transfer to the analyst, subject to the additional consideration that the analyst privately trades on own account. The analyst's reward

[7] The framework with only one risky security can be extended to multiple risky securities. In practice, a security analyst is responsible for covering a few stocks in a certain industry. Therefore, a single risky security framework does not seem to be too restrictive.

[8] Benabou and Laroque (1992) also employ a binary specification of the state space and the message space.

[9] Although some financial firms adopted new disclosure rules and restrictions of their own on analyst trades following the negative media coverage (see Gasparino and Opdyke, 2001), full monitoring of analysts' personal portfolios seems hard to implement.

[10] Similarly, the analyst may engage in speculative announcements to cause the stock price to fall (rise) while secretly buying (selling) the stock, a scheme analyzed in Benabou and Laroque (1992) which they call "post-announcement speculation."

scheme is described by a non-negative vector of monetary transfers $t(m, \theta) \geqslant 0$ for $m \in \{h, l\}$ and $\theta \in \{\theta_h, \theta_l\}$ that ties the analyst's compensation to his report and to the final verifiable return of the risky security.[11] Note that the limited liability constraint on the reward scheme implies that the incentive provision requires leaving rents to the analyst.[12]

Sequence of events. At date 0, the principal sets a monetary reward scheme $t(m, \theta) \geqslant 0$ for $m \in \{h, l\}$ and $\theta \in \{\theta_h, \theta_l\}$. At date 1, the analyst chooses whether or not to acquire costly information, a choice which is not observable to the principal. If he acquires information, the analyst observes a private signal $s \in \{h, l\}$. At date 2, the analyst issues a report $m \in \{h, l\}$ to the principal. At date 3, the analyst privately chooses his own portfolio (F, d), taking security prices as given. At date 4, the security returns are realized and the analyst is compensated.

□ **The optimal contracting problem.** This section formulates the principal's optimal contracting problem by establishing *ex ante* information acquisition and *ex post* truthfulness constraints. These constraints must also take into account the fact that the analyst privately trades on own account. Suppose the analyst expends c and acquires information. Given some initial wealth w_0, the risky security price p, and the reward scheme $t(m, \theta)$ in place and conditional on the signal $s \in \{h, l\}$, the analyst chooses a report $m \in \{h, l\}$ and a personal portfolio $(F, d) \in \mathbb{R}^2$ to maximize

$$E[u(t(m, \theta) + d\theta + F) \,|\, s] \text{ subject to } F + pd \leq w_0. \tag{P1}$$

For future reference, let us call this problem (P1). Substituting for F from the budget constraint, (P1) can be rewritten as choosing $m \in \{h, l\}$ and $d \in \mathbb{R}$ to maximize $E[u(\omega\ (m, d)) \,|\, s]$, where

$$\omega(m, d) \equiv t(m, \theta) + d(\theta - p) + w_0 \tag{1}$$

is the analyst's final wealth. For convenience, let $d^*(m, s)$ describe the analyst's optimal position in the risky security after observing $s \in \{h, l\}$ and reporting $m \in \{h, l\}$. This optimal position is given by

$$d^*(m, s) \in \arg\max E[u(\omega(m, d)) \,|\, s] \text{ for } m \in \{h, l\} \text{ and } s \in \{h, l\}. \tag{2}$$

Ex post truthfulness constraints. Upon observing $s = h$, the analyst must prefer to report $m = h$ and trade $d^*(h, h)$ rather than reporting $m = l$ and trading $d^*(l, h)$. Formally, this requires

$$E[u(\omega(h, d^*(h, h))) \,|\, h] - E[u(\omega(l, d^*(l, h))) \,|\, h] \geq 0, \tag{3}$$

where $d^*(h, h)$ and $d^*(l, h)$ are described by (2). Similarly, upon observing $s = l$, the analyst must prefer to report $m = l$ and trade $d^*(l, l)$ rather than reporting $m = h$ and trading $d^*(h, l)$, that is,

$$E[u(\omega(l, d^*(l, l))) \,|\, l] - E[u(\omega(h, d^*(h, l))) \,|\, l] \geq 0. \tag{4}$$

Ex ante information acquisition constraints. Let $d^*(m, n)$ denote an uninformed analyst's optimal position in the risky security following a report $m \in \{h, l\}$ where n stands for "not informed." This optimal position is given by

$$d^*(m, n) \in \arg\max E[u(\omega(m, d))] \text{ for } m \in \{h, l\}. \tag{5}$$

Ex ante, the analyst must not choose to remain uninformed to subsequently report $m = h$ and trade $d^*(h, n)$, which requires

[11] See Bergemann and Valimaki (2002) for a general mechanism design problem where the mechanism provides efficient incentives to acquire information *ex ante* and implements the efficient allocation conditional on private information *ex post*.

[12] Because the transfer is bounded below at zero, the principal is constrained in her ability to push the analyst down to his reservation utility.

$$\sigma_h E[u(\omega(h, d^*(h, h))) \mid h] + \sigma_l E[u(\omega(l, d^*(l, l))) \mid l] - c \geq E[u(\omega(h, d^*(h, n)))], \tag{6}$$

and must not prefer to remain uninformed to subsequently report l and trade $d^*(l, n)$:

$$\sigma_h E[u(\omega(h, d^*(h, h))) \mid h] + \sigma_l E[u(\omega(l, d^*(l, l))) \mid l] - c \geq E[u(\omega(l, d^*(l, n)))]. \tag{7}$$

The principal's problem. The principal's problem is to choose the reward scheme $t(m, \theta) \geqslant 0$ for $m \in \{h, l\}$ and $\theta \in \{\theta_h, \theta_l\}$ to minimize the *ex ante* expected transfer $\sigma_h E[t(h, \theta) \mid h] + \sigma_l E[t(l, \theta) \mid l]$ subject to the two truthful reporting constraints (3) and (4), the two information acquisition constraints (6) and (7), and a participation constraint

$$\sigma_h E[u(\omega(h, d^*(h, h))) \mid h] + \sigma_l E[u(\omega(l, d^*(l, l))) \mid l] - c \geq \bar{u} = 0, \tag{8}$$

where the analyst's expected outside utility $\bar{u}$ is normalized to zero. All the above constraints take into account the analyst's private portfolio choices when informed, described by (2) and when uninformed, described by (5).

3. No private trading by the analyst

■ As a benchmark for comparison, this section describes the properties of the optimal contract when the analyst cannot privately trade on own account. An important observation is that in this case the *ex post* truthfulness constraints are *not* binding. If the analyst has information acquisition incentives *ex ante*, he strictly prefers to report the true signal *ex post*. To verify this observation, note that with no private trading the two *ex post* truthfulness constraints (3) and (4) reduce to

$$E[u(t(h, \theta)) \mid h] - E[u(t(l, \theta)) \mid h] \geqslant 0, \tag{3a}$$

$$E[u(t(l, \theta)) \mid l] - E[u(t(h, \theta)) \mid l] \geqslant 0, \tag{4a}$$

and the two *ex ante* information acquisition constraints (6) and (7) become

$$\sigma_h E[u(t(h, \theta)) \mid h] + \sigma_l E[u(t(l, \theta)) \mid l] - c \geqslant E[u(t(h, \theta))], \tag{6a}$$

$$\sigma_h E[u(t(h, \theta)) \mid h] + \sigma_l E[u(t(l, \theta)) \mid l] - c \geq E[u(t(l, \theta))]. \tag{7a}$$

Because $E[u(t(m, \theta))] = \sigma_h E[u(t(m, \theta)) \mid h] + \sigma_l E[u(t(m, \theta)) \mid l]$ for $m \in \{h, l\}$, the information acquisition constraint (6a) can be rewritten as

$$E[u(t(l, \theta)) \mid l] - E[u(t(h, \theta)) \mid l] \geqslant \frac{c}{\sigma_l} > 0, \tag{6aa}$$

and therefore (6a) implies (4a). Similarly, (7a) can be rewritten as

$$E[u(t(h, \theta)) \mid h] - E[u(t(l, \theta)) \mid h] \geqslant \frac{c}{\sigma_h} > 0, \tag{7aa}$$

and hence (7a) implies (3a). Accordingly, the *ex post* adverse selection (truthtelling) problem becomes irrelevant if the *ex ante* moral hazard (information acquisition) problem is resolved.

The above observation implies that under a reward scheme where the two truthful reporting constraints remain binding, the analyst does not acquire costly information. The principal can provide information acquisition incentives only by offering a reward scheme that makes the analyst *strictly* better off from reporting the truth once he observes the signal. This can be readily observed from (6aa) and (7aa). For example, the information acquisition constraint (6aa) simply says that for the analyst to have incentives to acquire the low signal, he must be given an *ex post* rent, measured in expected utility terms, of at least c/σ_l for reporting the low signal truthfully.[13]

[13] Iossa and Legros (2004) obtain a similar result in the context of a model with costly auditing. To induce information acquisition, the auditor needs to be given a rent when his report is informative that is greater than what he obtains when his report is uninformative. To grant the auditor property rights when he reports the high signal is the only way to provide this rent and ensure information acquisition.

This observation rules out the optimality of flat-wage schemes, as with a flat scheme the truthful reporting constraints remain binding. When the analyst is indifferent between the two reports *ex post*, he has no incentive to acquire information *ex ante*.

Observation 1. If the analyst *cannot* privately trade, he acquires information only if truthful reporting gives a strictly higher expected utility compared to misreporting, that is, if the two *ex post* truthfulness constraints are not binding.

One can further characterize the optimal contract by using the two relevant constraints, the *ex ante* information acquisition constraints (6a) and (7a). For brevity, I present the formal arguments in the Appendix and here only describe the qualitative properties of the optimal contract. The two information acquisition constraints are both binding in the optimal contract: the principal sets the reward scheme such that the analyst is *ex ante* indifferent between acquiring information and remaining uninformed. This ensures that the analyst receives the minimum possible rent compatible with information acquisition. The optimal contract must have $t^*(h, \theta_l) = t^*(l, \theta_h) = 0$, as rewarding the analyst when his recommendation proves inaccurate does not provide any incentives for information acquisition and is not optimal. The optimal transfers $t^*(h, \theta_h)$ and $t^*(l, \theta_l)$ can then be determined by solving (6a) and (7a) as an equality. The optimal transfers $t^*(h, \theta_h)$ and $t^*(l, \theta_l)$ are both increasing in the cost of information acquisition c and are decreasing in the precision of the signal ϕ . The optimal contract rewards the analyst if his report proves accurate: the incentives are hence based on the analyst's "reporting performance."

4. Analyst trades on own account

■ This section turns to the main focus of the article, the information acquisition and reporting incentives of an analyst who can privately trade on own account.

□ **Reporting and private portfolio choice.** The following observation proves crucial in characterizing the analyst's optimal reporting and private portfolio choice. Consider *any* reward scheme $t(m, \theta)$ for $m \in \{h, l\}$ and $\theta \in \{\theta_h, \theta_l\}$ that the principal offers. For a given report m, it is always possible to find a corresponding portfolio $(x_m, y_m) \in \mathbb{R}^2$ indexed by m, such that this portfolio and the reward scheme $t(m, \theta)$ generate the same payoff at state $\theta \in \{\theta_h, \theta_l\}$. Formally, for a given report $m \in \{h, l\}$, one can find a portfolio (x_m, y_m) such that

$$x_m + y_m\theta_h = t(m, \theta_h), \tag{9a}$$

$$x_m + y_m\theta_l = t(m, \theta_l). \tag{9b}$$

Solving for x_m and y_m yields the following instrumental observation.

Lemma 1 (*Reward scheme corresponds to a portfolio*). Consider any reward scheme $t(m, \theta)$ for $m \in \{h, l\}$ and $\theta \in \{\theta_h, \theta_l\}$ that the principal offers. For a given report $m \in \{h, l\}$, there is a portfolio endowment

$$\left(x_m \equiv \frac{\theta_h t(m, \theta_l) - \theta_l t(m, \theta_h)}{\theta_h - \theta_l},\ y_m \equiv \frac{t(m, \theta_h) - t(m, \theta_l)}{\theta_h - \theta_l}\right) \tag{10}$$

such that $t(m, \theta) = x_m + y_m\,\theta$ at state $\theta \in \{\theta_h, \theta_l\}$.

Lemma 1 implies that by choosing a report, the analyst essentially chooses between different portfolio endowments. For a risky security price p that the analyst and all market participants take as given, the portfolio (x_m, y_m) that corresponds to reporting m is valued in the market at

$$v(m) \equiv x_m + py_m.$$

Using (10), one obtains

$$v(m) = \frac{(\theta_h - p)t(m, \theta_l) + (p - \theta_l)t(m, \theta_h)}{\theta_h - \theta_l} \quad \text{for } m \in \{h, l\}. \tag{11}$$

I now argue that regardless of the information signal he receives, the analyst's optimal reporting strategy is completely driven to maximize $v(m)$. To see this, consider the analyst's reporting and private portfolio problem in (P1). Using Lemma 1, one can substitute for $t(m, \theta) = x_m + y_m\,\theta$ and rewrite (P1) as choosing $m \in \{h, l\}$ and $(F, d) \in \mathbb{R}^2$ to maximize

$$E[u((d + y_m)\theta + F + x_m) \mid s] \quad \text{subject to } F + pd \leq w_0.$$

Using a transformation $F \equiv K - x_m$ and $d \equiv \tau - y_m$, this problem can be equivalently stated as choosing $m \in \{h, l\}$ and $(K - x_m, \tau - y_m)$ to maximize

$$E[u(K + \tau\theta) \mid s] \text{ subject to } K + p\tau \leq w_0 + v(m). \tag{P2}$$

The effect of a report m on the analyst's problem is only through $v(m)$, which serves as additional wealth to be allocated in an optimal portfolio (K, τ). This observation follows, because subsequent to reporting m, the analyst can always sell the corresponding portfolio (x_m, y_m) *as part* of his private trades and generate a wealth $v(m)$. The analyst can then allocate the wealth $v(m)$ plus any initial wealth w_0 in an optimal portfolio of risky and safe securities as stated in (P2). This property of the reward scheme implies that regardless of the information signal, the analyst chooses the report that maximizes the wealth endowment $v(m)$—as for a given report his reward scheme corresponds to a portfolio traded in the market—and allocates this maximized wealth in an optimal portfolio given the true signal. We have the following optimal reporting and private portfolio choice stated in two parts for ease of exposition.

Proposition 1a. Given a reward scheme $t(m, \theta)$, the analyst reports

$$m^* \in \arg\max_{m \in \{h,l\}} v(m) \text{ for } s \in \{h, l\}.$$

Proposition 1b. Subsequent to reporting $m^* \in \arg\max v(m)$ for $s \in \{h, l\}$, the analyst chooses a portfolio $(K - x_{m^*}, \tau - y_{m^*})$ where $(K, \tau) \in R^2$ maximize $E[u(K + \tau\theta) \mid s]$ subject to $K + p\tau \leq w_0 + v(m^*)$.

Proof. See the Appendix.

Using Proposition 1a, one can explicitly describe the analyst's optimal reporting strategy. The analyst reports $m^* = h$ for both signals if $v(h) > v(l)$, or using the expression for $v(m)$ in (11), if

$$(p - \theta_l)(t(h, \theta_h) - t(l, \theta_h)) > (\theta_h - p)(t(l, \theta_l) - t(h, \theta_l)),$$

and reports $m^* = l$ for both signals if $v(l) > v(h)$, that is, if

$$(\theta_h - p)(t(l, \theta_l) - t(h, \theta_l)) > (p - \theta_l)(t(h, \theta_h) - t(l, \theta_h)).$$

Therefore, the principal cannot make the analyst strictly prefer to report the true signal. To ensure truthful reporting, the principal is restricted to reward schemes for which the market value $v(m)$ of the corresponding portfolio endowment is the same for $m \in \{h, l\}$. Only if $v(h) = v(l)$, the analyst is indifferent and reports the true signal, if he has acquired information *ex ante*.[14] This follows under the standard assumption that when indifferent, the agent reports the truth.

Corollary 1. If the analyst acquires information, he reports the signal truthfully only if $t(m, \theta)$ is set such that $v(h) = v(l)$, that is,

$$(\theta_h - p)(t(l, \theta_l) - t(h, \theta_l)) = (p - \theta_l)(t(h, \theta_h) - t(l, \theta_h)). \tag{12}$$

Flat-wage schemes clearly belong to the set that elicits truthful reporting. The type of schemes $t(l, \theta_l) > 0$, $t(h, \theta_h) > 0$, and $t(h, \theta_l) = t(l, \theta_h) = 0$, which reward the analyst's

[14] As the optimal reporting choice maximizes $v(m)$ regardless of the information signal, an analyst who has not acquired information also reports $m^* = h$, if $v(h) > v(l)$, reports $m^* = l$, if $v(l) > v(h)$, and is indifferent between the two reports if $v(l) = v(h)$.

reporting performance, can also achieve truthfulness provided that $t(h, \theta_h)(p - \theta_l) = t(l, \theta_l)(\theta_h - p)$. However, unlike the case where the analyst cannot trade, such a scheme can no longer make the analyst strictly prefer to report the true signal. In terms of relaxing the *ex post* truthfulness constraints and hence providing "reporting performance-based" incentives for information acquisition, a scheme that ties the analyst's reward to his performance fares no better than a flat-wage scheme.

Corollary 2. The principal *cannot* make the analyst strictly prefer to report the true signal when the analyst privately trades. The *ex post* truthfulness constraints (3) and (4) are binding.

Proof. See the Appendix.

□ **Information acquisition incentives.** The following corollary describes the effect of a reward scheme that ensures truthfulness on the analyst's private portfolio choice problem, and follows from Propositions 1a and 1b.

Corollary 3. A reward scheme that ensures truthfulness serves as fixed additional wealth $v(h) = v(l) = \bar{v}$ that the analyst allocates in an optimal portfolio.

Under a reward scheme that elicits truthful reporting, an informed analyst's optimal risky security position $\tau^*(s)$ is given by

$$\tau^*(s) \in \arg\max E[u(w_0 + \bar{v} + \tau(\theta - p)) \,|\, s] \text{ for } s \in \{h, l\}. \tag{13}$$

An analyst who remains uninformed at the information acquisition stage is also indifferent between the two reports for $v(h) = v(l) = \bar{v}$. For this analyst, the optimal risky security position $\tau^*(n)$, where n again stands for "not informed," must be such that

$$\tau^*(n) \in \arg\max E[u(w_0 + \bar{v} + \tau(\theta - p))]. \tag{14}$$

Accordingly, the analyst *ex ante* prefers to acquire information if and only if

$$\begin{aligned} &\sigma_h E[u(w_0 + \bar{v} + \tau^*(h)(\theta - p)) \,|\, h] + \sigma_l E\,[u(w_0 + \bar{v} + \tau^*(l)(\theta - p)) \,|\, l] - c \\ &\geqslant\ E[u(w_0 + \bar{v} + \tau^*(n)(\theta - p))], \end{aligned} \tag{15}$$

where $\tau^*(h)$ and $\tau^*(l)$ are described by (13) and $\tau^*(n)$ is described by (14). The left-hand side of (15) is the *ex ante* expected utility from acquiring information under a reward scheme $t(m, \theta)$ which induces truthfulness, whereas the right-hand side is the *ex ante* expected utility without information. It is clear from (15) that when the analyst trades on own account, the *ex ante* information acquisition decision is driven only by private portfolio considerations. As *ex post* truthful reporting constraints are binding (Corollary 2), *ex ante* information acquisition incentives are no longer "reporting" based but "private portfolio" based. The analyst *ex ante* acquires information only if he will be holding a large enough position in the risky security, but not because he is *ex post* strictly better off from reporting the true signal.

Corollary 4. When the analyst can privately trade on own account, the *ex ante* information acquisition incentives are driven only by the private portfolio considerations.

To analyze the information acquisition incentives, one needs to focus on the analyst's private portfolio position in the risky security, which depends on his degree of risk aversion. Because a more risk-tolerant agent holds a larger position in the risky security, such an agent values information more (see, for example, Grossman and Stiglitz, 1980 and Peress, 2004). One possibility is that for a given cost and precision of information, the analyst may be sufficiently risk tolerant, so that once employed he has *a priori* incentives of his own to acquire information without requiring any incentives from the principal. In this case, the information acquisition constraint in (15) is satisfied for any $\bar{v} \geq 0$.

The alternative, and perhaps more interesting, case is when the analyst is sufficiently risk averse, and does not have *a priori* incentives of his own to acquire information. In this case, the principal can provide information acquisition incentives only by ensuring that the analyst holds a large enough position in the risky security. This is only possible through a wealth effect, as a reward scheme $t(m, \theta)$ that ensures truthfulness serves as fixed additional wealth $\bar{v}$ that the analyst allocates in an optimal private portfolio (Corollary 3). If the analyst's preferences exhibit decreasing absolute risk aversion (DARA), that is, if $r_A(\omega) \equiv -u''(\omega)/u'(\omega)$ is decreasing in ω, the principal can provide information acquisition incentives by increasing $\bar{v}$ in (15) sufficiently enough.[15] With DARA preferences, the risky security is a normal good: more available wealth to allocate in a portfolio implies a larger position in the risky security. Formally, as $\bar{v}$ increases, the optimal risky security position $\tau^*(s)$ in (13) increases, which, in turn, increases the analyst's *ex ante* expected utility from acquiring information.

I now formalize this argument and describe the optimal reward scheme by considering the specific functional form, $u(\omega) = \omega^{1-a}/(1-a)$, where $0 < a < 1$ for the analyst's preferences. This functional form exhibits DARA; $r_A(\omega) = a/\omega$ is decreasing in ω. The parameter a measures the analyst's risk aversion at a given wealth level: higher values of a imply more risk aversion. To simplify the algebra, I also assume that $\alpha = 1/2$ and $p = E[\theta]$, that is, there is risk-neutral pricing.[16] The following lemma derives the information acquisition decision in (15) in closed form.

Lemma 2. Suppose $u(\omega) = \omega^{1-a}/(1-a)$, $\alpha = 1/2$, and $p = E[\theta]$. The analyst acquires information if and only if

$$\frac{(w_0 + \bar{v})^{1-a}}{1-a}(A(\phi, a) - 1) \geqslant c, \tag{16}$$

where $A(\phi, a) = 2^{1-a}[\phi^{1/a} + (1-\phi)^{1/a}]^a$.

Proof. See the Appendix.

With DARA preferences, the analyst's expected utility gains from acquiring information is increasing in the available wealth $w_0 + \bar{v}$ to allocate in a private portfolio. The constant $A(\phi, a) > 1$ in (16), which measures the value of acquiring information, is increasing in precision ϕ of information and decreasing in analyst's risk aversion a.[17] One can conclude from (16) that it is less costly to provide incentives to acquire information (i) the higher the precision ϕ of information, (ii) the lower the cost c of information, (iii) the more risk tolerant the analyst (lower a), and, (iv) the higher the analyst's initial wealth w_0.

For a given cost and precision of information, the analyst may be initially wealthy enough and/or sufficiently risk tolerant so that he may acquire information at $\bar{v} = 0$. Consider the case when the analyst does not have *a priori* incentives of his own to acquire information and hence $\bar{v} > 0$. To remove the effect of initial wealth, also set $w_0 = 0$. For $u(\omega) = \omega^{1-a}/(1-a)$, $w_0 = 0$, $\alpha = 1/2$, and $p = E[\theta]$, the optimal reward scheme $\hat{t}(m, \theta) \geq 0$ for $m \in \{h, l\}$ and $\theta \in \{\theta_h, \theta_l\}$ is described by

$$\hat{t}(h, \theta_h) + \hat{t}(h, \theta_l) = \hat{t}(l, \theta_l) + \hat{t}(l, \theta_h) = 2\bar{v}, \tag{17a}$$

where

$$\frac{\bar{v}^{1-a}}{1-a} = \frac{c}{A(\phi, a) - 1}. \tag{17b}$$

The expression in (17b) solves the information acquisition constraint in (16) as an equality when $w_0 = 0$. The expression (17a) follows from the truthfulness requirement $v(h) = v(l) = \bar{v}$ in

[15] If the analyst's preferences exhibit constant absolute risk aversion (CARA), the optimal portfolio in the risky security does not depend on wealth. Therefore, if the analyst does *not* have *a priori* incentives of his own to acquire information, that is, if (15) is not satisfied for $\bar{v} = 0$, the principal cannot provide information acquisition incentives to an analyst with CARA preferences by increasing $\bar{v}$.

[16] Assuming $p = E[\theta]$ is not necessary. It just implies that a risk-averse agent with no information does not hold the risky security as there is no risk premium, that is, $\tau^*(n)$ in (14) is equal to zero. This simplifies the algebra.

[17] It can be shown that $\lim_{a\to 0} A(\phi, a) = 2\phi$ and $\lim_{a\to 1} A(\phi, a) = 1$.

(12) when $\alpha = 1/2$ and $p = E[\theta]$. Because a reward scheme that ensures truthfulness serves as a fixed wealth transfer, denoted by $\bar{v}$, that the analyst allocates in a private portfolio, what matters for information acquisition incentives is the size of this transfer. A fixed-wage scheme that satisfies (17a) is also optimal, as well as a scheme which solves (17a) by setting $\hat{t}(h, \theta_l) = \hat{t}(l, \theta_h) = 0$. Unlike the case when the analyst cannot trade, however, the reward schemes based on reporting performance do not fare better than flat-wage schemes to ensure acquisition and truthful revelation of information. Therefore, an implication of the analysis is that recent restrictions in the United States that aim to prevent analysts from privately trading on own account may lead to an increase in the use of explicit incentive schemes based on the analysts' performance.

A comparison of the principal's contracting costs. An implication of the above analysis is that when the analyst privately trades, the cost of ensuring acquisition and truthful revelation of information depends on the analyst's risk aversion parameterized by a. It may prove prohibitively costly to contract with an analyst who is too risk averse.[18] On the other hand, if the analyst is sufficiently risk tolerant, information acquisition incentives can be provided with an expected transfer lower than the case with no analyst trading. Under the assumptions $u(\omega) = \omega^{1-a}/(1 - a)$, $w_0 = 0$, $\alpha = 1/2$, and $p = E[\theta]$, one can provide the following comparison of the principal's optimal contracting costs in the two cases.

Corollary 5. For a given information precision ϕ, the principal's expected contracting cost when the analyst can trade is higher compared to the case with no analyst trading if $a > a^*$ and lower if $a < a^*$, where a^* solves

$$(A(\phi, a) - 1)\phi^{1-a} = \phi - \frac{1}{2}.$$

Proof. See the Appendix.

The above comparison formalizes the argument that the analyst's private trading ability is a bigger problem for the principal if the analyst is very risk averse. This result may seem surprising. One might be tempted to argue that a very risk-averse analyst would not trade the risky security, and therefore his private trading ability is irrelevant. This reasoning, however, does not take into account the fact that the ability to trade does not necessarily imply creating exposure to the risky security. The analyst can simply trade to remove the risk exposure stemming from the reward scheme, and holds only a privately optimal exposure determined by own risk preferences (Proposition 1b). An excessively risk-averse analyst sells the portfolio endowment that corresponds to the reward scheme, and allocates the proceeds of this sale plus any initial wealth almost exclusively in the safe security.[19] In effect, this analyst does not care much to learn more about θ, making it much costlier to provide information acquisition incentives. Therefore, if trading restrictions on analysts are lax, it is better to hire a relatively risk-tolerant analyst who tends to put his money in the security he covers, instead of a more risk-averse analyst who uses his trading ability to reduce his exposure to the security.

As mentioned, some practitioners in the United States favor analysts' ownership in stocks they cover, arguing that this possibility would allow analysts to "put their money where their mouth is" and enhance their credibility. The implicit suggestion in this argument is that an analyst can back up his recommendation by holding the stocks he recommends in a way *observable* to

[18] This can be readily verified from the information acquisition constraint in (16) by noting that $A(\phi, a)$ decreases and approaches 1 as a increases.

[19] In this case, the implication of private trading ability is only to mute the "reporting performance" based channel of providing information acquisition incentives.

the clients.[20] In this article, the analyst's trades are unobservable, and hence cannot be used as a credible mechanism to ensure truthful reporting. Furthermore, the analyst does not necessarily seek exposure to the stock in his private portfolio and may rather use the private trading ability to remove any "contractually imposed" exposure to the stock value. When trades are unobservable, the question becomes whether the analyst will be putting his money in the security he covers.

5. A general separation result

■ This section shows that the optimal reporting and private portfolio strategy in Propositions 1a and 1b generalize to any setting, where for any given report the part of the analyst's reward scheme that depends on the report corresponds to a portfolio endowment traded in the market. Suppose that the risky security return θ is distributed with a general distribution function $F(\theta)$. The realizations of θ are drawn from a generic set Θ. The analyst's private signal s is correlated with θ according to some joint distribution function, and the posterior distribution of θ conditional on s is given by $G(\theta \mid s)$. The signal realizations are drawn from a set S. Denote the analyst's reward scheme by $\pi(m, \theta)$ for $\theta \in \Theta$ and $m \in S$. Without loss of generality, let me write the reward scheme $\pi(m, \theta)$ as

$$\pi(m, \theta) \equiv h(m, \theta) + g(\theta),$$

where $h(m, \theta)$ is the part of the reward scheme that depends on the report. I also include the part $g(\theta)$ independent of m for generality. Upon observing the signal, the analyst issues a report $m \in S$ and privately chooses a portfolio (F, d) on own account. Given the risky security price p, the signal s, the reward scheme $\pi(m, \theta)$ in place, and some initial wealth w_0, the analyst chooses a report $m \in S$ and a private portfolio $(F, d) \in \mathbb{R}^2$ to maximize

$$E[u(h(m, \theta) + g(\theta) + F + d\theta)) \mid s] \text{ subject to } F + pd \leq w_0. \tag{P3}$$

The following assumptions describe the class of reward schemes $\pi(m, \theta)$ for which the separation result holds.

Assumption 1. For every report $m \in S$, there is a portfolio $(\alpha(m), \beta(m))$ such that this portfolio and the reward scheme $h(m, \theta)$ generate the same payoff. Hence, $h(m, \theta)$ can be written as $h(m, \theta) \equiv \alpha(m) + \beta(m)\theta$ where $\alpha(m)$ and $\beta(m)$ are continuous real valued functions of m.

The key implication of Assumption 1 is that for every report m, the part $h(m, \theta)$ of the analyst's reward scheme that depends on the report corresponds to a portfolio endowment $(\alpha(m), \beta(m))$ traded in the market. For a given risky security price p, the portfolio $(\alpha(m), \beta(m))$ is valued in the market at $V(m) \equiv \alpha(m) + p\beta(m)$. Now, define $Z \equiv \arg\max V(m)$ as the set of reports that correspond to portfolio endowments with the maximum market value given security prices. The following technical assumption ensures that the set Z is non-empty.

Assumption 2. The set of messages S is compact. The functions $\alpha(m)$ and $\beta(m)$ are continuous and quasi-concave.

The following proposition states a more general version of the "separation of the optimal reporting strategy from private information" result.

Proposition 2. Suppose the analyst's reward scheme $\pi(m, \theta)$ satisfies Assumptions 1 and 2. For every signal s, the analyst reports $m^* \in \arg\max V(m) \equiv \alpha(m) + p\beta(m)$ and chooses a portfolio $(K - \alpha(m^*), \tau - \beta(m^*))$, where K and τ maximize $E[u(K + \tau\theta + g(\theta)) \mid s]$ subject to $K + p\tau \leq w_0 + V(m^*)$.

[20] For example, Schack (2001) quotes the research head at a major firm saying, "I like seeing stock ownership in the industries, particularly in the names that the analyst recommends. If you are going to recommend it to your clients, then why on earth don't you own it yourself?"

Proof. See the Appendix.

This result again follows, because for different reports, the analyst's reward scheme essentially provides him with portfolio endowments that he can sell at market prices as part of his trades. For every signal realization and independent of the signal's precision, the analyst chooses the report that corresponds to the portfolio endowment with the maximum market value given security prices. The analyst then allocates this maximized wealth plus any initial wealth in an optimal portfolio given the true signal. This optimal reporting choice is based only on public information, whereas the analyst's private information is used for the private portfolio decision. The analyst's optimal report is driven by the market's beliefs, which are embedded in the prevailing security price, and by the specifics of his reward scheme, but not by his private information.

It follows from the above result that when they can privately trade on own account, analysts employed under similar reward schemes can pool and make similar recommendations based on completely different private signals and precisions. The way the optimal reporting strategy ignores private information has a flavor akin to the results found in the literature on "reputation-induced" herding. For example, in a model where analysts are solely concerned with convincing the market of their forecasting accuracy, Trueman (1994) shows that analysts with more precise signals truthfully reveal their information, whereas analysts with low precision mimic the high types.[21] The result also illustrates the inadequacy of explicit incentive schemes with payoff structures similar to the financial claims that the analyst can trade in the market. Such schemes can fail to elicit truthful recommendations, even if they are designed purely to reward the analyst's performance. I now provide a practically and theoretically relevant example of such a performance-based scheme, which fails to elicit any information when the analyst can privately trade on own account.

Scoring rules. Consider a reward scheme of the form $-(m - \theta)^2$ which compensates the analyst based on reporting performance.[22] This type of scheme is known to elicit truthful disclosure of the signal in the absence of any analyst trades (see Bhattacharya and Pfleiderer, 1985; Stoughton, 1993). This scheme satisfies Assumption 1, as it can be written as

$$-(m - \theta)^2 = \underbrace{-m^2 + 2m\theta}_{h(m,\theta)} \underbrace{-\theta^2}_{g(\theta)} .$$

The part of the scoring rule that depends on the report is given by $h(m, \theta) = 2m\theta - m^2$. In the language of Assumption 1, this part corresponds to a portfolio endowment of $\beta(m) = 2m$ shares of the risky security and $\alpha(m) = -m^2$ shares of the safe security. The market value of this portfolio endowment is given by $V(m) = 2mp - m^2$, which has a *unique* maximum at $m^{**} = p$. Therefore, under the scoring rule, the set $Z \equiv \arg\max V(m)$ contains a unique report. From Proposition 2, it follows that when the analyst can trade on own account, the scoring rule fails completely to elicit any information revelation. Regardless of the true signal and the precision of the signal, the analyst always reports $m^{**} = p$ and maximizes $V(m) = 2mp - m^2$.

Proposition 3. Suppose the analyst's reward scheme is given by $-(\theta - m)^2$ and the analyst can privately trade on own account. Then for every signal s, the analyst reports $m^{**} = p$.

The "separation result" crucially relies on the property of the reward scheme in Assumption 1. If this property holds, that is, if for any given report the analyst can always find a portfolio traded in the market that corresponds to the reward scheme, then the principal cannot do any

[21] Another feature that bears some similarity to reputation/career concern-driven environments is that the reporting strategy uses public information, summarized by the prevailing market prices, more than private information. In Ottaviani and Sorensen (2006), the concern for reputation drives experts to herd on the prior belief, as extreme predictions are too likely to be perceived as coming from uninformative signals.

[22] This scheme may be of interest for practical purposes as well. The Institutional Investor All-American Research Team poll, based on a survey of money managers and institutions, ranks analysts on their forecasting performance. This poll is a commonly accepted measure of analysts' standing in the industry.

better than offering a flat-wage scheme in the optimal contract. However, unlike the case with a binary message and state space, the separation result may not necessarily hold in the optimal contract in a general message and state space: the principal may be able to construct reward schemes such that for certain reports, the analyst cannot find a portfolio traded in the market that exactly corresponds to the reward scheme. The preceding analysis implies that in a two-asset framework, to prevent complete separation and ensure some information revelation, the optimal contract should introduce a nonlinearity to the part of the reward scheme that depends on the report, that is, $h(m, \theta)$ cannot be linear in θ. To verify that this nonlinearity would prevent the complete separation of the reporting strategy from the true signal, consider (P3) and suppose that $h(m, \theta)$ is continuous and differentiable in m. By differentiating the objective function in (P3) with respect to d and m, respectively, one obtains the two first-order conditions

$$E[u'(.)(\theta - p) \mid s] = 0 \text{ and } E\left[u'(.)\frac{\partial h(m, \theta)}{\partial m} \,\middle|\, s\right] = 0.$$

When $h(m, \theta)$ (and hence $\partial h(m, \theta)/\partial m$) is *not* linear in θ, the analyst's optimal reporting strategy will rely on s and hence there is no complete separation. The nonlinear component of $h(m, \theta)$ prevents the agent from finding a corresponding portfolio for any given report. Although this article has identified when the analyst's private trading ability results in a reporting strategy that does not use private information at all, the optimal contracting analysis in a general report and message space, and the extent that the principal can ensure information revelation, remain an open question.

6. Conclusion

■ This article analyzes the implications of an analyst's private trading ability for information acquisition and truthful reporting incentives. With a binary message and state space, I show that any reward scheme offered to the analyst corresponds to a portfolio endowment of the risky security he covers and a safe security. By choosing a report, the analyst essentially chooses between portfolio endowments. Taking security prices as given, for every signal, the analyst chooses the report that corresponds to the portfolio endowment with the highest market value. The principal cannot make the analyst strictly prefer to report the true signal. Furthermore, the analyst's information acquisition incentive is driven only by private portfolio considerations. The analyst acquires information only if he will be holding a large enough position in the risky security he covers, but not because he is *ex post* strictly better off from reporting the true signal. The comparison of the optimal contract when the analyst can and cannot trade illustrates that an incentive scheme that rewards the analyst's reporting performance, which is optimal when the analyst cannot trade, does no better than a flat scheme when the analyst privately trades. Therefore, the superiority of incentive schemes based on reporting performance depends on the trading opportunities available to the analyst. The analyst's private trading ability is a bigger problem for the principal if the analyst is too risk averse. If the trading restrictions on analysts are lax, it may be better to hire a relatively risk-tolerant analyst who tends to put his money in the security he covers, instead of a more risk-averse analyst who seeks to hold little exposure to the risky security.

The article also extends the above argument to a general setting, and establishes a separation of the optimal reporting strategy from the private information result. This result applies to any reward scheme where for a given report the part of the reward scheme that depends on the report corresponds to a portfolio that the analyst can trade in the market. Under any such reward scheme, the analyst's optimal reporting strategy is completely separated from his private information.

Appendix

■ The derivation of the optimal contract when the analyst cannot trade, the proofs of Propositions 1a, 1b, and 2, Corollaries 2 and 5, and Lemma 2 follow.

Optimal contract when the analyst cannot trade. First, let us explicitly write the posterior distribution given the signal realization:

$$\Pr(\theta_h \mid h) = \alpha\phi/[\alpha\phi + (1-\alpha)(1-\phi)],$$
$$\Pr(\theta_l \mid l) = (1-\alpha)\phi/[(1-\alpha)\phi + \alpha(1-\phi)]. \tag{A1}$$

Using (A1), the information acquisition constraints (6a) and (7a) can be written as

$$(1-\alpha)\phi[u(t(l,\theta_l)) - u(t(h,\theta_l))] + \alpha(1-\phi)[u(t(l,\theta_h)) - u(t(h,\theta_h))] \geqslant c \tag{A2}$$

and (7a) becomes

$$\alpha\phi[u(t(h,\theta_h)) - u(t(l,\theta_h))] + (1-\alpha)(1-\phi)[u(t(h,\theta_l)) - u(t(l,\theta_l))] \geqslant c. \tag{A3}$$

The principal chooses $t(m,\theta) \geqslant 0$ for $m \in \{h, l\}$ and $\theta \in \{\theta_h, \theta_l\}$ to minimize the *ex ante* expected transfer

$$\phi[\alpha t(h,\theta_h) + (1-\alpha)t(l,\theta_l)] + (1-\phi)[\alpha t(l,\theta_h) + (1-\alpha)t(h,\theta_l)]$$

subject to (A2), (A3), and the participation constraint

$$\sigma_h E[u(t(h,\theta)) \mid h] + \sigma_l E[u(t(l,\theta)) \mid l] - c \geqslant \bar{u} = 0,$$

which is implied by (6a) and (7a). Because $\phi > 1/2$ and hence $\Pr(\theta_l \mid l) > \Pr(\theta_h \mid l)$, one can keep the expected transfer constant and (A3) unchanged, and relax the constraint (A2) by lowering $t(h, \theta_l)$. Similarly, as $\Pr(\theta_h \mid h) > \Pr(\theta_l \mid h)$, one can lower $t(l, \theta_h)$ and relax (A3) while keeping (A2) unchanged. Therefore, the optimal reward scheme must have $t^*(h, \theta_l) = t^*(l, \theta_h) = 0$. To minimize the *ex ante* expected transfer, the principal gives just enough rent compatible with information acquisition. Accordingly, both information acquisition constraints (A2) and (A3) bind in equilibrium. To obtain closed-form expressions for the optimal $t(h, \theta_h)$ and $t(l, \theta_l)$, assume that $u(0) = 0$. Under this assumption, one obtains

$$u(t^*(h,\theta_h)) = c/[\alpha(2\phi - 1)].$$
$$u(t^*(l,\theta_l)) = c/[(1-\alpha)(2\phi - 1)]. \tag{A4}$$

by solving (A2) and (A3) as an equality. *Q.E.D.*

Proofs of Propositions 1a and 1b. To prove that an optimal reporting strategy must maximize $v(m)$ regardless of the true signal, fix any signal $s \in \{h, l\}$ and let $m^* \in \arg\max v(m)$ for $m \in \{h, l\}$. Now suppose, contrary to the claim, that the analyst optimally reports $\bar{m} \notin \arg\max v(m)$ and follows $d^*(\bar{m}, s)$, which is the optimal private portfolio subsequent to reporting $\bar{m}$ at signal s as described in (2). As $\bar{m} \notin \arg\max v(m)$, we have $v(m^*) - v(\bar{m}) = \delta > 0$. Using the portfolios in Lemma 1, one can define $\Delta_x \equiv x_{m^*} - x_{\bar{m}}$ and $\Delta_y \equiv y_{m^*} - y_{\bar{m}}$ and write

$$v(m^*) - v(\bar{m}) = \Delta_x + \Delta_y p = \delta > 0 \tag{A5}$$

$$t(m^*, \theta) - t(\bar{m}, \theta) = \Delta_x + \Delta_y \theta. \tag{A6}$$

I now show that the strategy pair $(\bar{m}, d^*(\bar{m}, s))$ cannot be optimal, as reporting m^* and trading $d^*(\bar{m}, s) - \Delta_y$ gives a strictly higher expected utility conditional on $s \in \{h, l\}$. To prove this, use the definition of analyst's final wealth $\omega(m, d)$ in (1) and write

$$\begin{aligned} \omega(m^*, d^*(\bar{m}, s) - \Delta_y) &= t(m^*, \theta) + (d^*(\bar{m}, s) - \Delta_y)(\theta - p) + w_0 \\ &= \Delta_x + \Delta_y p + \omega(\bar{m}, d^*(\bar{m}, s)) = \delta + \omega(\bar{m}, d^*(\bar{m}, s)), \end{aligned} \tag{A7}$$

which implies $E[u(\omega(m^*, d^*(\bar{m}, s) - \Delta_y)) \mid s] > E[u(\omega(\bar{m}, d^*(\bar{m}, s))) \mid s]$ for any $s \in \{h, l\}$ and contradicts the initial assumption that reporting $\bar{m} \notin \arg\max v(m)$ is optimal. Therefore, the analyst's optimal report must maximize $v(m)$ for every signal as stated in Proposition 1a.

The analyst's problem now reduces to choosing a portfolio (F, d) to maximize $E[u(t(m^*, \theta) + F + d\theta) \mid s]$ subject to $F + pd \leq w_0$. Let $F \equiv K - x_{m^*}$ and $d \equiv \tau - y_{m^*}$. Applying Lemma 1, the problem becomes choosing a portfolio $(K - x_{m^*}, \tau - y_{m^*})$, where K and τ maximize $E[u(K + \tau\theta) \mid s]$ subject to $K + p\tau \leq w_0 + v(m^*)$ as stated in Proposition 1b. *Q.E.D.*

Proof of Corollary 2. First consider (2) in the text that describes the analyst's optimal portfolio after observing $s \in \{h, l\}$ and reporting $m \in \{h, l\}$. Using Lemma 1, one can substitute for $t(m, \theta) = x(m) + y(m)\theta$ and rewrite (2) as

$$\tau^*(m, s) \in \arg\max E[u(v(m) + w_0 + \tau(\theta - p)) \mid s] \tag{A8}$$

for $m \in \{h, l\}$ and $s \in \{h, l\}$. Similarly, using Lemma 1 and the above definition of $\tau^*(m, s)$ in (A8), the two truthfulness constraints at $s = h$ and $s = l$, given by (3) and (4) in the text, can be respectively written as

$$E[u(v(h) + w_0 + \tau^*(h,h)(\theta - p)) \mid h] \geq E[u(v(l) + w_0 + \tau^*(l,h)(\theta - p)) \mid h]$$

$$E[u(v(l) + w_0 + \tau^*(l,l)(\theta - p)) \mid l] \geq E[u(v(h) + w_0 + \tau^*(h,l)(\theta - p)) \mid l].$$

Proposition 1a shows the above truthfulness constraints can only be satisfied if $v(h) = v(l)$. But from (A8), notice that $v(h) = v(l)$ implies $\tau^*(h, h) = \tau^*(l, h)$ and $\tau^*(l, l) = \tau^*(h, l)$. Therefore both of the above constraints, and hence (3) and (4) in the text, are binding. *Q.E.D.*

Proof of Lemma 2. Consider (13), which describes the optimal risky security portfolio when the analyst observes $s = h$. For $u(\omega) = \omega^{1-a}/(1-a)$, $\alpha = 1/2$, and $p = E[\theta]$, the problem in (13) can be written as choosing τ to maximize

$$\frac{\phi(w_0 + \bar{v} + \tau(\theta_h - p))^{1-a}}{1-a} + \frac{(1-\phi)(w_0 + \bar{v} - \tau(p - \theta_l))^{1-a}}{1-a}.$$

This maximization yields

$$\tau^*(h) = \frac{2(z-1)(w_0 + \bar{v})}{(z+1)(\theta_h - \theta_l)},$$

where $z \equiv (\phi/(1-\phi))^{1/a}$. The derivation for $\tau^*(l)$ is similar and yields

$$\tau^*(l) = -\frac{2(z-1)(w_0 + \bar{v})}{(z+1)(\theta_h - \theta_l)}.$$

Consider now the uninformed analyst's portfolio problem in (14) for any concave $u(.)$. When $p = E[\theta]$ and $\alpha = 1/2$, the optimal $\tau^*(n)$ must solve the first-order condition

$$u'(w_0 + \bar{v} + \tau^*(n)(\theta_h - p)) = u'(w_0 + \bar{v} - \tau^*(n)(p - \theta_l)), \tag{A9}$$

which yields $\tau^*(n) = 0$. With risk-neutral pricing, an uninformed and risk-averse agent does not hold exposure to the risky security, as there is no risk premium. Now substitute the optimal risky security portfolios $\tau^*(h)$, $\tau^*(l)$, and $\tau^*(n)$ into (15). As $\alpha = 1/2$, we have $\sigma_h = \sigma_l = 1/2$. After simplification, the analyst acquires information if and only if

$$\frac{(w_0 + \bar{v})^{1-a}}{1-a}\left[\phi\left(\frac{2z}{z+1}\right)^{1-a} + (1-\phi)\left(\frac{2}{z+1}\right)^{1-a} - 1\right] \geq c. \tag{A10}$$

The expression in the square brackets can be simplified further by substituting for $z \equiv (\phi/(1-\phi))^{1/a}$. First note that

$$2^{1-a}\left(\frac{\phi z^{1-a} + (1-\phi)}{(z+1)^{1-a}}\right) = 2^{1-a}\left(\frac{\phi\left(\frac{\phi}{1-\phi}\right)^{\frac{1}{a}-1} + (1-\phi)}{\left(\left(\frac{\phi}{1-\phi}\right)^{\frac{1}{a}} + 1\right)^{1-a}}\right) = 2^{1-a}[\phi^{1/a} + (1-\phi)^{1/a}]^a.$$

Defining $A(\phi, a)$ as in the lemma, one arrives at (16). *Q.E.D.*

Proof of Corollary 5. The principal's expected contracting cost when the analyst privately trades is simply given by $\bar{v}$ in (17b). Consider the optimal reward scheme when the analyst *cannot* trade, as described in (A4). For $u(\omega) = \omega^{1-a}/(1-a)$ and $\alpha = 1/2$, this optimal scheme implies an expected contracting cost

$$\phi\left(\frac{2c(1-a)}{2\phi - 1}\right)^{\frac{1}{1-a}}. \tag{A11}$$

The principal's expected contracting cost is higher when the analyst privately trades if $\bar{v}$ in (17b) is higher than (A11), which, after simplifying, implies

$$\phi - \frac{1}{2} > (A(\phi, a) - 1)\phi^{1-a}. \tag{A12}$$

For a given ϕ, the left-hand side of (A12) is constant, whereas the right-hand side is monotone decreasing in a. For $a = 1$, the right-hand side equals zero and hence (A12) is satisfied, whereas for $a = 0$, the right-hand side equals $(2\phi - 1)\phi > \phi - \frac{1}{2}$ and hence (A12) is not satisfied. Therefore, the principal's expected contracting cost when the analyst privately trades is higher compared to the case with no analyst trading if $a > a^*$ and lower if $a < a^*$, where a^* solves $(A(\phi, a) - 1)\phi^{1-a} = \phi - \frac{1}{2}$. *Q.E.D.*

Proof of Proposition 2. I first show that for all s, the optimal report m^* must belong to the set $Z \equiv \arg\max V(m) \equiv \alpha(m) + p\beta(m)$. Suppose, for a contradiction, that there is a signal s' such that $(\bar{m}, \bar{d})$ is optimal and $\bar{m} \notin Z$. This implies, by Assumption 2, that there is a report $m^* \in Z$ such that $V(m^*) - V(\bar{m}) \equiv \delta > 0$. Now define $\Delta_\alpha \equiv \alpha(m^*) - \alpha(\bar{m})$ and $\Delta_\beta \equiv \beta(m^*) - \beta(\bar{m})$, and note that

$$V(m^*) - V(\bar{m}) = \Delta_\alpha + \Delta_\beta p = \delta > 0 \text{ and } h(m^*, \theta) - h(\bar{m}, \theta) = \Delta_\alpha + \Delta_\beta \theta. \tag{A13}$$

I now show that $(m^*, \bar{d} - \Delta_\beta)$ is a strictly better strategy than $(\bar{m}, \bar{d})$. To prove this, first let me write the analyst final wealth as $W(m, d) \equiv h(m, \theta) + d(\theta - p) + g(\theta) + w_0$. By Assumption 1 and (A13), we have

$$W(m^*, \bar{d} - \Delta_\beta) = \Delta_\alpha + \Delta_\beta p + W(\bar{m}, \bar{d}) = \delta + W(\bar{m}, \bar{d}), \tag{A14}$$

which proves that $E[u(W(m^*, \bar{d} - \Delta_\beta)) \mid s'] > E[u(W(\bar{m}, \bar{d})) \mid s']$ and contradicts the initial assumption that $(\bar{m}, \bar{d},)$ is optimal at signal s'. As the signal s' was arbitrarily chosen, it follows that for all $s \in S$ the optimal m^* must belong to Z. The analyst's problem now reduces to choosing (F, d) to maximize $E[u(h(m^*, \theta) + g(\theta) + F + d\theta) \mid s]$ subject to $F + pd \leq w_0$. Let $d \equiv \tau - \beta(m^*)$ and $F \equiv K - \alpha(m^*)$. Using Assumption 1, the problem becomes choosing $(K - \alpha(m^*), \tau - \beta(m^*))$, where K and τ maximize $E[u(K + \tau\theta + g(\theta)) \mid s]$ subject to $K + p\tau \leq w_0 + V(m^*)$, as stated in the proposition. *Q.E.D.*

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