Motivational versus Informational Financial Ratings

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November 28, 2025

Abstract

We study how the funding structure of financial intermediaries affects the type of information they produce and its real effects. When ratings are sold to investors, they resolve uncertainty about firm fundamentals ("informational ratings"); when sold to issuers, they bundle signals about fundamentals and managerial effort ("motivational ratings"). Motivational ratings increase effort incentives but may be crowded out by informational ratings in highly liquid markets. With enough uncertainty, ratings can provide implicit incentives such that an insider's exit does not matter – the "time-horizon irrelevance" result. More broadly, it provides a unified framework for analyzing the real effects of financial information design.

Keywords: corporate governance, crowding-out effect, information acquisition, short-termism.

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1 Introduction

Information about firms is not freely available. It must be produced and financed. In modern capital markets, this task is often delegated to intermediaries such as credit rating agencies, equity research providers, and ESG rating agencies. These intermediaries operate under distinct business models: their ratings will be financed either by issuers or by investors.[1] This distinction matters because issuers and investors value information for fundamentally different reasons. investors would like to better assess firm value, whereas issuers would like to improve firm value. Understanding how these different business models affect the type of information produced, and how that in turn affects firm behavior and market efficiency, is central to the economics of information intermediation.

This paper develops a unified framework to analyze the design and funding of financial ratings. We study how a profit-maximizing rating agency endogenously determines what type of information to produce, specifically information that motivates managerial effort or information that reduces uncertainty about firm fundamentals, and who finances it. The analysis delivers a novel characterization of equilibrium "motivational" versus "informational" ratings, and identifies when each arises as the optimal business model. We highlight a new trade-off: informational ratings improve market efficiency but depress output, while motivational ratings raise firm value by increasing managerial effort. Thus, we uncover a new dimension of inefficiency distinct from rating bias: the most informative rating design, which is unbiased and may arise in equilibrium, results in low output.

We show that an issuer-funded motivational rating, which is a public signal that aggregates information about both managerial effort and firm type, maximizes firm value. However, when stock markets are highly liquid or corporate insiders have long-term horizons, a rating agency will optimally cater to investors by selling informational ratings that minimize uncertainty about firm value but provide limited incentives for value creation. Thus, financial market liquidity and the horizon of corporate insiders jointly determine whether financial information serves a motivational or purely informational role. Paradoxically, in sufficiently liquid markets, "bad information" (i.e., information that maximizes trading profits but not firm output) can crowd out "good information".

Our analysis is motivated by some empirical and conceptual puzzles. Despite well-documented biases in issuer-paid credit ratings (Skreta and Veldkamp (2009), Bolton, Freixas, and Shapiro (2012)), many forms of financial information, including credit ratings and underwriter research, continue to be funded by issuers. At the same time, investor-funded ratings and information, including ESG ratings and independent equity research, have proliferated. Why do different

[1]Credit ratings are purchased by firms that issue debt securities; equity research by large investment banks is often widely disseminated and either directly or indirectly paid for by issuers (e.g. via investment banking fees); smaller independent research firms and brokerages also produce equity research which is either directly or indirectly sold to their investor clientele (e.g. via trading fees); likewise, ESG ratings are purchased by investors.

market segments adopt different funding models, and what are their real effects?

When investors pay, the rating agency optimally designs a rating that maximizes their trading advantage. They only value information that reduces uncertainty. The resulting informational rating maximizes stock price informativeness but results in low effort incentives. When issuers pay, the agency instead designs a rating that is sensitive to managerial effort as well as firm type. Such a motivational rating improves effort incentives by increasing the extent to which equilibrium stock prices reflect managerial actions. Importantly, a rating that were not informative about the unknown firm type would be ignored by market participants, would have no price impact, and would therefore fail to generate any effort incentives. As a result, the rating agency must bundle information about fundamentals and effort into a single signal.

This endogenous information design yields several novel implications. First, we highlight a new cost of stock market liquidity.[2] Greater liquidity raises the profitability of investor-funded information production, which may substitute for motivational ratings. This substitution depresses effort incentives and lowers output, all the more that the insider has a short-term horizon and cares more about the stock price. Thus, by altering the nature of financial information, highly liquid markets may improve informational efficiency at the expense of value creation.

Second, uncertainty about firm fundamentals can mitigate short-termism. When uncertainty is sufficiently large, a properly designed rating can provide implicit effort incentives such that the equilibrium effort matches the level attainable when the insider can commit to effort. This is achieved when the rating places a slightly greater weight on effort than a rating that merely reflects firm output. We obtain this result even though the insider might need to sell his shares in the short-term, before the effect of his effort materializes. We call this the *time horizon irrelevance* result. It implies that corporate insiders with a medium-term horizon, such as venture capitalists which fund early-stage firms with long-term projects, may not necessarily underinvest in effort. This contrasts from standard frameworks without information design such as Faure-Grimaud and Gromb (2004) and Chemla and Hennessy (2014), where the possibility of exit or sale always decreases effort incentives, so that the equilibrium effort is always lower than when the insider can commit.

We consider a firm managed by an "insider" who exerts costly effort to increase firm output but may need to sell his stake at an interim date, as in Faure-Grimaud and Gromb (2004). This can be interpreted as the stochastic "exit" of founders, managers, or involved shareholders such as venture capitalists. Firm output depends on the insider's effort and a source of uncertainty that we call the "firm type".[3] The firm's shares are traded at an interim date on a financial market in the spirit of Kyle (1985), with a potentially informed speculator who trades alongside liquidity traders, and a market maker. The insider, who might need to sell his shares, cares

[2]The literature has already identified some costs of financial market liquidity, including inadequate internal monitoring (Bhide (1993)), and liquidations that lead to financial contagion (Allen and Gale (2000)).

[3]We are agnostic about the source of uncertainty, whether it relates to fundamental firm value or uncertainty about the insider's characteristics such as his ability to make investment decisions.

about the firm's output and about its market valuation. He may not internalize all the benefits of his effort, depending on the extent to which the market price reflects his actual effort.

A rating agency observes noisy signals about each component and can design a single rating as a linear combination of the two signals, as in in Hörner and Lambert (2021). The agency chooses both the information weights and its business model (whether to sell ratings to the issuer or to investors) to maximize profits.

If the rating is sold to the speculator, it is purely informational: it reveals only firm type. Intuitively, the speculator is willing to pay for the rating to the extent that it increases her informational advantage. In particular, she is not interested in purchasing information to better learn the manager's effort, since effort is correctly anticipated in equilibrium.[4] This is the most informative rating design, but also the one that minimizes the insider's effort.[5]

If the issuer pays for a rating, it is communicated to all market participants and it aggregates both dimensions, striking a balance between informativeness and motivational power. When uncertainty about firm value is large enough, the equilibrium rating weight is such that the level of effort induced is the same as if the insider could commit to effort. Intuitively, the rating agency caters to the issuer, and the level of effort under commitment is his preferred outcome. Moreover, large enough uncertainty increases the stock price impact of the rating, which makes it possible to provide sufficiently strong implicit incentives.

When stock markets are very liquid, the rating agency optimally sells an informational rating to the speculator. Indeed, the speculator values private information all the more that she can profitably trade on this information, which is easier in more liquid markets. While this maximizes the agency's profits, this also results in low output.

In an extension, we show that competition between private rating agencies reinforces this pattern: when an informational rating can be produced cheaply, it may drive out motivational ratings even if the latter would raise output. Intuitively, an informational rating is already very informative about firm value, which reduces the price impact and therefore the effectiveness of a hypothetical motivational rating. In short, *bad information drives out good information*. This captures the idea that information most valuable for trading can crowd out information that encourages real activity.

In this context, it would be welfare-improving if the availability of a "good rating" crowded out the production of other (bad) information. This is possible if the cost of information production is sufficiently high. This is in contrast to the well-known result that disclosure can crowd

[4]That effort is correctly anticipated is not crucial for our results. What matters is the distinction between information that improves incentives and information that resolves uncertainty. In an extension in which the insider's effort is uncertain, we show that an informational rating rating will instead be informative about effort but it will still not motivate effort.

[5]In our baseline model, an informational rating places zero weight on effort. This is not because it would be more expensive for the rating to also be sensitive to effort – the agency receives signals for free. Instead, this is because a rating that also puts some weight on the signal about effort would be more noisy and therefore less informative about the firm type.

out (good) information acquisition by investors (e.g. Verrecchia (1982), Goldstein and Yang (2017)).[6]

The theory extends beyond explicit "ratings". It applies to any setting where intermediaries produce information about firms: investment banks underwriting Initial Public Offerings (IPOs), external auditors certifying private company reports,[7] or ESG rating agencies evaluating sustainability performance. In each case, our framework predicts when information design will have real effects and when it will simply facilitate trading.

For example, ESG ratings, which are sold to investors, may emphasize corporate exposure to sustainability risks but do little to motivate firms to improve their actual social and environmental impact. This is consistent with the methodologies currently used by leading ESG rating agencies.[8] Conversely, issuer-oriented ESG certification can act as a commitment device that encourages socially beneficial investment, though it may be crowded out in highly liquid markets. In an extension, we show that (currently emerging) "impact funds"[9] will generate social impact not because of their investment decisions, but through their influence on the design of financial information, such as ESG ratings. This is a new channel in the literature on socially responsible investments (Edmans, Levit, and Schneemeier (2023), Oehmke and Opp (2025)).

The results have regulatory implications. Our analysis revisits the policy debate on how rating agencies should be funded (Hayward and Boeker (1998), Benmelech and Dlugosz (2010), Bolton, Freixas, and Shapiro (2012), Kraft (2015)). Conventional wisdom holds that issuer-paid ratings will be more biased than investor-paid ratings. Our model identifies a countervailing inefficiency: investor-paid ratings will be excessively informative about fundamentals and insufficiently motivational, which reduces economic output. Regulatory efforts to promote investor-

[6]It is also related to the more recent result that public information can crowd in voluntary disclosure (Banerjee, Marinovic, and Smith (2024)).

[7]Whereas audit reports of public companies must adhere to strict regulatory requirements, audit reports of private companies are more flexible and can be tailored to the specific needs of the firm. For example, the information disclosed can include a combination of GAAP earnings and non-GAAP earnings (Leung and Veenman (2018)). The types of risks assessed and the procedures used for risk assessment must be determined (Knechel et al. (2013)). The audited information can also be presented with various levels of complexity and disaggregation (Chen, Miao, Shevlin (2015), Hoitash and Hoitash (2018), Noordermeerb and Vorst (2024)). These degrees of freedom may allow to shift the extent to which the audit reflects insider effort rather than firm type, which is equivalent to shifting rating weights. These audit reports can be kept private, privately shared with some investors, or made publicly available.

[8]The ratings of a prominent agency, MSCI take into account the risk exposure of the firm rather than its social or environmental impact: "Our ratings provide insight into how companies within a given industry compare with one another based on their exposure to, and management of, financially relevant, sustainability-related risks." https://www.msci.com/data-and-analytics/sustainability-solutions/esg-ratings. Morningstar uses very similar language to describe its ESG ratings (https://www.sustainalytics.com/esg-data). Institutional Shareholder Services (ISS) mentions that "Our research is instrumental in helping investors minimize sustainability risks, comply with evolving regulatory and stakeholder requirements and seize opportunities." (https://www.issgovernance.com/sustainability/ratings/)

[9]The modern Socially Responsible Investing (SRI) approach dates back to the 1970s, whereas the distinct category of "impact investing" was institutionalized only in the mid-2000s and consolidated by industry reports around 2010 (Agrawal and Hockerts (2021), Martini (2021)). It fundamentally differs from the ESG approach to SRI (Foroughi (2022)).

funded ratings or increase disclosure should therefore weigh the trade-off between informational accuracy and motivational power.

The time horizon irrelevance result can shed light on the business model of venture capitalists and its limitations. These shareholders with a short investment horizon are actively involved in the firms in their investment portfolio (Hellmann and Puri (2002), Bernstein, Giroud, and Townsend (2016)). They primarily target young firms in industries undergoing technological revolutions, which tend to be subject to a lot of uncertainty (Gompers and Lerner (2001), Janeway, Nanda, and Rhodes-Kropf (2021)). This narrow focus has been deplored by Lerner and Nanda (2020). However, our results suggest that a *partial* generalization of this model, such as venture capital investments in more mature industries, or short-term private equity investments in mature companies that need key shareholders to be actively involved, might lead to worse outcomes. Indeed, since there is not enough uncertainty about these firms, financial information cannot be designed to offset the effort-reducing effect of a short-term horizon. The time horizon irrelevance result can also contribute to explain the apparently puzzling fact noted by Lerner and Nanda (2020) that the time horizons of venture capital funds do not vary depending on the type of firms financed, even though "great diversity across industries exists in terms of the typical project length."[10]

Finally, the result that effort incentives with endogenous information design can be as high as when the insider can commit to effort has implications for security design and capital structures. When uncertainty is sufficiently high that the outcome preferred by the insider is achievable, there is no role for debt issuance – in contrast to standard models of moral hazard which predict that firms will issue debt (Innes (1990), Townsend (1979), Hart and Moore (1998)). This can help explain why many firms with high market-to-book ratios operate with little or no debt.[11]

2 Related literature

We contribute to the literature on endogenous information production and disclosure in financial markets. Admati and Pfleiderer (1986, 1988) analyze how an informed agent should sell some exogenously given information. This started a large literature (Admati, Pfleiderer, and Zechner (1994), Fulghieri and Lukin (2001), Peress (2010), Ferreira, Manso, and Silva (2014), Dasgupta and Matthews (2024)). We extend this literature by analyzing not only how much information is produced but also which kind and for whom.

In our model, the rating agency does not care about the actions taken by the firm or about

[10]Their tentative explanations for this puzzling fact involve historical norms and conflicts of interest between limited partners and general partners.

[11]Strebulaev and Yang (2013) find that many firms do not issue any debt. They note that firms with zero leverage tend to have higher R&D expenses and higher market-to-book ratios. Market-to-book ratios are usually viewed as a proxy for growth opportunities, which involve more uncertainty than established assets. This is in line with the implication from our model that issuing securities other than equity is not beneficial when information is designed for the issuer and there is enough uncertainty about firm type.

its output, instead it is designing information to maximize its profits. This differs from a pure information design problem, in which the information designer cares about actions or outcomes (Bergemann and Morris (2019)). In particular, in Hörner and Lambert (2021), the rating is designed to maximize the social surplus, which is equivalent to maximizing effort. In our model, the equilibrium rating weights generally differ from the rating weights that induce first-best effort. Moreover, when there is enough uncertainty, the rating weight could be such that effort is above the first-best level, so that maximizing the social surplus is not equivalent to maximizing effort.

Pollrich and Strausz (2024) analyze a model with a seller and a buyer of information, and show that the fee structure is irrelevant. In their model, differences in transparency do not affect economic efficiency. In our model, by contrast, there are several potential buyers for the information, and differences in transparency affect economic efficiency via the insider's effort choice. Saeedi and Shourideh (2024) study the optimal design of a rating when it is sold to a given third party. In their model, the rating provider observes only one signal, whereas the combination of two different signals in the rating is crucial in our model.

In a model of certification, Stahl and Strausz (2017) point out that a buyer and a seller use information for different purposes, inspection and signaling. There is also a dual purpose in our model, where the speculator and the insider are interested respectively in learning the firm type and setting appropriate effort incentives. In their model, certification does not have implications for effort. Bouvard and Levy (2018) also consider a model of certification in which the certifier chooses accuracy to maximize its profits. In their model, certification is informative about one dimension, "quality", whereas in our model the rating can depend on effort and firm type. Faure-Grimaud, Peyrache, and Quesada (2009), Daley, Green, and Vanasco (2020), and Kashyap and Kovrijnykh (2016) consider contracting with ratings in models without effort from firm insiders or originators and uni-dimensional ratings that are informative about the asset type. In our model, ratings can also be informative about the insider's effort.

Many papers study the optimal weights to put on various signals to encourage effort in a principal-agent framework (e.g. Banker and Datar (1989), Paul (1992), Datar, Kulp, and Lambert (2001)). In our model, the optimal rating is a combination of two signals, and only one of these two signals is informative about effort. The other signal is unrelated to effort, and it is not useful to reduce the risk borne by the insider since all agents are risk neutral.

Despite the fact that information about firms is multidimensional, ratings are often uni-dimensional. Our model can help explain this puzzle for financial ratings, especially ratings which are sold to issuers such as credit ratings.[12] As in Hörner and Lambert (2021), a rating that were just informative about effort would be ignored, and a rating that were just informative

[12]In our model, aggregation matters for a rating to affect the stock price and incorporate the insider's actual effort. Aggregation does not matter for a rating that just improves the speculator's information. This is consistent with the fact that information in ratings sold directly to investors is presented in aggregated and disaggregated form – in ESG ratings and ESG scores, respectively.

about firm value would not improve aggregate surplus. This contributes to a literature that studies properties of ratings.[13]

The finance literature has focused on credit ratings. In the models of Manso (2013) and Goldstein and Huang (2020), credit ratings have real effects because they affect the probability of default of the borrower, which results in a feedback loop. Bolton, Freixas, and Shapiro (2012) study conflicts of interest in credit rating agencies, including their reliance on fees from firms, and the ability of firms to selectively purchase ratings. In this context, they show that ratings can be inflated, and that competition between rating agencies can reduce efficiency by encouraging ratings shopping. Ratings shopping and selective disclosure is also studied in Sangiorgi and Spatt (2017), and competition between credit rating agencies is studied in Doherty, Kartasheva, and Phillips (2012). The notion that credit rating agencies cater to issuers is supported by empirical studies (Griffin, Nickerson, and Tang (2013), Kraft (2015)).[14]

A more recent literature focuses on ESG ratings. In a closely related paper where investors have heterogeneous preferences for socially responsible investments, Olivier and Lovo (2025) study who should pay for ESG ratings. An important difference is that there is no effort decision in their model. They show that the rating is publicly disclosed when socially responsible investors predominate, so that public disclosure of the firm's nonfinancial performance tends to increase the stock price, whereas it is sold directly to socially responsible investors when they are a minority, so that public disclosure could decrease the stock price. Azarmsa and Shapiro (2023) study whether competing ESG rating agencies that can gather information about different dimensions of ESG performance (e.g. social or environmental) will generalize or specialize. Specialization maximizes the transmission of information and maximizes value, but it may not be an equilibrium outcome in their model. In our model, specialization is not an equilibrium outcome with two rating agencies, because a highly informative rating ("bad information") renders irrelevant a rating that depends on the insider's effort.

Our paper is related to the large literature on the real effects of financial markets, reviewed by Bond, Edmans, and Goldstein (2012) and Goldstein (2023). The outcome with highly informed investors and low economic efficiency (low effort by the firm insider) that we describe is reminiscent of the result by Dow and Gorton (1997) that the economy may be stuck in a bad equilibrium with informationally efficient markets and depressed corporate investment. However, the mechanism at play is very different. In Dow and Gorton (1997), this inefficiency is possible because managers learn from prices, as in the literature on feedback effects. In our

[13]Even though they are less precise, discrete ratings can be justified because they preclude rating inflation (Goel and Thakor (2015)), or because they reduce the probability of misinterpretation (Martel, van Wesep and van Wesep (2022)).

[14]Mathis, McAndrews, and Rochet (2009) and Bar-Isaac and Shapiro (2013) study the reputational concerns of these agencies. Alessio and Shapiro (2022) study how the market for credit risk has a disciplinary effect on credit rating agencies. Opp, Opp and Harris (2013) study the biases that may arise when ratings are also used for regulatory purposes. Fulghieri, Strobl, and Xia (2014) show that credit rating agencies can benefit from the possibility of issuing unsolicited ratings at no fee, by using it as a threat to extract higher fees. Alissa et al. (2013) and Cohn, Rajan, and Strobl (2025) study credit ratings when the issuer can manipulate information.

model, the information in stock prices matters because it has implication for effort incentives.

The model is also related to the literature on exit as a governance mechanism (Admati and Pfleiderer (2009), Edmans (2009), Edmans and Manso (2011), and Cvijanović, Dasgupta, and Zachariadis (2022)). In these models, shareholders can sell their shares, which disciplines the manager – as opposed to the discipline imposed by shareholders' internal monitoring (Bhide (1993)). In our model, the "insider" can take actions to improve firm value but might need to sell his shares.

Thus, the paper is related to the literature on short-termism. This literature examines the possibility of short-termism (Narayanan (1985), Stein (1989), and Von Thadden (1995)), how to prevent short-termism (with contracting in Marinovic and Varas (2019), with monitoring in Von Thadden (1995)), and the endogenous determination of investment horizons (Gryglewicz, Mayer, and Morellec (2020), Hackbarth, Rivera, and Wong (2021), Thakor (2021)). By contrast, we take the insider's horizon as given and we study its consequences for value creation when ratings are optimally determined. Our time horizon irrelevance result offers a new perspective: a short-term horizon is not necessarily detrimental when there is enough uncertainty about firm value and information is optimally designed. In Bolton, Scheinkman, and Xiong (2006), when stock prices deviate from their fundamental values, corporate short-termism can be optimal to take advantage of erroneous investor beliefs. In our model, all market participants have rational expectations and unbiased beliefs.

The adaptation of Gresham's law to the economics of information, the notion that bad information can drive out good information, was already proposed by Varian (1998) in another context. He argued that "Cheap, low quality information on the Internet can cause problems for providers of high-quality information." Instead, we are pointing out that the preferred information of investors and market participants focuses on reducing uncertainty rather than encouraging value-improving actions. Consequently, their demand for information may lead to the production of information that results in low economic output, in part because it makes irrelevant information that affects incentives and output.[15]

3 Model

3.1 The firm

A firm is owned and managed by an "insider" who exerts effort to improve its output. The insider initially owns a fraction $1 - \delta$ of the shares, such that he has effective control of the firm. As in Faure-Grimaud and Gromb (2004), the insider can be viewed as an entrepreneur

[15]This is also related to the Hirshleifer effect that releasing information can prevent efficiency gains from optimal risk sharing (Hirshleifer (1971)). In our model, it is crucial that information can be obtained on two dimensions (effort and the firm type), whereas the Hirshleifer effect only relies on information about the asset type.

who founded or purchased the firm, or as an involved shareholder such as a venture capitalist. The output of the firm, which is realized at $t = 2$, is given by:

$$\tilde{X} \quad = \quad A + \tilde{\theta}. \tag{1}$$

where A is the insider's effort, and θ is the firm's "type". The latter should be interpreted broadly: it includes any source of uncertainty about firm output, whether this uncertainty depends on the firm itself or the insider's characteristics such as his ability.[16] In any case, information about θ is symmetric.[17] Effort A is unobservable and optimally chosen by the insider at $t = 0$. The firm type θ, which is unknown at $t = 0$, is drawn from a normal distribution with mean $\bar{\theta}$ and variance σ_θ^2. The realization θ of the random variable $\tilde{\theta}$ is unobservable. Effort is privately costly for the insider, with a monetary cost of $C(A)$, with $C' > 0$, $C'' > 0$, $C(0) = 0$, and $C'(0) = 0$.

3.2 Financial market

Trading occurs at $t = 1$. The financial market is in the spirit of Kyle (1985). In addition to the insider, who may or may not trade as specified below, it involves three economic agents:

- Noise traders submit a random market order $\tilde{u}$, which is normally distributed with mean 0 and variance σ_u^2 and is independent of the firm type $\tilde{\theta}$.
- A risk-neutral speculator obtains information about the firm by observing a rating $\tilde{R}$, then she submits a market order $q(R)$.
- A competitive and risk-neutral market maker observes whether the insider is hit by a liquidity shock as well as the total order flow. He may observe the rating or not, depending on the business model chosen by the rating agency. He sets the price of the asset to its expected value given his information.

As in Faure-Grimaud and Gromb (2004), with probability $\pi \in (0, 1]$, the "insider" is hit by a publicly observable liquidity shock at $t = 1$ and sells his shares in the firm.[18] The model allows for $\pi = 1$, in which case the insider has a fixed investment horizon of $t = 1$. As in Faure-Grimaud and Gromb (2004), the insider's trade is observable and cannot be anonymous.

The game is sequential: the insider and the informed speculator submit market orders, then the market maker sets the market price p depending on the aggregate order flow.

[16] We interpret output as firm profits, but other interpretations are also possible. For example, if some economic agents also have nonpecuniary preferences, "effort" could represent actions that improve social and environmental outcomes. We explore this possibility in section 8.4.

[17] If θ is interpreted as the manager's ability, this is consistent with a standard model of career concerns, where the agent's ability is unknown ex-ante.

[18] As in Faure-Grimaud and Gromb (2004), this assumption allows to abstract from adverse selection issues that could lead to a market breakdown when initial owners have private information about firm value.

3.3 Rating

A rating agency observes two signals at $t = 1$, one about effort and the other about the firm type:

$$\tilde{S}_1 = A + \tilde{\varepsilon}_1 \quad (2)$$

$$\tilde{S}_2 = \theta + \tilde{\varepsilon}_2 \quad (3)$$

where θ is the realization of $\tilde{\theta}$; for $i \in \{1, 2\}$, $\tilde{\varepsilon}_i$ follows a standard normal distribution and is independent from other random variables. The unit variance assumption is to simplify expressions (it is not crucial and could be relaxed). The rating agency designs the rating R to maximize its expected profits. It chooses the rating design at $t = 0$ and reveals the rating R at $t = 1$, as specified in subsection 4.1 below. Below we will consider different "business models" for the rating agency, depending on whether it sells its rating to the firm ("the issuer") or to the speculator.

The timeline of events is summarized in Figure 1.

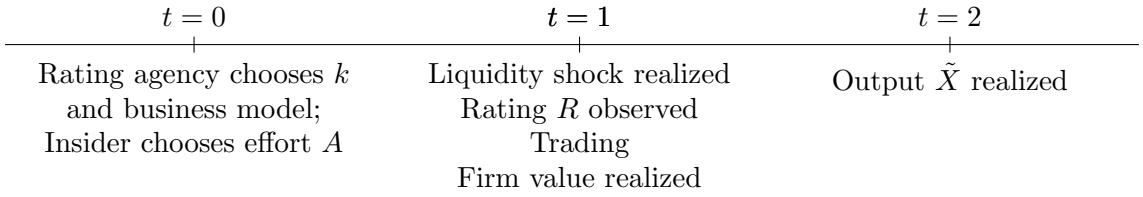


Figure 1: Timeline of the model.

4 Preliminaries

4.1 Rating design

The objective of the rating agency is to maximize revenues from its ratings. Ratings matter because they change the beliefs of market participants (the speculator and the market maker) about firm value. We start by ruling out a simple rating design that maximizes information revelation. Selling two ratings which involve linearly independent combinations of the signals S_1 and S_2 allows market participants to infer S_1 and S_2. It is therefore equivalent to providing one rating on S_1 and one rating on S_2. By contradiction, suppose that the rating agency provides these two ratings. The rating on S_1 is not valued by market participants, since the insider's effort is already known in equilibrium, i.e. this rating is not informative. As a result, market participants only consider the rating on S_2. Lemma 1 summarizes this reasoning.

Lemma 1 *Suppose that the rating agency sells two ratings which are linear functions of S_1 and S_2. The same information will be revealed by selling a single rating which is a linear function of S_1 and S_2.*

Lemma 1 implies that, considering linear ratings, there is no loss of generality in assuming that the rating agency designs a single rating which depends on signals S_1 and S_2. Moreover, as will be shown below, restricting attention to linear ratings is without loss of generality when the rating is sold to the speculator, and when the rating is sold to the issuer and there is enough uncertainty about firm value.

As in Hörner and Lambert (2021), we henceforth assume that the rating agency can commit to a rating design by choosing $k \in [0,1]$ such that its rating R is:

$$\tilde{R} \;=\; k\tilde{S}_1 + (1-k)\,\tilde{S}_2. \tag{4}$$

The rating design is parametrized by k, which captures the weight on each of the two signals. With $k > \frac{1}{2}$, the rating is more sensitive to effort; with $k < \frac{1}{2}$, the rating is more informative about the firm type; in the special case $k = \frac{1}{2}$, the rating is simply a linear transformation of a noisy version of output, as is standard in career concerns model. For a given k, the variance of the rating is equal to:

$$\sigma_R^2 \equiv (1-k)^2\,\sigma_\theta^2 + k^2 + (1-k)^2\,. \tag{5}$$

The rating agency designs the rating by choosing k, which is common knowledge.

4.2 Market equilibrium

This subsection defines and derives the stock market equilibrium when the rating is privately observed by the speculator (the stock market equilibrium when the rating is public knowledge is straightforward).

Since the market maker observes the insider's market order and the total order flow, he can infer $y \equiv q+u$, which is the part of the order flow emanating from the speculator and the noise trader. Since the order from the insider is only driven by an exogenous shock whose probability is independent of firm value, it does not affect beliefs about firm value. As a result, regardless of whether the insider sells his shares, we define the equilibrium as follows:

Definition 1 *An equilibrium is a market order $q(R) = \alpha+\beta R$ and a price function $p(y) = \mu+\lambda y$ such that:*

$$q\,(R) \;=\; \arg\max_{q} \mathbb{E}\left[\left(\tilde{X} - p\,(q+u)\right) q \middle| R\right] \tag{6}$$

$$p(q+u) \;=\; \mathbb{E}\left[\tilde{X}\middle| q+u\right]. \tag{7}$$

As in the Kyle (1985) model, we consider linear equilibria.

Lemma 2 *When the speculator privately observes the rating R, the stock market equilibrium is described by:*

$$\alpha = \frac{\sigma_u}{\sigma_R}\left(k\hat{A} + (1-k)\,\bar{\theta}\right) \tag{8}$$

$$\beta = \frac{\sigma_u}{\sigma_R} \tag{9}$$

$$\mu = \hat{A} + \bar{\theta} - \frac{(1-k)\,\sigma_\theta^2}{2\sigma_u\sigma_R} \tag{10}$$

$$\lambda = \frac{(1-k)\,\sigma_\theta^2}{2\sigma_u\sigma_R} \tag{11}$$

In particular, we show that the speculator's optimal market order is:

$$q^*(R) = \frac{\mathbb{E}\left[\tilde{X}\middle|R\right] - (\mu+\lambda)}{2\lambda} \tag{12}$$

and the equilibrium price function is:

$$p(y) = \hat{A} + \bar{\theta} + \frac{\beta\,(1-k)\,\sigma_\theta^2}{\beta^2\sigma_R^2 + \sigma_u^2}\,(y - \mathbb{E}[\tilde{y}]) \tag{13}$$

Parameter λ, the sensitivity of the market price to the order flow, is a measure of market illiquidity. As in the Kyle (1985) model, it is increasing in σ_θ, which reflects the informational advantage of the speculator, and decreasing in σ_u, which reflects the random part of the order flow. In addition, market illiquidity λ is decreasing in σ_R. Intuitively, holding σ_θ constant, a higher σ_R makes the speculator's signal less precise, which makes her trade less informative, which reduces the price sensitivity to the order flow, i.e. the market is more liquid.

Parameter β represents the trading aggressiveness of the speculator. As in Kyle (1985), it is increasing in the magnitude σ_u of noise trading. It is also decreasing in the standard deviation σ_R of the rating. This is for two reasons. First, σ_R is increasing in prior uncertainty about firm value, as measured by σ_θ. This is as in the Kyle model: the greater σ_θ, the more information is asymmetric, which reduces market liquidity, which reduces trading aggressiveness. Second, σ_R also measures the unreliability of the speculator's information, which is driven by the noise in signals $\tilde{S}_1$ and $\tilde{S}_2$. This is different from the Kyle model, in which the insider is perfectly informed. Intuitively, prices move against the speculator whenever she trades, so that she will refrain from trading based on unreliable information. Holding σ_θ constant, the greater σ_R, the more unreliable her information.

5 Implicit effort incentives

We now consider the insider's effort incentives, with a focus on the implicit incentives that arise from the rating's impact on the stock price.

Define the expected stock price at $t = 0$ as a function of the manager's actual effort A and his anticipated effort $\hat{A}$ as $\mathbb{E}\left[p\middle|A, \hat{A}\right]$. Even though $A = \hat{A}$ in equilibrium, implicit effort incentives emanating from the firm's market valuation depend on the relation between actual effort A and firm value.

5.1 Effort under commitment

First, as a benchmark, we consider the effort that would be optimally chosen by the insider if he could commit to a level of effort at $t = 0$. We denote this effort by A^{LT}. This level of effort solves:

$$\max_A (1-\delta)\left(\pi\mathbb{E}\left[p\middle|A, A\right] + (1-\pi)\left(A + \bar{\theta}\right)\right) - C(A) \quad \Leftrightarrow \quad \max_A \left\{(1-\delta)A - C(A)\right\} \tag{14}$$

This gives:

$$C'(A^{LT}) = 1 - \delta \tag{15}$$

We call this level of effort optimally chosen under commitment A^{LT} because it is also the level of effort that would be achieved at the second-best if the insider were never hit by a liquidity shock, i.e. if he had a long-term ("LT") horizon with $\pi = 0$.

Appendix A derives the first-best effort and the rating weights that elicit this level of effort.

5.2 Private rating

We now study the case when the rating is privately observed by the speculator.

We start by expressing the expected market value of the firm as a function of the insider's actual and anticipated effort.

Lemma 3 *The expected stock price when the speculator privately observes rating R is:*

$$\mathbb{E}\left[p\middle|A, \hat{A}\right] \;=\; \hat{A} + \bar{\theta} + \frac{1}{2}k\,(1-k)\,\frac{\sigma_\theta^2}{\sigma_R^2}\left(A - \hat{A}\right) \tag{16}$$

Informed trading on the market for firm shares at $t = 1$ generates implicit effort incentives for an insider who might need to sell his shares. Indeed, the market value of the firm will depend on the observed rating, which in turn depends on the insider's actual effort as long as $k > 0$. For $k = 0$, the rating is independent of effort and therefore does not provide effort

incentives. At the opposite extreme, for $k = 1$, the rating only depends on effort, not on firm type $\tilde{\theta}$, and it is consequently ignored in equilibrium, as already discussed. Therefore, it does not provide effort incentives either. As can be seen in equation (16), the weight k that maximizes the sensitivity of expected firm value to effort is in-between these two extremes. Moreover, the implicit effort incentives from market valuation are stronger when prior uncertainty about firm value, as measured by σ_θ, is higher ($\frac{\sigma_\theta^2}{\sigma_R^2}$ is strictly increasing in σ_θ, see equation (5)). Indeed, in this case, the rating is more informative about firm type $\tilde{\theta}$, and therefore it has a greater impact on firm valuation.

Lemma 4 shows that, if prior uncertainty about firm value is sufficiently high, there exists two rating weights such that the effort preferred by the insider under full commitment is achieved at the second-best when the rating is privately observed by the speculator.

Lemma 4 *When the speculator privately observes the rating, the insider effort is* A^{LT} *if* $\sigma_\theta \geq 2\sqrt{2+\sqrt{5}}$ *and* $k = k^{LT} \equiv \frac{4+5\sigma_\theta^2 \pm \sqrt{\sigma_\theta^4 - 16 - 16\sigma_\theta^2}}{2(4+3\sigma_\theta^2)}$.

The insider's optimal effort corresponds to the level of effort that he would choose if he could commit to effort, when the implicit incentives embedded in the rating are such that he exerts as much effort when he may have to sell his shares in the firm ($\pi > 0$) as he would if he never had to ($\pi = 0$). This is only possible if prior uncertainty about firm value, as measured by σ_θ, is sufficiently high (see Figure 2). Intuitively, for any given rating weight $k > 0$, higher uncertainty about firm value increases the stock price impact of the rating, which increases the implicit incentives for effort emanating from the effect of the rating on the resale value of the firm.

If σ_θ is sufficiently large for the level of effort under full commitment to be achievable, there are two rating weights k^{LT} that induce it. Indeed, for any given $\sigma_\theta > 2\sqrt{2+\sqrt{5}}$, the rating weight that maximizes effort elicits a level of effort above the full commitment level. Any deviation from this rating weight will therefore decrease effort. In order for the effort optimally chosen by the insider to coincide with the level of effort under full commitment, the rating weight can be either increased or decreased relative to the weight that maximizes effort. In the former case, the rating is more sensitive to effort and less informative about firm value, so that it has a lower price impact. In the latter case, the rating is less sensitive to effort and more informative about firm value, so that it has a larger price impact. These two rating weights, denoted by k^{LT}, are such that the implicit incentives from the resale value of the firm are the same.

5.3 Public rating

We now study the case when the rating is observable by all market participants.

As in the previous subsection, the insider's effort incentives depend on the effect of his actual effort A on the expected market value of the firm.

Lemma 5 *The expected stock price when the rating R is public information is:*

$$\mathbb{E}\left[p\middle|A,\hat{A}\right] = \hat{A}+\bar{\theta}+k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}(A-\hat{A}) \tag{17}$$

The expression is similar to the one in Lemma 3. One difference is that the sensitivity of firm value to the rating, and therefore to actual effort, is twice as high in Lemma 5 relative to Lemma 3. In the case studied in Lemma 3, the informed speculator trades strategically, which reduces price informativeness, which reduces the sensitivity of firm value to the actual effort of the insider. In Lemma 5, the rating is public information and therefore fully incorporated in the firm's market price. This emphasizes that, for any given positive rating weight k, implicit effort incentives are higher when the rating is public information (Lemma 5) than when it is privately observed by the speculator (Lemma 3). Finally, as in Lemma 3, in Lemma 5 the implicit effort incentives from market valuation are stronger when prior uncertainty about firm value, as measured by σ_θ, is higher.

Lemma 6 *When the rating is publicly disclosed, the insider effort is A^{LT} if $\sigma_\theta \geq \sigma_\theta^d \equiv \sqrt{2\left(1+\sqrt{2}\right)}$ and $k = k_d^{LT} \equiv \frac{3\sigma_\theta^2 \pm \sqrt{\sigma_\theta^4 - 4\sigma_\theta^2 - 4}+2}{4\sigma_\theta^2+4}$.*

In sum, when uncertainty about firm value is sufficiently high, there exists a rating weight that induces the level of effort under full commitment. Denote by σ_θ^d this threshold level of uncertainty. We have $\sigma_\theta^d < \sigma_\theta^*$: the minimum level of uncertainty is lower when the rating is public information than when it is the speculator's private information. Indeed, in the latter case, the speculator's strategic trading reduces the transmission of the information contained in the rating in the stock price.

6 Business models

6.1 Private rating

We now study the rating design when the rating agency sells the rating to the speculator. Specifically, it sets the rating price and the rating weight, and makes a take-it-or-leave-it offer to the speculator. This is the business model of ESG rating agencies, for example. It is also the business model for some equity research conducted by investment banks and brokerage houses, which is privately communicated to their investor clientele.

A speculator who does not privately observe the rating does not have an informational advantage, does not trade, and makes zero profits. By contrast, a speculator who privately observes the rating makes positive expected profit from informed trading, as described in Lemma 7.

Lemma 7 *The expected profit of the speculator when she privately observes rating R is $\frac{\sigma_u(1-k)\sigma_\theta^2}{2\sigma_R}$.*

This expected profit represents the speculator's maximum willingness to pay for the rating.

We can now derive the equilibrium rating.

Proposition 1 *When the rating agency sells the rating to the speculator, it optimally sets:*

$$k = k^{**} \equiv 0 \tag{18}$$

A speculator who purchases the rating wants to maximize her informational advantage to generate trading profits. This is achieved by having a rating which is as informative as possible about firm type $\tilde{\theta}$. Indeed, information about effort is useless in that regard because it can be correctly anticipated in equilibrium. This implies that a rating that puts a positive weight k on the signal about effort would just be more noisy and less informative about $\tilde{\theta}$. As a result, the rating weight that maximizes the speculator's willingness to pay is $k = k^{**} = 0$. It does not imply that the stock price will always be most informative about the firm type under this business model, because the strategic trading of the informed speculator reduces information transmission into the stock price.

We now consider the business model such that the firm pays the rating agency to communicate the rating to the speculator. Specifically, the rating agency sets the rating price and the rating weight, and makes a take-it-or-leave-it offer to the insider. This case, which might be less practically relevant, is still useful as a benchmark against other business models. Incidentally, we will show below (in Proposition 4) that this business model is always dominated by other business models. Define:

$$k^* \equiv \frac{1+\sigma_\theta^2-\sqrt{1+\sigma_\theta^2}}{\sigma_\theta^2}, \qquad \sigma_\theta^* \equiv 2\sqrt{2+\sqrt{5}}. \tag{19}$$

It can easily be shown that k^* is the effort-maximizing rating weight.

Proposition 2 *When the insider pays the rating agency to communicate the rating to the speculator, the rating agency optimally sets:*

$$k = \begin{cases} k^* & \text{if } \sigma_\theta < \sigma_\theta^* \\ k^{LT} & \text{if } \sigma_\theta \geq \sigma_\theta^* \end{cases} \tag{20}$$

The rating agency chooses the weight k of the rating to maximize the insider's willingness to pay. If the rating that induces the level of effort under full commitment is achievable, it is the most valuable rating for the insider. If it is not, then the most valuable rating is the one that maximizes the insider's effort.

Figure 2 depicts the rating weights corresponding to the business model in Proposition 2. It shows that, for any σ_θ, we have $k^* > k^{**}$, i.e. the weight on the signal S_1, which is informative

about effort, is always higher when the rating is designed to maximize the firm insider's willingness to pay. It also shows that, at $k = k^*$, the optimal weight on the signal S_1 is increasing in σ_θ. The greater the prior uncertainty about firm value, the more the rating is informative about the insider's actual effort. Intuitively, the greater the uncertainty about firm value, the more valuable is a rating informative about firm value, and the greater its price impact. As a result, as uncertainty about firm value increases, the rating agency can increase the weight on the signal S_1 about effort in the optimal rating. This allows the insider to commit to a higher level of effort while still maintaining a sufficiently high price impact of the rating.

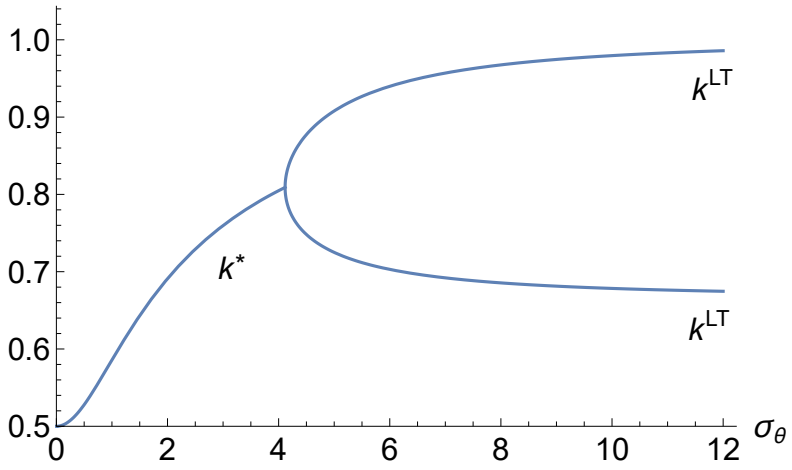


Figure 2: Optimal rating weight k from Proposition 2 as a function of σ_θ.

6.2 Public rating

We now study the rating design when the issuer pays the rating agency to give a public rating, observable by all market participants. Specifically, it sets the rating price and the rating weight, and makes a take-it-or-leave-it offer to the insider. This is the business model of credit rating agencies, for example. It is also the business model for some equity research conducted by investment banks, when it is made publicly available.

Proposition 3 *When the insider pays the rating agency to publicly disclose the rating, the rating agency optimally sets:*

$$k = \begin{cases} k^* & \text{if } \sigma_\theta < \sigma_\theta^d \\ k_d^{LT} & \text{if } \sigma_\theta \geq \sigma_\theta^d \end{cases} \tag{21}$$

The logic is similar to Proposition 2. If possible, the rating weight is the one that induces the level of effort under full commitment (k^{LT}), and if not it is the same rating weight k^* that maximizes the insider's effort. Intuitively, the information mix that maximizes effort incentives

does not change when the rating is communicated to the speculator as in Proposition 2, and when it is publicly revealed as in Proposition 3. Moreover, since $\sigma_\theta^d < \sigma_\theta^*$, the optimal effort under full commitment is compatible with a lower level of uncertainty σ_θ when the rating is publicly disclosed, because of the higher sensitivity of firm value to the rating in this case. This has implications for economic efficiency, which we study in subsection 6.3.

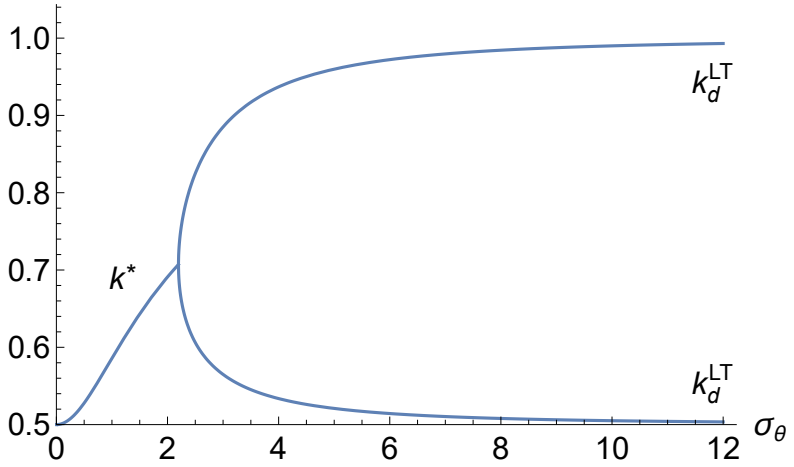


Figure 3: Optimal rating weight k from Proposition 3 as a function of σ_θ.

Corollary 1 *As σ_θ increases, one of the two optimal rating weights k_d^{LT} in Proposition 3 tends asymptotically to $\frac{1}{2}$:*

$$\lim_{\sigma_\theta \to \infty} \frac{3\sigma_\theta^2 - \sqrt{\sigma_\theta^4 - 4\sigma_\theta^2 - 4} + 2}{4\sigma_\theta^2 + 4} = \frac{1}{2} \tag{22}$$

The optimal rating corresponding to the lowest value of k_d^{LT} in Proposition 3 converges asymptotically to $k = \frac{1}{2}$ as uncertainty about firm value increases. Intuitively, when uncertainty about firm value is very high, there is a lot of scope for learning, so that the rating has a very high price impact. To not provide excessive effort incentives, the rating weight converges to either $\frac{1}{2}$ or to 1. For $k = \frac{1}{2}$, the rating is simply a linear transformation of a noisy version of output. Thus, as uncertainty about firm value is sufficiently high, it is approximately optimal to provide a rating which is simply informative about output. This rating will approximately induce the level of effort under full commitment.

6.3 Economic efficiency

The economic efficiency of various business models depends on their implications for the insider's equilibrium effort. Figure 4 depicts the equilibrium efforts corresponding to the three different business models and associated optimal ratings derived in Propositions 1-3.

When the rating is designed to maximize the speculator's willingness to pay, the equilibrium effort, A_1, is minimal. It is decreasing in the probability that the insider needs to sell his stake in the firm, and independent of the level of uncertainty about firm value. Indeed, the rating is uninformative about the insider's effort, so that the market valuation of the firm does not reflect his actual effort. An insider who always had to sell the firm ($\pi = 1$) would not have any effort incentives. More generally, with $k = k^{**}$, effort incentives are decreasing in the probability π that the insider needs to exit.

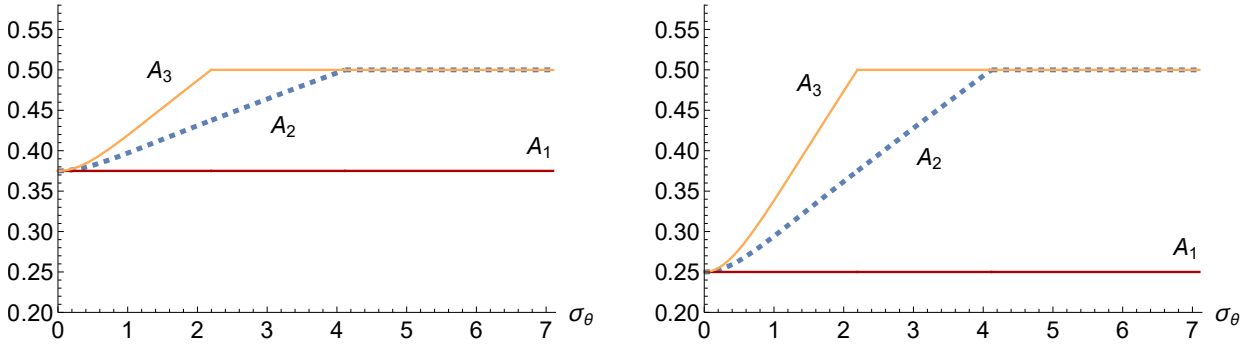


Figure 4: Equilibrium effort A_1, A_2, and A_3 corresponding to the equilibrium and rating weights as in Propositions 1, 2, and 3, respectively, as a function of σ_θ, with $C(A) = \frac{A^2}{2}$, $\delta = 0.5$, $\pi = 0.25$ (left panel), and $\pi = 0.5$ (right panel).

When the rating is instead designed to maximize the insider's willingness to pay, the equilibrium effort, A_2 or A_3, is weakly increasing in the uncertainty about firm value σ_θ. When uncertainty about firm value is low, the rating has a low price impact even when optimally designed, so that implicit incentives from the firm's resale value are low. In this case, the weight k^* on the signal S_1 that reflects the insider's effort is increasing in the uncertainty σ_θ about firm value (see Figure 2). The greater the uncertainty, the more firm value is sensitive to the insider's actual effort, and the greater his effort incentives. When uncertainty about firm value is high, equilibrium effort is equal to the optimal effort under commitment, as already established. This can be achieved with a rating which is publicly disclosed, but also with a rating which is privately communicated to investors if uncertainty is sufficiently high (i.e. for σ_θ such that $A_2 = A_3 = 0.5$ in Figure 4). Moreover, in this case, expected firm output does not depend on the probability π of the insider's exit. This is the time horizon irrelevance result.

This suggests that, when financial information is designed optimally, the short investment horizon of some key investors is not necessarily costly. For example, venture capitalists have limited horizons, yet they and the firms they support are often very successful. Our model emphasizes that two conditions are especially important: the optimal design of financial information, and the substantial uncertainty about the assets financed. This is consistent with the business model of venture capitalists, who finance firms early in their life cycle, especially firms with a very uncertain future, and generally liquidate their stake before the firm has reached

its full potential. For example, venture capitalists tend to finance "technological revolutions" (Lerner and Nanda (2020)), in which the idiosyncratic uncertainty about each firm's potential is compounded by uncertainty about the space that the firm is trying to enter. Thus, our model can help explain the narrow focus of venture capitalists noted by Lerner and Nanda (2020), and the finding that VC funding is especially beneficial for firms that face high uncertainty (Park and Steensma (2012)).

6.4 Rating selection

We now determine the equilibrium outcome, by showing how the equilibrium business model depends on model parameters.

Proposition 4 *The rating agency optimally sells the rating to the speculator rather than the firm insider if σ_u is sufficiently high (i.e. $\sigma_u \geq \overline{\sigma}_u$) or π is sufficiently low. When it sells the rating to the firm insider, it discloses it publicly if $\sigma_\theta < \sigma_\theta^*$. Otherwise, if $\sigma_\theta \geq \sigma_\theta^*$, it is indifferent between disclosing it publicly or privately communicating it to the speculator.*

The business model described in Proposition 2 is always weakly dominated. Indeed, the insider's willingness to pay is higher when the rating is publicly disclosed rather than when it is communicated privately to the speculator (it is only higher in a weak sense when $\sigma_\theta \geq \sigma_\theta^*$).

In an illiquid stock market with a low σ_u, the expected profit of the informed speculator is very low, and so is her willingness to pay for a rating. On the contrary, if the stock market is sufficiently liquid, the rating agency can sell its rating at a higher price to the speculator than to the firm insider. This highlights a new cost of financial market liquidity. Now consider the insider's liquidity shock, which proxies for his time horizon. If $\pi = 0$, the insider does not value the rating: he will never sell the firm and therefore does not care about its market value. More generally, when π is low, the insider has a low willingness to pay for the rating since he already largely internalizes the benefits of his effort. Therefore, the rating agency will rather sell a rating to the speculator.

7 Competition and policy

7.1 Competition between rating agencies

We now extend the model to address the possibility of competition between rating agencies and its possible side effects. We are considering a setting similar to the one described in section 3, except that a second rating agency can now decide to enter. After the first agency has designed and sold its rating $R_1(k_1)$, the second agency can acquire at cost C the same signals S_1 and S_2

and can design its rating $R_2(k_2)$ to sell to the firm's insider or to the speculator.[19]

The first rating $R_1(k_1)$ provides valuable information to the speculator. However, if a second agency provided a different rating $R_2(k_2)$, then the speculator could use both ratings to recover the initial signals S_1 and S_2, as shown in the proof of Lemma 1. Thus, the second rating would be valuable for the speculator. From Lemma 7, the expected profit of the speculator when she purchases rating $R_1(k_1)$ is $\frac{\sigma_u(1-k_1)\sigma_\theta^2}{2\sigma_R}$. With a second rating, the speculator's expected profit would be $\frac{\sigma_u\sigma_\theta^2}{2\sqrt{1+\sigma_\theta^2}}$. A speculator who observed both ratings would then behave by only taking into account the information provided by S_2, i.e., as if a single rating were designed with $k = 0$.

Let $\Delta(k_1)$ be the additional value to the speculator of a second rating given the weight k_1 of the first rating. We have $\Delta(k_1) = 0$ if $k_1 = 0$. The second agency, after observing the first rating $R_1(k_1)$, acquires information only if a second rating is sufficiently valuable to the speculator. The equilibrium depends on model parameters.

First, for high values of σ_u and low values of π, the first agency designs a rating with $k_1 = 0$ even without the threat of entry of a second agency (see Proposition 4). Then, the second agency does not acquire information since the willingness to pay of any economic agent for an additional rating is too low.

Second, for low values of σ_u, information has little value to speculators. In that case, the first agency will sell a rating designed for the firm's insider as derived in Proposition 3. A second agency would not make enough profit by selling a second rating to speculators to cover the cost of information acquisition. This happens when $\Delta(k_1) \leq C$.

Using terminology from the industrial organization literature, these first two possibilities involve "blockaded entry": the threat of entry does not change the rating provided by the first rating agency.

Third, for intermediate values of σ_u, the first agency will deter entry by altering its optimal rating k_1. This happens when the first agency sells a rating to the insider without the threat of entry and when $\Delta(k_1) \geq C$, i.e., when the second agency would enter profitably in that case. The first agency either chooses to sell a rating with $k_1 = 0$ to the speculator or will modify the design of the rating sold to the insider. The first agency then decreases the value of k_1 so that $\Delta(k_1) = C$ thus making the entry of the second agency unprofitable.

7.2 Socially optimal rating

We now assume that there exists a rating agency that provides the first-best rating when it exists, as defined and derived in Appendix A. For example, an ESG rating agency might not be profit-maximizing, but instead have a mission to improve social welfare. When this is the only rating provided, the first-best outcome is achieved, by definition of the first-best rating.

[19] A potential benefit of an additional rating agency is that it provides different information. We turn off this well-understood channel to focus on a new effect.

Now consider the more interesting case when this benevolent rating agency coexists with a profit-maximizing rating agency.

Corollary 2 *If σ_θ is sufficiently high for a first-best rating to exist and if σ_u is sufficiently high or π sufficiently low, the profit-maximizing rating agency provides a rating with $k = k^{**} = 0$. The first-best rating provided by the benevolent rating agency is ignored by the speculator.*

When it faces competition by a benevolent rating agency, a profit-maximizing rating agency's profits are reduced because investors have a lower willingness to pay. However, when markets are sufficiently liquid or the insider is sufficiently unlikely to face a liquidity shock, the latter agency still maximizes its profits by providing the most informative rating possible to the speculator, i.e. by setting $k = 0$.

8 Discussion and alternative assumptions

8.1 Uncertain effort

In our model, the agent's equilibrium effort is known, as is common in moral hazard models (Bolton and Dewatripont (2004)). This is not a crucial assumption.

Indeed, the model can be reinterpreted when there is uncertainty about the insider's action (i.e. the level of effort) rather than about the "firm type". Suppose that firm output is simply:

$$X = A, \tag{23}$$

and the cost of effort is now:

$$C(A) = \frac{c}{2}\left(A - \overline{A}\right)^2 \tag{24}$$

where c is common knowledge and $\overline{A}$, which is drawn from $\overline{A} \sim \mathcal{N}(\bar{\theta}, \sigma_\theta^2)$, is privately learned by the insider at the effort choice stage.[20] There is uncertainty about the parameter $\overline{A}$, which enters the effort cost function and affects the equilibrium effort. This is similar to the specification in Akerlof and Kranton (2005) and Fischer and Huddart (2008), where $\overline{A}$ would be interpreted as the "effort norm". This implies:

$$C'(A) = c\left(A - \overline{A}\right) \tag{25}$$

The first-order condition with respect to the insider's effort is now, given a first derivative of the

[20]This is for tractability and avoid issues that arise with asymmetric information at the contracting stage (Lizzeri (1999)).

insider's wealth with respect to effort ξ:[21]

$$\xi = c\left(A - \overline{A}\right) \quad \Leftrightarrow \quad A = \frac{\xi}{c} + \overline{A} \tag{26}$$

Thus, output, as defined in equation (23), can be decomposed as:

$$X = \underbrace{A - \overline{A}}_{\text{correctly anticipated}} + \underbrace{\overline{A}}_{\text{uncertain}} = \frac{\xi}{c} + \overline{A} \tag{27}$$

In this setting, the two signals which can be combined into a rating are $\tilde{S}_1 = A - \overline{A} + \tilde{\varepsilon}_1$, and $\tilde{S}_2 = \overline{A} + \tilde{\varepsilon}_2$. As in the main model, the first signal is sensitive to the level of effort A chosen by the insider, and the second signal reduces uncertainty about firm output. Note that the first signal is not informative in equilibrium: it it common knowledge that $A - \overline{A} = \frac{\xi}{c}$ (see equation (26)). Thus, as in the main model, S_1 is not informative in equilibrium but it can still be used to provide effort incentives since it is sensitive to the level of effort A actually chosen by the insider.

For comparison purposes, the first-order condition with respect to effort in the main model, which relies on the more standard specification $C(A) = \frac{c}{2}A^2$, would be:

$$\xi = cA \quad \Leftrightarrow \quad A = \frac{\xi}{c} \quad \Rightarrow \quad X = \frac{\xi}{c} + \theta \tag{28}$$

Comparing the equalities on the right of equations (26) and (28) shows that the firm output X is additive in a constant ($\frac{\xi}{c}$) and either $\overline{A}$ (in the alternative setting) or $\tilde{\theta}$ (in the main model). In both cases, this latter variable is unknown, normally distributed, and the signal S_2 reduces uncertainty about it: $\tilde{S}_2 = \theta + \tilde{\varepsilon}_2$ in the main model, and $\tilde{S}_2 = \overline{A} + \tilde{\varepsilon}_2$ in this alternative setting.

In sum, the tradeoff remains essentially the same in this alternative setting: shall information motivate effort or resolve uncertainty about firm value? The difference lies in the interpretation of the source of uncertainty. In the main model, it is uncertainty about the "firm type" $\tilde{\theta}$. In the alternative setting outlined here, it is uncertainty about the baseline level of effort $\overline{A}$.

8.2 Excessive effort

In models of career concerns, the agent's effort can exceed the efficient level when one of the purposes of effort is to improve beliefs about ability (Holmström (1999), Prendergast (1999)). Our model is similar in that regard, with the slight difference that the insider is not concerned about his ability per se but about the type of his firm, which matters to the extent that he may need to sell his shares. Moreover, when uncertainty about firm value is sufficiently high, there exists rating weights that induce a level of effort above the first-best level (specifically, this is

[21] There are several possible expressions for ξ, depending on the business model used by the rating agency.

when $\sigma_\theta > \Sigma(\delta, \pi)$, where $\Sigma(\delta, \pi)$ is defined in Appendix A).

However, the equilibrium effort is never above the full commitment level in our model (effort under commitment is lower than first-best effort as long as $\delta > 0$). Indeed, there are two possibilities. Either the rating is chosen to maximize the speculator's willingness to pay, which generates low effort incentives. Or the rating is chosen to maximize the insider's willingness to pay. In this latter case, the insider will never choose a rating such that his own effort incentives are higher than the preferred level under full commitment. Put differently, the implicit incentives generated via the market valuation of the firm will never be greater than the intrinsic effort incentives of a hypothetical long-term insider (i.e. an insider with $\pi = 0$).

8.3 Speculator endowed with shares

We assumed that the speculator did not initially own any shares in the firm. We now relax this assumption to allow the speculator to also be an initial shareholder.

Corollary 3 *When the speculator owns q_0 shares in the firm at $t = 0$, the rating that maximizes her willingness to pay involves a strictly positive weight k.*

A speculator who initially owns shares in the firm does not only care about maximizing her informational advantage. She also cares, to an extent that depends on her stake, about maximizing the expected value of the firm. The latter is achieved by increasing effort incentives, which in turn involves increasing the rating weight above the level that maximizes the rating's informativeness, i.e. above $k^{**} = 0$.

This result has ambiguous implications for economic efficiency. On the one hand, if the rating agency sells the rating to the speculator, it will now sell a rating that is not purely informational but instead partly motivational. On the other hand, a speculator with a stake in the firm has a higher willingness to pay for the rating, which makes it more profitable for the rating agency to sell the rating to her rather than to the issuer – who would prefer a purely motivational rating.

8.4 Socially responsible speculator

Now suppose that the insider's effort A does not affect output, but instead improves social and environmental outcomes, including the externalities generated by the firm. In addition, suppose that the speculator intrinsically values improvements in social and environmental outcomes. Her objective function is not merely to maximize her expected wealth, but instead to maximize expected wealth plus social impact, where the latter is equal to A. This is the "impact mandate" assumption (Oehmke and Opp (2025)), which in practice characterizes the recent breed of "impact funds". The objective of other economic agents in the model remains to maximize expected wealth. As in the baseline model, $\tilde{\theta}$ reflects uncertainty about the firm's output, potentially including the firm's exposure to sustainability risks. In this setting, the rating optimally

designed by an agency that sells it to the speculator is in-between a purely motivational rating and a purely informational rating (see the Online Appendix for a proof).

Corollary 4 *When the manager's effort improves social outcomes and the speculator is socially responsible, the rating that maximizes her willingness to pay involves a strictly positive weight k.*

Intuitively, a motivational rating is informative about the actual effort decision A, which captures social and environmental improvements that are valued by a socially responsible speculator. As a result, her willingness to pay is now maximized by a rating which not only increases her informational advantage about $\tilde{\theta}$, but is also sensitive to the manager's effort A, similar to the reasoning in section 8.3 (although the interpretation is different). However, she trades only on the basis of her information about firm value ($\tilde{\theta}$) in the rating that she privately observes. As a result, the rating has a stock price impact, and provides implicit effort incentives to the insider.

Thus, perhaps surprisingly, the speculator's impact on social outcomes does not stem from her trading activity, but it is due to her influence on the design of financial information. Specifically, she will value more highly a rating that provides stronger implicit incentives to improve social and environmental outcomes, i.e. a (partly) motivational rating rather than a purely informational rating. This result contrasts with the theoretical literature on socially responsible investment, where socially responsible funds have an impact because of their investment decisions (Edmans, Levit, and Schneemeier (2023), Oehmke and Opp (2025)).

Finally, rating agencies that cater to this type of investor will design ratings accordingly. For example, they will provide ESG ratings that account for both firms' social and environmental impacts and their implications for firm value, consistent with the double materiality framework that has been used by S&P Global since 2023.

8.5 Belief updating and contracting

Like Faure-Grimaud and Gromb (2004), we do not consider contracting.[22] Our model does not involve a principal-agent relationship, but instead an insider who controls the firm and is also making decisions. A controlling shareholder has a fiduciary duty of fair dealing to the firm and its minority shareholders, and faces legal limitations in his ability to contract with third parties. These transactions often involve heightened scrutiny and judicial reviews, instead of simply relying on the default business judgment rule. For such transactions which are subject to entire fairness review, "a court that would otherwise defer to the business judgment of the board could instead find a transaction lacking in fair price or fair dealing, and thus void the transaction entirely."[23]

[22] When the full commitment outcome is achievable at the second-best, contracting would not be valuable even if it were feasible.

[23] The quote is from "Controller Confusion: Realigning Controlling Stockholders and Controlled Boards" in the Harvard Law Review (March 2020). See also "Controlling Shareholder Transactions" (April 26 2018) and

Contracting between the insider and the rating agency would involve possibilities of collusion and expropriation of minority shareholders. For example, suppose that the rating is $R = \zeta\,(kS_1 + (1-k)S_2)$, where ζ is observable but uncontractible, and could be inflated ex-post ("rating inflation") following a tacit agreement between the insider and the rating agency. This would not affect belief updating and stock price determination, since market participants correctly account for the effect of rating inflation when they update their beliefs, but it would increase the insider's contractual payoff.

8.6 Entrepreneurship

The model has implications for the decision of potential entrepreneurs to found firms. The equilibrium level of effort can be lower than the level of effort that the insider would exert if he could commit to effort. In addition, the business model of rating agencies and associated design of financial information has implications for the equilibrium level of effort, which matters for the insider's utility. It matters all the more that the insider sells his stake with a high probability (as can be seen by comparing the two panels in Figure 5). In turn, although we do not model this decision, this has straightforward implications for the willingness of potential entrepreneurs to found firms – assuming that a higher insider utility helps in that regard: would-be entrepreneurs are more likely to found companies when financial information is designed for issuers and uncertainty is sufficiently high.

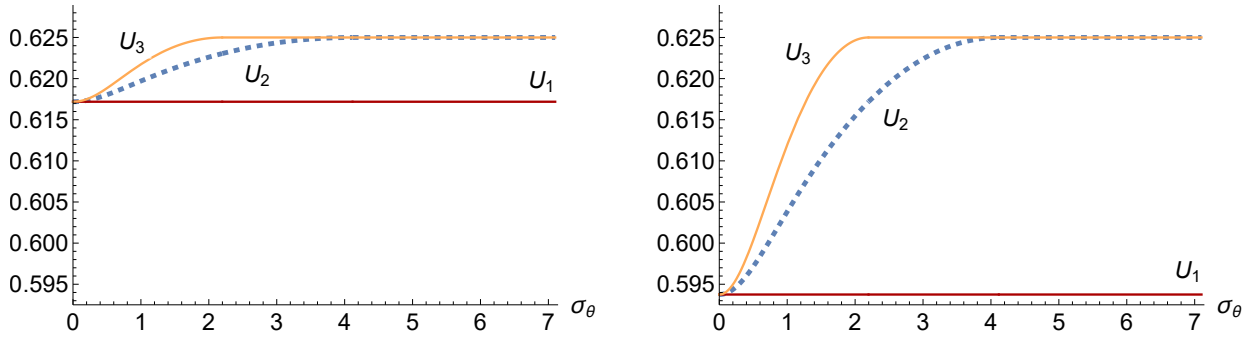


Figure 5: Insider's expected utility U_1, U_2, and U_3 corresponding to the equilibrium and rating weights as in Propositions 1, 2, and 3, respectively, as a function of σ_θ, with $C(A) = \frac{A^2}{2}$, $\delta = 0.5$, $\pi = 0.25$ (left panel), and $\pi = 0.5$ (right panel).

9 Conclusion

The paper develops a framework in which the funding structure of financial ratings affects the information that ratings agencies produce. The rating design matters because it affects the

"Contract Rights and Control" (April 27 2025) both published at the Harvard Law School Forum on Corporate Governance.

firm's market valuation, which in turns affects the incentives of firm insiders who might sell their shares. In our model, aggregating multidimensional information about a firm in a single rating paid by the issuer maximizes firm value. However, it may not be the equilibrium outcome. When stock markets are highly liquid or when insiders have long-term horizons, the equilibrium will instead involve highly informed investors and low firm output.

The model generates important implications. First, we show that information design can fully offset the distortions associated with the insider's exit. When prior uncertainty is sufficiently high, the optimal motivational rating induces the same effort as if the insider could commit to long-term effort. Second, we identify a novel crowding-out effect of informational ratings. When investor-funded ratings are cheap to produce, they may eliminate the scope for issuer-funded ratings that increase effort incentives. Thus, more precise information can paradoxically reduce welfare by eliminating motivational information. Third, our framework explains why the interests of venture capitalists, whose investment horizon is significantly shorter than the horizon of the firms they invest in, can actually be closely aligned with these firms. However, this is only true if they invest in firms with a sufficiently uncertain outlook: only then can ratings be designed to provide adequate effort incentives.

Appendix

A First-best outcome

The first-best effort A^{FB} of the insider maximizes aggregate welfare, i.e. expected output minus the effort cost. It solves:

$$\max_{A} \{A - C(A)\} \tag{29}$$

which gives:

$$C'(A^{FB}) = 1 \tag{30}$$

The insider's optimally chosen effort is first-best if he owns the whole firm and is never hit by a liquidity shock, i.e. $\delta = 0$ and $\pi = 0$. In this case, he knows ex-ante that he will own the whole firm ex-post, and therefore fully internalizes the effect of his effort on firm value.

Lemma 8 shows that, when the speculator privately observes the rating and when uncertainty about firm value is sufficiently high, there are rating weights that induce the first-best effort.

Lemma 8 *When the speculator privately observes the rating, the insider effort is* A^{FB} *if* $\sigma_\theta \geq \sqrt{4\sqrt{\frac{\delta^2-2\delta+5}{(\delta-1)^4}} + \frac{8}{(\delta-1)^2}}$ *and* $k = k^{FB} \equiv \frac{(\delta-5)\sigma_\theta^2 - 4 \pm \sqrt{(\delta-1)^2\sigma_\theta^4 - 16\sigma_\theta^2 - 16}}{2(\delta-3)\sigma_\theta^2 - 8}$.

The insider's effort is first-best when the implicit incentives from the resale value of the firm are sufficiently high to outweigh the insider's partial ownership of the firm (when $\delta > 0$). This is only possible for a subset of parameter values.

First, insider ownership $1 - \delta$ must be high enough (see the right panel in Figure 6). Otherwise, there is no rating design such that market pricing based on the rating delivers first-best incentives. Intuitively, the insider's incentives can be decomposed into two components. First, the explicit incentives from his (stochastic) long-term ownership. These incentives are proportional to $(1 - \delta)(1 - \pi)$. Second, the implicit incentives from the firm's market valuation when he needs to liquidate his stake. These incentives are proportional to $(1 - \delta)\pi$. By contrast, first-best effort incentives are independent of the manager's ownership $1 - \delta$. As a result, when the insider does not own the whole firm, i.e. $1 - \delta < 1$, a necessary condition for first-best effort is that the implicit incentives from market valuation be sufficiently stronger than the explicit incentives from the insider's long-term ownership.

Second, prior uncertainty about firm value, as captured by σ_θ, must be sufficiently high (see the left and right panels in Figure 6). Otherwise, the rating is not very informative, so that the market value of the firm is not very sensitive to the rating, and therefore the implicit incentives

for effort emanating from the effect of the rating on the resale value of the firm cannot be high enough, for any rating weight k on the signal $\tilde{S}_1$ which depends on the insider's effort.

If the first-best effort is achievable, there are two rating weights k^{FB} that induce it. Intuitively, there are two ways to deviate from the effort-maximizing rating weight, which induces a level of effort higher than at the first-best. The first is for the rating to put a high weight on effort, so that it is very sensitive to effort, but not very informative about firm value. Because of the latter, the price impact of the rating is small. The second possibility is for the rating to put a relatively low weight on effort, so that it is not very sensitive effort. However, the rating is then very informative about firm value, so that its price impact is large. The implicit incentives from the resale value of the firm are the same in these two cases.

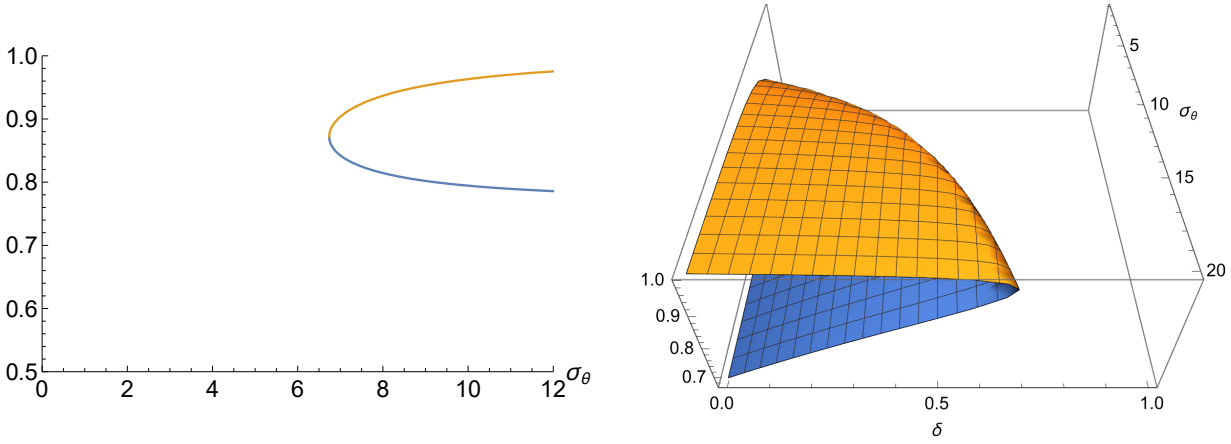


Figure 6: Left panel: rating weight k^{FB} that induces effort A^{FB} as a function of σ_θ, for $\delta = 0.25$ and $\pi = 0.5$. Right panel: rating weight k^{FB} as a function of σ_θ and δ, for $\pi = 0.5$. In each panel, the two different colors correspond to the two possible rating weights.

Lemma 9 shows that, when the rating is publicly disclosed and when uncertainty about firm value is sufficiently high, there are rating weights that induce the first-best effort defined in equation (30).

Lemma 9 *When the rating is publicly disclosed, the insider effort is A^{FB} if $\sigma_\theta \geq \Sigma(\delta, \pi)$ and $k = k_d^{FB}$, where $\Sigma(\delta, \pi)$ and k_d^{FB} are defined in the proof of Lemma 9.*

Lemma 9 describes the rating weights that induce the first-best optimal effort. These rating weights are displayed in Figure 7. As when ratings are communicated privately to the speculator (see Lemma 8 and Figure 6), insider ownership $1 - \delta$ and prior uncertainty about firm value σ_θ, must be sufficiently high for these rating weights to exist. The difference is that these rating weights exist for a larger subset of parameter values when the rating is publicly disclosed. This is because a publicly disclosed rating will have a higher price impact. In particular, the market value of the firm will be more sensitive to the insider's actual effort, all else equal.

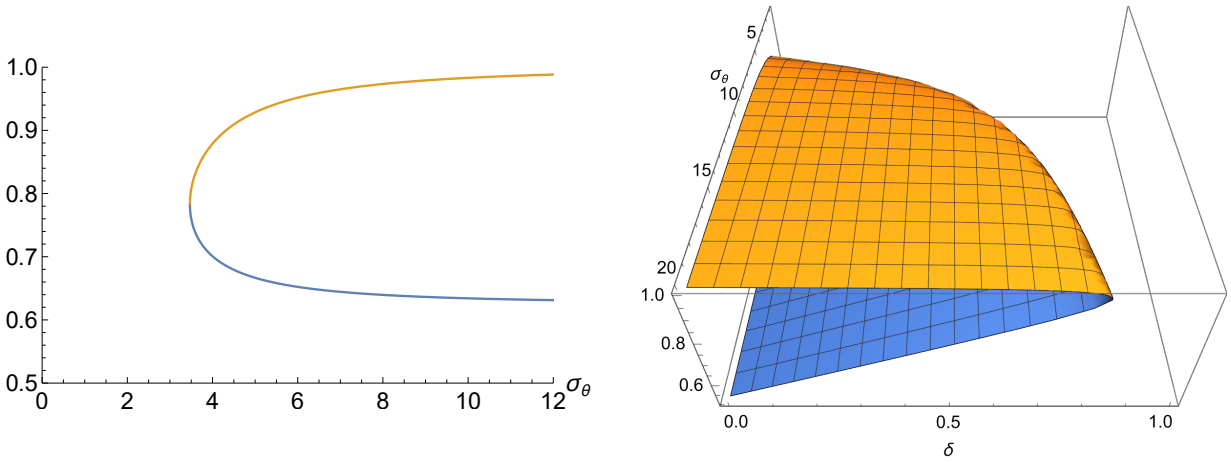


Figure 7: Left panel: rating weight k_d^{FB} that induces effort A^{FB} as a function of σ_θ, for $\delta = 0.25$ and $\pi = 0.5$. Right panel: rating weight k_d^{FB} as a function of σ_θ and δ, for $\pi = 0.5$. In each panel, the two different colors correspond to the two possible rating weights.

A rating that induces first-best effort with $k = k^{FB}$, if it exists, would be the rating used by a benevolent rating agency whose objective is to maximize social welfare. Of course, even if this rating exists, this is not necessarily the rating that arises at the second-best when the rating agency designs the rating to maximize its profits.

B Iso-effort curves

This Appendix depicts iso-effort curves for the two business models considered. Figures 8 and 9 illustrate that the minimum level of σ_θ required for a given effort is lower when the rating is publicly disclosed. They also illustrate how the rating weights that induce a given effort differ depending on the business model.

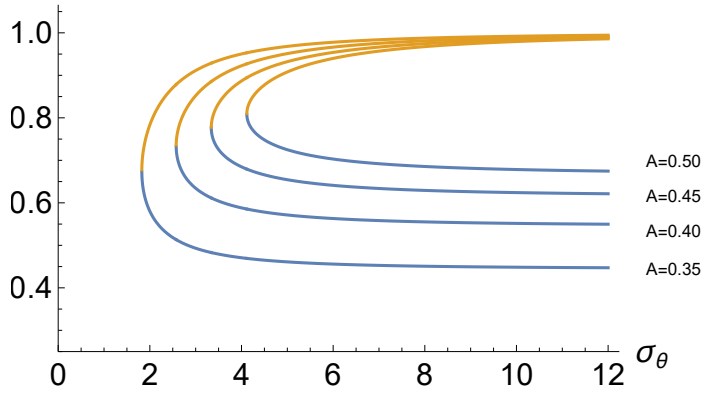


Figure 8: Iso-effort curves in the $\{\sigma_\theta, k\}$ plane that induce effort levels of $A = 0.35, 0.40, 0.45, 0.50$, for $\delta = 0.5$, $\pi = 0.5$, and $C(A) = \frac{A^2}{2}$, when the rating is privately communicated to the speculator. The rating weight k^{LT}, as defined in Lemma 4, induces $A = 0.5$. For each effort level depicted, the two parts of the iso-effort curve with different colors correspond to the two rating weights that induce this effort.

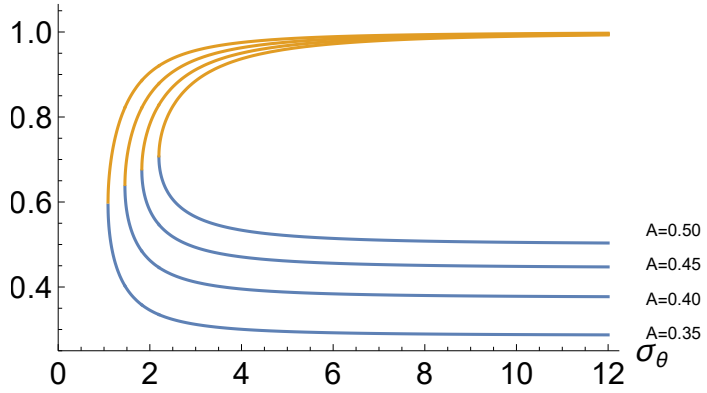


Figure 9: Iso-effort curves in the $\{\sigma_\theta, k\}$ plane that induce effort levels of $A = 0.35, 0.40, 0.45, 0.50$, for $\delta = 0.5$, $\pi = 0.5$, and $C(A) = \frac{A^2}{2}$, when the rating is publicly disclosed. The rating weight k_d^{LT}, as defined in Lemma 6, induces $A = 0.5$. For each effort level depicted, the two parts of the iso-effort curve with different colors correspond to the two rating weights that induce this effort.

C Proofs

Proof of Lemma 1:

The speculator uses the ratings to update her beliefs about the value of the firm. As the signal S_1 does not provide additional information about θ, traders will disregard a rating based solely on S_1. Now, suppose that the speculator has access to two ratings, R and R', which are

independent linear combinations of signals S_1 and S_2 with weights k and k'.

$$R = kS_1 + (1-k)S_2. \tag{31}$$
$$R' = k'S_1 + (1-k')S_2. \tag{32}$$

From observing R and R', the speculator can recover signals S_1 and S_2. We get:

$$S_1 = \frac{(1-k')R - (1-k)R'}{k-k'} \tag{33}$$
$$S_2 = \frac{kR' - k'R}{k-k'} \tag{34}$$

The speculator will then use only S_2 to update her beliefs about θ. This is equivalent to providing a single rating with $k = 0$. ■

Proof of Lemma 2:

The speculator solves:

$$\begin{aligned} & \max_q \ \mathbb{E}\left[(\tilde{X} - p(\tilde{y}))q \middle| R\right] \\ \Leftrightarrow \qquad & \max_q \ \left(\mathbb{E}[\tilde{X}|R] - (\mu + \lambda(1+q))\right) q \end{aligned} \tag{35}$$

The second-order condition for a maximum is satisfied, so the optimum $q^*(R)$ is described by the first-order necessary condition:

$$q^*(R) = \frac{\mathbb{E}\left[\tilde{X}\middle|R\right] - (\mu + \lambda)}{2\lambda} \tag{36}$$

We have:

$$\begin{aligned} \mathbb{E}[\tilde{X}|R] &= \hat{A} + \bar{\theta} + \frac{cov(\tilde{X}, \tilde{R})}{var(\tilde{R})}\left(R - k\hat{A} - (1-k)\bar{\theta}\right) \\ &= \hat{A} + \bar{\theta} + \frac{(1-k)\sigma_\theta^2}{\sigma_R^2}\left(R - k\hat{A} - (1-k)\bar{\theta}\right) \end{aligned} \tag{37}$$

Denoting $b_I \equiv \frac{(1-k)\sigma_\theta^2}{\sigma_R^2}$, we have:

$$q^*(R) = \frac{\hat{A} + \bar{\theta} - (\mu + \lambda)}{2\lambda} + \frac{b_I\left(R - k\hat{A} - (1-k)\bar{\theta}\right)}{2\lambda} \tag{38}$$

So we get

$$\beta = \frac{b_I}{2\lambda} \tag{39}$$

$$\alpha = \frac{\hat{A}+\bar{\theta}-(\mu+\lambda)}{2\lambda} - \frac{b_I\left(k\hat{A}+(1-k)\,\bar{\theta}\right)}{2\lambda} \tag{40}$$

The price set by the market maker corresponds to the expected value of the firm given the total order flow y observed, including an order $\alpha+\beta R$ from the speculator and an order u from noise traders.

$$\begin{aligned} p(y) &= \mathbb{E}\left[\tilde{X}\middle|y\right] \\ &= \mathbb{E}\left[\tilde{X}\right] + \frac{cov(\tilde{X},\tilde{y})}{Var(\tilde{y})}\left(y-\mathbb{E}[\tilde{y}]\right) \\ &= \hat{A}+\bar{\theta}+\frac{\beta\,(1-k)\,\sigma_\theta^2}{\beta^2(\sigma_R^2)+\sigma_u^2}\left(y-\mathbb{E}[\tilde{y}]\right) \end{aligned} \tag{41}$$

In particular:

$$\begin{aligned} p\left(\mathbb{E}[\tilde{y}]\right) &= \hat{A}+\bar{\theta} \\ &= \mu+\lambda\left(1+\alpha+\beta\left(k\hat{A}+(1-k)\,\bar{\theta}\right)\right) \end{aligned} \tag{42}$$

We get:

$$\begin{aligned} \lambda &= \frac{\beta\,(1-k)\,\sigma_\theta^2}{\beta^2(\sigma_R^2)+\sigma_u^2} \\ \mu &= \hat{A}+\bar{\theta}-\lambda\left(1+\alpha+\beta\left(k\hat{A}+(1-k)\,\bar{\theta}\right)\right. \end{aligned}$$

Solving for α, β, λ and μ yields:

$$\beta = \frac{\sigma_u}{\sigma_R} \tag{43}$$

$$\lambda = \frac{(1-k)\,\sigma_\theta^2}{2\sigma_u\sigma_R} \tag{44}$$

$$\alpha = \beta\mathbb{E}[\tilde{R}] = \beta\left(k\hat{A}+(1-k)\,\bar{\theta}\right) \tag{45}$$

$$\mu = \mathbb{E}[\tilde{X}]-\lambda = \hat{A}+\bar{\theta}-\lambda \tag{46}$$

■

Proof of Lemma 3:

The expected stock price as a function of the expected effort of the insider, $\hat{A}$, and his actual

effort, A, is:

$$\begin{aligned}
\mathbb{E}\left[p|A,\hat{A}\right] &= \mathbb{E}\left[\mu+\lambda y\right] \\
&= \mu+\lambda+\lambda\beta\mathbb{E}\left[R-\mathbb{E}[\tilde{R}]\right] \\
&= \hat{A}+\bar{\theta}+\lambda\beta k\left(A-\hat{A}\right) \\
&= \hat{A}+\bar{\theta}+\frac{1}{2}\left(1-k\right)k\frac{\sigma_\theta^2}{\sigma_R^2}\left(A-\hat{A}\right)
\end{aligned}$$

■

Proof of Lemma 4:

At the second-best, when the liquidity shock occurs with probability π, the insider maximizes:

$$\max_A \left(1-\delta\right)\left(\left(1-\pi\right)\left(A+\bar{\theta}\right)+\pi\left(\left(\hat{A}+\bar{\theta}\right)+\lambda\beta k\left(A-\hat{A}\right)\right)\right)-C(A) \tag{47}$$

The second-order condition for a maximization problem is satisfied, so that the optimal effort is given by the first-order necessary condition:

$$C'(A)=\left(1-\delta\right)\left(1-\pi+\pi\lambda\beta k\right) \tag{48}$$

From the solution to the insider's maximization problem in equation (48) and the definition of the effort preferred by the insider in equation (15), the rating induces the effort preferred by the insider if and only if:

$$\left(1-\delta\right)\left(1-\pi+\pi\lambda\beta k\right)=1-\delta \quad \Leftrightarrow \quad \lambda\beta k=1 \tag{49}$$

Substituting for λ and β, the condition is:

$$\frac{k\left(1-k\right)\sigma_\theta^2}{2\sigma_R^2}=1 \qquad \Leftrightarrow \qquad k\left(1-k\right)\sigma_\theta^2=2\left(\left(1-k\right)^2\left(\sigma_\theta^2+1\right)+k^2\right) \tag{50}$$

Solving for k gives the optimal weights in Lemma 4. ■

Proof of Lemma 5:

With a public rating, the market maker sets the market value of the firm equal to its expected output given the rating. The order flows are irrelevant as they do not include any additional

information about firm value. Given rating R, the market value of the firm is:

$$\begin{aligned} p &= \hat{A} + \mathbb{E}\left[\tilde{\theta}\middle|R\right] \\ &= \hat{A} + \mathbb{E}\left[\tilde{\theta}\right] + \frac{cov(\tilde{\theta},\tilde{R})}{var(\tilde{R})}\left(R - \mathbb{E}\left[\tilde{R}\right]\right) \\ &= \hat{A} + \bar{\theta} + \frac{(1-k)\sigma_\theta^2}{\sigma_R^2}\left(R - \mathbb{E}\left[\tilde{R}\right]\right) \end{aligned}$$

The expected market value conditional on actual effort A and expected effort $\hat{A}$ is:

$$\mathbb{E}\left[p\middle|A,\hat{A}\right] = \hat{A} + \bar{\theta} + k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}(A - \hat{A}) \tag{51}$$

■

Proof of Lemma 6:

At the second-best, when the liquidity shock occurs with probability π, the insider maximizes:

$$\max_A (1-\delta)\left((1-\pi)\left(A+\bar{\theta}\right) + \pi\left(\hat{A} + \bar{\theta} + k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}(A-\hat{A})\right)\right) - C(A) \tag{52}$$

The second-order condition for a maximization problem is satisfied, so that the optimal effort is given by the first-order necessary condition:

$$C'(A) = (1-\delta)\left(1 - \pi + \pi k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}\right) \tag{53}$$

From the solution to the insider's maximization problem in equation (53) and the definition of the effort preferred by the insider in equation (15), the rating induces the effort preferred by the insider if and only if:

$$\begin{aligned} (1-\delta)\left(1 - \pi + \pi k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}\right) = 1-\delta \quad &\Leftrightarrow \quad k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2} = 1 \\ &\Leftrightarrow \quad k\left(1-k\right)\sigma_\theta^2 = \left((1-k)^2\left(\sigma_\theta^2+1\right) + k^2\right) \end{aligned} \tag{54}$$

Solving for k gives the optimal weights in Lemma 6. ■

Proof of Lemma 7:

The expected (ex-ante) profit of the speculator who is trading after privately observing rating

R is:

$$\begin{aligned}\mathbb{E}\left[\left(\tilde{X}-p(1+q+u)\right)q\right] &= \mathbb{E}\left[(\tilde{X}-\mu-\lambda-\beta(R-\mathbb{E}[\tilde{R}]))(\lambda\beta(R-\mathbb{E}[\tilde{R}])\right] \\ &= \beta\mathbb{E}\left[\tilde{X}(R-\mathbb{E}[\tilde{R}])\right]-\lambda\beta^2\mathbb{E}\left[\left(R-\mathbb{E}[\tilde{R}]\right)^2\right] \\ &= \frac{\sigma_u}{\sigma_R}(1-k)\,\sigma_\theta^2-\lambda\beta^2\sigma_R^2 \\ &= \frac{\sigma_u\,(1-k)\,\sigma_\theta^2}{2\sigma_R} \end{aligned} \tag{55}$$

■

Proof of Lemma 8:

At the second-best, when the liquidity shock occurs with probability π, the insider maximizes:

$$\max_A\,(1-\delta)\left((1-\pi)\left(A+\bar{\theta}\right)+\pi\left(\left(\hat{A}+\bar{\theta}\right)+\lambda\beta k\left(A-\hat{A}\right)\right)\right)-C(A) \tag{56}$$

The second-order condition for a maximization problem is satisfied, so that the optimal effort is given by the first-order necessary condition:

$$C'(A)=(1-\delta)\,(1-\pi+\pi\lambda\beta k) \tag{57}$$

From the solution to the insider's maximization problem in equation (57) and the definition of the first-best effort in equation (30), the rating induces the first-best effort if and only if:

$$(1-\delta)\,(1-\pi+\pi\lambda\beta k)=1 \quad\Leftrightarrow\quad \lambda\beta k=1+\frac{1}{\pi}\frac{\delta}{1-\delta} \tag{58}$$

Substituting for λ and β, the condition is:

$$\frac{k\,(1-k)\,\sigma_\theta^2}{2\sigma_R^2}=1+\frac{1}{\pi}\frac{\delta}{1-\delta} \quad\Leftrightarrow\quad k\,(1-k)\,\sigma_\theta^2=2\left((1-k)^2\,(\sigma_\theta^2+1)+k^2\right)\left(1+\frac{1}{\pi}\frac{\delta}{1-\delta}\right)$$

Solving for k gives the optimal weights in Lemma 8. ■

Proof of Lemma 9:

At the second-best, when the liquidity shock occurs with probability π, the insider maximizes:

$$\max_A\,(1-\delta)\left((1-\pi)\left(A+\bar{\theta}\right)+\pi\left(\hat{A}+\bar{\theta}+k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}(A-\hat{A})\right)\right)-C(A) \tag{59}$$

The second-order condition for a maximization problem is satisfied, so that the optimal effort is

given by the first-order necessary condition:

$$C'(A) = (1-\delta)\left(1-\pi+\pi k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}\right) \tag{60}$$

From the solution to the insider's maximization problem in equation (60) and the definition of the first-best effort in equation (30), the rating induces the first-best effort if and only if:

$$(1-\delta)\left(1-\pi+\pi k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}\right) = 1 \quad \Leftrightarrow \quad k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2} = \frac{1}{\pi}\frac{\delta}{1-\delta}+1 \tag{61}$$

Solving for k gives the optimal weights $k = k_d^{FB}$, which exist for $\sigma_\theta \geq \Sigma(\delta,\pi)$, where k_d^{FB} and $\Sigma(\delta,\pi)$ are defined as:

$$\begin{aligned}
k_d^{FB} &\equiv \frac{\frac{2\delta\sigma_\theta^2}{(1-\delta)\pi}+\frac{2\delta}{(1-\delta)\pi}+3\sigma_\theta^2+2 \pm \sqrt{-\frac{4\delta^2\sigma_\theta^2}{(1-\delta)^2\pi^2}-\frac{4\delta^2}{(1-\delta)^2\pi^2}-\frac{8\delta\sigma_\theta^2}{(1-\delta)\pi}-\frac{8\delta}{(1-\delta)\pi}+\sigma_\theta^4-4\sigma_\theta^2-4}}{2\left(\frac{\delta\sigma_\theta^2}{(1-\delta)\pi}+\frac{2\delta}{(1-\delta)\pi}+2\sigma_\theta^2+2\right)} \\
\Sigma(\delta,\pi) &\equiv \left(\frac{2\left(\delta^2\pi^2-2\delta^2\pi+\delta^2-2\delta\pi^2+2\delta\pi+\pi^2\right)}{(\delta-1)^2\pi^2}\right. \\
&\quad \left.+2\sqrt{\frac{2\delta^4\pi^4-6\delta^4\pi^3+7\delta^4\pi^2-4\delta^4\pi+\delta^4-8\delta^3\pi^4+18\delta^3\pi^3-14\delta^3\pi^2+4\delta^3\pi+12\delta^2\pi^4-18\delta^2\pi^3+7\delta^2\pi^2-8\delta\pi^4+6\delta\pi^3+2\pi^4}{(\delta-1)^4\pi^4}}\right)^{\frac{1}{2}}
\end{aligned}$$

■

Proof of Proposition 1:

Using Lemma 7, the rating weight that maximizes the speculator's willingness to pay is given by:

$$\max_k \left(\frac{\sigma_u\left(1-k\right)\sigma_\theta^2}{2\sigma_R}\right) \tag{62}$$

Since σ_u and σ_θ are constants, and substituting for σ_R, this is equivalent to:

$$\max_k \left(\frac{1-k}{\sqrt{(1-k)^2\left(\sigma_\theta^2+1\right)+k^2}}\right) \tag{63}$$

The first derivative with respect to k is:

$$-\frac{k}{\left(k^2+(k-1)^2(1+\sigma_\theta^2)\right)^{\frac{3}{2}}} \tag{64}$$

which is negative for any $\sigma_\theta > 0$ and $k \in (0,1)$. The optimal weight k^{**} is given by:

$$k = k^{**} \equiv 0 \tag{65}$$

■

Proof of Proposition 2:

Given equilibrium effort $\hat{A}$ induced by the contract, the insider's willingness to pay is maximized by solving:

$$\max_k (1-\delta)\left(\pi\left(\hat{A}+\bar{\theta}\right)+(1-\pi)\left(\hat{A}+\bar{\theta}\right)\right)-C(\hat{A}) \quad \Leftrightarrow \quad \max_k (1-\delta)\hat{A}-C(\hat{A}) \tag{66}$$

The first-order condition is:

$$(1-\delta-C'(\hat{A}))\frac{d\hat{A}}{dk}=0 \tag{67}$$

There are two cases.

First, if parameters are such that there exists a rating weight k that induces $1-\delta=C'(\hat{A})$, then the optimal rating weight is implicitly determined to induce $1-\delta=C'(\hat{A})$, and it is derived in Lemma 4. This maximizes the insider's objective function in equation (66).

Second, if parameters are such that there does not exist a rating weight k that induces $1-\delta=C'(\hat{A})$, the level of k that maximizes the insider's willingness to pay maximizes the equilibrium effort. It is given by:

$$\max_k \lambda\beta k=\frac{k(1-k)}{\sigma_R^2}=\frac{k(1-k)}{(1-k)^2\left(\sigma_\theta^2+1\right)+k^2} \tag{68}$$

The solutions are thus the roots of:

$$k^2(\sigma_\theta^2)-2(\sigma_\theta^2+1)k+\left(\sigma_\theta^2+1\right) \tag{69}$$

We find:

$$k=k^*\equiv\frac{\sigma_\theta^2+1\pm\sqrt{1+\sigma_\theta}}{\sigma_\theta^2} \tag{70}$$

The maximum is reached for the smaller root. The larger root corresponds to a minimum. ■

Proof of Proposition 3:

The insider chooses effort to maximize:

$$\max_A (1-\delta)\left((1-\pi)\left(A+\bar{\theta}\right)+\pi\left(\hat{A}+\bar{\theta}+k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}(A-\hat{A})\right)\right)-C(A) \tag{71}$$

The second-order condition for a maximum is satisfied. At the time of exerting effort, the insider takes the rating k as given. The equilibrium effort, $\hat{A}$, is described by the first-order necessary condition:

$$C'(\hat{A})=(1-\delta)\left(1-\pi+\pi k(1-k)\frac{\sigma_\theta^2}{\sigma_R^2}\right) \tag{72}$$

The rating agency chooses k to maximize the insider's objective function and thus his willingness to pay for the rating.

$$\max_k \left((1-\delta)\hat{A} - C(\hat{A})\right) \tag{73}$$

The first-order condition is:

$$(1-\delta-C'(\hat{A}))\frac{d\hat{A}}{dk} = 0 \tag{74}$$

There are two cases.

First, if parameters are such that there exists a rating weight k that induces $1-\delta = C'(\hat{A})$, then the optimal rating weight is implicitly determined to induce $1-\delta = C'(\hat{A})$, and it is derived in Lemma 6. This maximizes the insider's objective function in equation (71).

Second, if parameters are such that there does not exist a rating weight k that induces $1-\delta = C'(\hat{A})$, the level of k that maximizes the insider's willingness to pay maximizes the equilibrium effort. It is given by:

$$\max_k \frac{k(1-k)}{\sigma_R^2} = \frac{k(1-k)}{(1-k)^2\left(\sigma_\theta^2+1\right)+k^2} \tag{75}$$

The first-order necessary conditions are

$$\frac{1+\sigma_\theta^2+k^2\sigma_\theta^2-2k(1+\sigma_\theta^2)}{(\sigma_R^2)^2} = 0 \tag{76}$$

The solutions are thus the roots of

$$1+\sigma_\theta^2+k^2\sigma_\theta^2-2k(1+\sigma_\theta^2) \tag{77}$$

We find:

$$k = k^* \equiv \frac{1+\sigma_\theta^2 \pm \sqrt{1+\sigma_\theta^2}}{\sigma_\theta^2} \tag{78}$$

The maximum is reached for the smaller root. The larger root corresponds to a minimum. ■

Proof of Proposition 4:

First, with $k = k^{**} = 0$, the expected profit of the speculator derived in Lemma 7 becomes:

$$\frac{\sigma_u\sigma_\theta^2}{2\sigma_R} = \frac{\sigma_u}{2}\frac{\sigma_\theta^2}{\sqrt{\sigma_\theta^2+1}}, \tag{79}$$

which is linearly increasing in σ_u. Since the rating agency makes a take-it-or-leave-it offer, it captures the surplus from the speculator's valuation. In addition, the insider's willingness to pay is independent from σ_u.

Second, the insider's valuation of any given rating is linear in π; with $\pi = 0$, the insider does not value any rating. In addition, the speculator's willingness to pay with $k = k^{**}$ is independent

from π (see Lemma 7). ■

Proof of Corollary 3:

The speculator's expected profit is now equal to:

$$\underbrace{\frac{\sigma_u (1-k)\,\sigma_\theta^2}{2\sigma_R}}_{f(k)} + \underbrace{q_0(\hat{A}+\bar{\theta})}_{g(k)} \tag{80}$$

The objective function of the speculator is additive in two functions: $f(k)$ and $g(k)$.

The first derivative with respect to k is:

$$-\frac{\sigma_u \sigma_\theta^2}{2} \frac{k}{(k^2+(k-1)^2(1+\sigma_\theta^2))^{\frac{3}{2}}} + q_0 \frac{d\hat{A}}{dk} \tag{81}$$

When $q_0 = 0$, the rating weight that maximizes the speculator's objective function is simply the one that maximizes $f(k)$. It is $k^{**} = 0$. Indeed, for $k > 0$, $f'(k) < 0$.

When $\sigma_u = 0$, the rating weight that maximizes the speculator's objective function is simply the one that maximizes $g(k)$. It is:

$$k = k^* \equiv \frac{1+\sigma_\theta^2 - \sqrt{1+\sigma_\theta^2}}{\sigma_\theta^2}$$

and $g'(k) < 0$ for $k < k^*$.

By the intermediate value theorem, the rating weight that maximizes $f(k) + g(k)$ is in-between k^{**} and k^*. Thus, the rating weight that maximizes the speculator's willingness to pay is strictly positive. ■

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Online Appendix

Proof of Corollary 4:

The speculator solves:

$$\begin{aligned} & \max_q \ \mathbb{E}\left[A + (\tilde{\theta} - p(\tilde{y}))q \middle| R\right] \\ \Leftrightarrow \qquad & \max_q \ \mathbb{E}[A|R] + \left(\mathbb{E}[\tilde{\theta}|R] - (\mu + \lambda(1+q))\right) q \end{aligned} \tag{82}$$

The second-order condition for a maximum is satisfied, so the optimum $q^*(R)$ is described by the first-order necessary condition:

$$q^*(R) = \frac{\mathbb{E}\left[\tilde{\theta}\middle|R\right] - (\mu + \lambda)}{2\lambda} \tag{83}$$

We have:

$$\begin{aligned} \mathbb{E}\left[\tilde{\theta}\middle|R\right] &= \bar{\theta} + \frac{cov(\tilde{X}, \tilde{R})}{var(\tilde{R})}\left(R - k\hat{A} - (1-k)\bar{\theta}\right) \\ &= \bar{\theta} + \frac{(1-k)\sigma_\theta^2}{\sigma_R^2}\left(R - k\hat{A} - (1-k)\bar{\theta}\right) \end{aligned} \tag{84}$$

Denoting $b_I \equiv \frac{(1-k)\sigma_\theta^2}{\sigma_R^2}$, we have:

$$q^*(R) = \frac{\bar{\theta} - (\mu + \lambda)}{2\lambda} + \frac{b_I\left(R - k\hat{A} - (1-k)\bar{\theta}\right)}{2\lambda} \tag{85}$$

So we get

$$\beta = \frac{b_I}{2\lambda} \tag{86}$$

$$\alpha = \frac{\bar{\theta} - (\mu + \lambda)}{2\lambda} - \frac{b_I\left(k\hat{A} + (1-k)\bar{\theta}\right)}{2\lambda} \tag{87}$$

The price set by the market maker corresponds to the expected value of the firm given the total order flow observed, including an order $\alpha + \beta R$ from the speculator and an order u from

noise traders.

$$\begin{aligned} p(y) &= \mathbb{E}\left[\tilde{\theta}\middle|y\right] \\ &= \mathbb{E}\left[\tilde{\theta}\right] + \frac{cov(\tilde{\theta},\tilde{y})}{Var(\tilde{y})}\left(y - \mathbb{E}[\tilde{y}]\right) \\ &= \bar{\theta} + \frac{\beta\left(1-k\right)\sigma_\theta^2}{\beta^2(\sigma_R^2)+\sigma_u^2}\left(y - \mathbb{E}[\tilde{y}]\right) \end{aligned} \tag{88}$$

In particular:

$$\begin{aligned} p\left(\mathbb{E}[\tilde{y}]\right) &= \bar{\theta} \\ &= \mu + \lambda\left(1 + \alpha + \beta\left(k\hat{A} + \left(1-k\right)\bar{\theta}\right)\right) \end{aligned} \tag{89}$$

We get:

$$\begin{aligned} \lambda &= \frac{\beta\left(1-k\right)\sigma_\theta^2}{\beta^2(\sigma_R^2)+\sigma_u^2} \\ \mu &= \bar{\theta} - \lambda\left(1 + \alpha + \beta\left(k\hat{A} + \left(1-k\right)\bar{\theta}\right)\right. \end{aligned}$$

Solving for α, β, λ and μ yields:

$$\beta = \frac{\sigma_u}{\sigma_R} \tag{90}$$

$$\lambda = \frac{\left(1-k\right)\sigma_\theta^2}{2\sigma_u\sigma_R} \tag{91}$$

$$\alpha = \beta\mathbb{E}[\tilde{R}] = \beta\left(k\hat{A} + \left(1-k\right)\bar{\theta}\right) \tag{92}$$

$$\mu = \mathbb{E}[\tilde{\theta}] - \lambda = \bar{\theta} - \lambda \tag{93}$$

The expected stock price as a function of the expected effort of the insider, $\hat{A}$, and his actual effort, A, is:

$$\begin{aligned} \mathbb{E}\left[p\middle|A,\hat{A}\right] &= \mathbb{E}\left[\mu + \lambda y\right] \\ &= \mu + \lambda + \lambda\beta\mathbb{E}\left[R - \mathbb{E}[\tilde{R}]\right] \\ &= \bar{\theta} + \lambda\beta k\left(A - \hat{A}\right) \\ &= \bar{\theta} + \frac{1}{2}\left(1-k\right)k\frac{\sigma_\theta^2}{\sigma_R^2}\left(A - \hat{A}\right) \end{aligned}$$

From equations (83) and (93), we have:

$$\mathbb{E}[q^*(R)] \;=\; \mathbb{E}\left[\frac{\mathbb{E}\left[\tilde{\theta}\middle|R\right]-\bar{\theta}}{2\lambda}\right]=0 \tag{94}$$

Using equation (84), we also have:

$$\mathbb{E}\left[\tilde{\theta}\middle|R\right] \;=\; \bar{\theta}+\frac{(1-k)\,\sigma_\theta^2}{\sigma_R^2}\left(R-k\hat{A}-(1-k)\,\bar{\theta}\right) \tag{95}$$

The speculator's expected utility is now equal to:

$$\underbrace{\frac{\sigma_u\,(1-k)\,\sigma_\theta^2}{2\sigma_R}}_{f(k)}+\underbrace{A}_{g(k)} \tag{96}$$

The objective function of the speculator is additive in two functions: $f(k)$ and $g(k)$.

When $q_0=0$, the rating weight that maximizes the speculator's objective function is simply the one that maximizes $f(k)$. It is $k^{**}=0$. Indeed, for $k>0$, $f'(k)<0$.

When $\sigma_u=0$, the rating weight that maximizes the speculator's objective function is simply the one that maximizes $g(k)$, which is equivalent to maximizing the equilibrium effort. It is:

$$k=k^*\equiv\frac{1+\sigma_\theta^2-\sqrt{1+\sigma_\theta^2}}{\sigma_\theta^2}$$

and $g'(k)<0$ for $k<k^*$.

By the intermediate value theorem, the rating weight that maximizes $f(k)+g(k)$ is in-between k^{**} and k^*. Thus, the rating weight that maximizes the speculator's willingness to pay is strictly positive. ■

Acknowledgments

Sources of research support: none.
Financial relationships or other potential conflicts of interest: none.