Managerial Myopia, Financial Expertise, and Executive-Firm Matching*

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Abstract

Existing literature emphasizes skills-based explanations for executive-firm matching, namely in the context of financial expertise. In contrast, our paper argues that informational concerns may also be relevant. We model a public firm with a project opportunity of uncertain quality, where long-run shareholders choose between hiring an operational manager or a financial expert. These managers are equally myopic, however financial experts are also privy to stock-market beliefs. Financial experts invest sub-optimally due to catering incentives, while operational managers tend to engage in signaling-driven overinvestment. We show that operational managers are preferred for low-NPV projects or when stock markets are well informed.

January 23, 2017

JEL classification: D82, G14, G31.

Keywords: managerial myopia, catering, financial expertise, executive-firm matching.

*We thank Andres Almazan, Adolfo de Motta, Vincent Glode, Konstantinos Zachariadis (discussant), Hongda Zhong (discussant), and seminar participants at the 2014 FIRN annual meeting, 2015 China International Conference in Finance, 2016 FIRS meeting, SKK GSB, and University of Texas at Austin, for comments and suggestions. All errors are our own. Previous versions of this paper circulated under two different titles: "Informative stock prices and optimal managerial style" and "Informative stock prices and managerial financial expertise".

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1 Introduction

Recent literature analyzes how the work experience of CEOs affects corporate financial policies and performance. Specifically, Custódio and Metzger (2014) study financial-expert CEOs, i.e., executives with previous experience in the financial industry or in a financial role. These CEOs are an important fraction of the overall CEO population (41% in the paper's sample), they are financially more sophisticated, and they are better able to raise external capital.[1] Custódio and Metzger (2014) acknowledge that the matching between firms and financial-expert CEOs is endogenous, following previous literature on the topic (Bertrand and Schoar, 2003), and attempt to characterize which observable characteristics drive these matches. In particular, they find that financial-expert CEOs tend to be appointed by mature firms, while non-experts tend to be appointed by firms in the growth stage of their life cycle. The authors suggest a financial-skills/assortative-matching interpretation for this pattern, where skilled CEOs are assumed to be more valuable for bigger firms.

Notwithstanding a skills-based explanation for executive-firm matching, our paper proposes an alternative mechanism that might be at play. We build from the notion that financial experts are, amongst other things, better able to understand the stock market's opinion about the firm's investment opportunities. The combination of such knowledge with managerial myopia (Stein, 1989; Antia, Pantzalis, and Park, 2010) can then lead these financial experts to make inefficient investment decisions that maximize short-run stock prices, where managers cater to the market's beliefs and ignore valuable private information (Brandenburger and Polak, 1996; Aghion and Stein, 2008). We thus introduce a "dark side" associated with financial expertise.

The myopia concern associated with financial experts raises the question of whether non-experts are always preferred, at least if one abstracts from skills-based effects (e.g., being better at valuing M&A targets). We show in the context of the model that the answer

[1] Some literature also shows that the financial experience of outside directors also matters for firm financial policies. See, for example, Booth and Deli (1999) or Byrd and Mizruchi (2005).

is no, which is at first counter-intuitive. In fact, financial experts are strictly preferred in some instances, even without skills-based advantages. This result follows from the fact that non-experts face important signaling incentives, and end up trapped in an equilibrium where they sometimes invest in bad projects in an attempt to pass them as good. These signaling incentives are irrelevant for managers who are informed about stock-market beliefs, due to the dominating catering effect. Which friction is more costly to shareholders is essentially what we investigate.

In short, our paper suggests a natural trade-off associated with managerial financial expertise, here narrowly construed as the ability to know what the market is thinking. In particular, we show that such expertise of myopic managers is detrimental for long-run shareholders only when projects have relatively low NPV or when stock markets have very accurate beliefs about project quality. The former result is consistent with the finding of Custódio and Metzger (2014), who show that financial-expert CEOs are less likely to work in younger companies, which have higher investment rates and lower profitability. Also, the strong perverse catering incentive of finance-savvy managers could justify why a large fraction of firms employs non-finance-savvy CEO's, even though both finance-savvy and non-finance-savvy executives command similar pay.

We now turn to the details of our approach. We model a publicly traded firm that has an investment opportunity of uncertain quality. In our baseline model, managers are perfectly informed about quality, whereas the stock market receives only a noisy signal thereof. The market signal is observable to the manager only if she is a *financial expert*. If the manager is an *operational manager*, then she is not privy to stock-market beliefs. We refer to the dichotomy operational manager / financial expert as *managerial style* and we are interested in understanding which style of manager the firm should hire.[2] In our opinion it is plausible that some managers have more ability to understand stock prices than others, eminently

[2]We note that our model is not about some managers—for example, engineers—being able to generate specific types of information about project quality that are not available to other managers. Rather, the model compares managers who observe stock-market signals to those who do not.

because of different training and previous work experience. Specifically, we argue that a non-trivial level of financial expertise is necessary in order to disentangle the market's view about the marginal project from all other inputs that form a stock price.

The timeline is as follows. Initially the firm hires a specific style of manager. Then, true project quality is realized, and the stock-market signal is generated. Managers then make their investment decision, after which the market updates its beliefs about project quality. These updated beliefs are incorporated into *interim stock prices.* Finally, at the last stage, the project's true payoff is realized. We assume the firm's shareholders have a long-run view and would prefer the manager to maximize expected realized payoffs. In contrast, we assume managers are myopic and wish to maximize interim stock prices instead.

Given the assumption of myopia, in equilibrium financial experts have no interest in using inside information for making their investment decision. To see this, suppose the manager obtains very positive information about a project, but knows that the market received a bad signal. In the interesting case, where average project quality is not too high, equilibrium low-stock-market-signal prices upon investment are below low-stock-market-signal prices upon no investment. Therefore, the financial-expert manager rationally passes up this project, despite the positive inside information.

Now we turn to operational managers. These managers are unaware of the specific signal obtained by the stock market but are equally myopic. In fact, notwithstanding this lack of information about stock-market beliefs, what operational managers really care about are interim stock prices, and they use their own information in the way that is most useful for predicting these prices. Interestingly, this may align their interests with those of long-run shareholders. When operational managers have positive inside information, this means that it is likely that the stock market received a good signal, which creates an incentive for operational managers to invest (as shareholders want). Unfortunately, the fact that investment itself is a signal of positive inside information creates an incentive for the manager to over-invest, trying to pass bad projects as good,[3] a distortion which is absent in the financial expert's case.

Above we outlined each managerial style's incentives and investment behavior. The key question of our paper is what determines the optimal hiring choice from the perspective of long-run shareholders. Our main comparative-statics result is that operational managers are preferred for low-NPV projects, i.e., projects with low probability of success or low return conditional on success. To see why operational managers are preferred for low-NPV projects, note that their investment distortion is one-sided: they always invest in projects with good inside information, which is very efficient given the strength of this information; but they sometimes invest in bad projects as well, in an attempt to pass them as good. The incentive to engage in the latter behavior is however limited, and in particular it is disciplined by interim stock prices. Once the manager has bad news, she knows it is likely that the market has bad news as well. If this is true, then the realized interim price upon investment, in the case of low-NPV projects, is quite low. Therefore, the marginal incentive to invest becomes low as well. In fact, in equilibrium the operational manager is indifferent between investing or not,[4] which gives shareholders a baseline level of performance associated with operational managers (the value of not investing). Having this baseline level of performance is important for projects that are not too attractive economically. In contrast, financial experts' only choice for low-NPV projects may be to never invest: Even if they act on some information (stock-market signal) about project quality, investing just based on good news may still destroy value when stock-market signals are not very precise.[5]

Next we turn to the analysis of stock-price signal precision and optimal managerial style. We start by noting that both styles' performance (weakly) increases in stock-price signal pre-

[3]The market is however not fooled in equilibrium and properly discounts the price by incorporating the possibility of inefficient investment. See also Holmström (1999) for details.

[4]In our setting, full separation does not obtain in equilibrium since, in contrast to the traditional costly signaling model (e.g., Spence, 1973), the cost of signaling (i.e., investment) is not type-specific under the market belief that supports the full separating equilibrium. In that sense, our model is also related to cheap-talk games (e.g., Crawford and Sobel, 1982).

[5]Indeed, we show that for *any* level of stock-price signal precision one can always find hard enough projects that operational managers are preferred.

cision: financial experts differentiate better between good and bad projects, and operational managers have fewer incentives to pass bad projects as good, since they assign a higher likelihood that the stock market also has bad news. In terms of comparative statics, we find that operational managers are preferred for high enough stock-market signal precision, i.e., the disciplining effect of the market on operational-manager behavior is very strong and these managers end up investing more efficiently than financial experts.[6] On the other hand, when precision is low, which managerial style is preferred depends on other parameters as well, which implies that under certain conditions there is a non-monotonic relationship between stock-market signal precision and optimal managerial style.

Our baseline model makes the extreme assumption that managers know the project's true quality, whereas the stock market only observes a noisy signal thereof. We make this assumption for ease of exposition, and it aims to capture the notion that insiders are relatively better informed, which seems plausible. Nevertheless, it is also plausible that stock markets convey information that is complementary to the manager's, as argued by some literature (Dow and Gorton, 1997; Titman and Subrahmanyam, 1999; Chen, Goldstein, and Jiang, 2007).[7] To study whether this would change our results, the online appendix (available from the authors' websites) develops a more generalized version of the model, where managers no longer observe true project quality but only a noisy signal thereof. We show in this extension that the model's key results go through, under the assumption that the manager's signal is more precise than the stock market's. Specifically, it is still the case that financial experts ignore their own information due to catering effects and that long-run shareholders prefer operational managers for low-NPV projects or when the stock market is very well informed.

We now briefly review additional research that our paper relates to. A paper very close to ours is Brandenburger and Polak (1996), who show that a stock-price-maximizing manager may destroy firm value in order to cater to the beliefs of the stock market (the financial

[6] See also Ferreira, Ferreira, and Raposo (2011) who consider the role of informative stock prices as a substitute for manager monitoring by the board.

[7] See Bond, Edmans, and Goldstein (2012) for a recent literature review.

expert in our model). Brandenburger and Polak (1996) do not however consider uninformed myopic managers (the operational manager in our model) and the respective inefficiencies associated with signaling. Our paper also contributes to the literature which analyzes investment distortions induced by the manager's incentive to influence the opinion of stock-market participants (Jensen, 2004; Aghion and Stein, 2008; Kedia and Phillipon, 2009). In particular, our model is closely related to Kedia and Phillipon (2009), who show that firms engage in significant hiring and investment in order to misrepresent their investment opportunities to the market. To our best knowledge, however, our paper is the first to present a framework that compares the effects of managerial myopia (the disadvantage of financial experts) with the effects of perverse signaling incentives (the disadvantage of operational managers). The determinants of which is the overriding concern are not trivial, and, by shedding light on this economic tension, our model hopefully furthers our understanding of executive-firm matching. Finally, our results are in the spirit of Fu and Subramanian (2011), who develop a theory model linking heterogeneous managerial myopia and risk aversion to corporate financial policies. Our work is different in that we focus on financial expertise and introduce signaling effects.

The remainder of the paper is organized as follows. Section 2 develops the baseline setup, which has a simplified information structure, and section 3 characterizes the equilibrium. Section 4 investigates the conditions under which each style of manager is preferred. Section 5 concludes. All proofs and some intermediate results are contained in the appendix.

2 Baseline setup

In this section we analyze our baseline setup, which employs a simplified information structure and focuses on the most interesting results. A more general version of the model is presented in the online appendix.

2.1 Firm

We consider an all-equity firm that operates in a risk-neutral economy where the market rate of return is normalized to zero. The firm's assets consist of unit cash and a growth option. The growth option is a project that requires unit investment and yields a random terminal payoff denoted by r. The project is successful with probability p, paying off $R > 1$; otherwise the project payoff is zero. To facilitate presentation, we define an indicator $k \in \{0, 1\}$, where $k = 1$ if the firm invests in the project and $k = 0$ otherwise. The terminal value of the firm can then be written as

$$v := kr + (1 - k). \tag{1}$$

The firm is run by a manager who makes the investment decision on behalf of shareholders. We denote the manager's (possibly mixed) strategy by σ, and it stands for the likelihood that the firm invests in the project.

2.2 Information structure and managerial style

The firm is publicly traded in a competitive stock market.[8] In the general model, presented in the online appendix, both managers and investors receive informative signals about r. To facilitate presentation and focus on the most interesting features of the model, the baseline setup makes the stark assumption that managers are perfectly informed about r,[9] whereas investors receive a signal $s \in \{S_L, S_H\}$ which discloses the actual state of r with probability $q \geq 1/2$. Investors also use the information contained in the managerial investment decision k and update their beliefs about r accordingly.

The distinctive feature of our model is that not all managers possess the same information. Specifically, we consider a binary *managerial style*, denoted by $\theta \in \{FE, OM\}$. The FE style refers to *financial experts*, who observe both the project payoff r and the market signal

[8]We abstract from asymmetric-information problems between investors in the stock market. For these issues, see Grossman and Stiglitz (1980), Kyle (1985), and Kyle (1989), among others.

[9]We show later that our main results are robust to perturbing this stark assumption.

s. The OM style refers to *operational managers*, who only observe r. Recovering the signal s from observing stock market activity is plausibly non-trivial, since prices are noisy and affected in complex ways by many different factors. Furthermore, s could be revealed in part from looking at the prices of multiple assets jointly (for example, stocks of competitor firms or suppliers). Financial experts can thus be interpreted as managers who are savvy about stock markets and who are able to correctly back out the the market's belief about the firm's marginal projects.

2.3 Timeline and objective functions

The sequence of events unfolds as follows:

- $t = 0$: Shareholders appoint θ-style managers.
- $t = 1$: Managers observe r and the stock market receives a signal s. The signal s is also observed by managers if $\theta = FE$.
- $t = 2$: Managers choose whether to invest ($k = 1$) or not ($k = 0$). The stock market observes k and forms a competitive interim price u by updating its beliefs about r.
- $t = 3$: The terminal value of the firm v is realized.

Notice that in this setting the stock price is formed at $t = 2$ after the market observes the signal s and the firm's investment k, and then updated at $t = 3$ after r is realized.

Shareholders only care about the long run, and they wish to maximize the expectation of v. On the other hand, managers do not focus on long-term performance ($t = 3$), but rather maximize the interim stock price ($t = 2$). This assumption of *managerial myopia* is in line with previous research, e.g., Stein (1989). Myopic managers only care about what the stock market believes about the project,[10] and this plays an important role in our results.

[10] For simplicity our managers are fully myopic. We make this assumption to facilitate exposition; the main results would still hold if managers do not place much weight on long-run outcomes.

3 Managerial style and equilibrium investment strategies

In this section we characterize the investment strategy chosen by each manager style, solving the subgame that starts at period $t = 1$. Before proceeding, it is useful to define $\mu(k, s)$ as the posterior probability that the market assigns to the event $r = R$ after observing the investment decision k and the signal s. Then, the interim stock price formed at $t = 2$ can be written as follows:

$$u(k, s) = 1 + k[\mu(k, s)R - 1] \tag{2}$$

The interim price corresponds to the baseline value of the firm (unit cash) plus, conditional on investment occurring, the expected net present value of the project. Myopic managers choose the investment strategy σ (probability of investing) that maximizes the expected interim price conditional on their information set, i.e., r for operational managers and (r, s) for financial experts.

3.1 Operational-manager subgame

Consider the case in which shareholders hire operational managers at $t = 0$. Since the stock market forms the interim price u after observing the firm's investment k and the signal s, managers who have profitable projects (i.e., $r = R$) would like to convey this information to the market via their investment choice. To be a credible signal about r, however, the investment choice of those managers should not be easily mimicked by other managers who have unprofitable projects (i.e., $r = 0$). As formally shown below, it is indeed the case that operational managers invest more frequently in profitable projects in equilibrium and, thus, the market rationally takes the firm's investment as a positive signal about the project's payoff r. We first discuss the intuition associated with this signaling mechanism and then formally solve for the equilibrium investment strategy of operational managers.

3.1.1 Overview of the signaling mechanism

In this section, we provide the preliminary intuition for the signaling mechanism that emerges as an equilibrium outcome in the operational-manager subgame. We start by noting, as we demonstrate later, that the stock market views the firm's investment as economic only after receiving a good signal S_H. Therefore myopic managers would ideally maximize the interim price by investing only when the market receives S_H. However, given their lack of information about s, operational managers cannot condition their investment decision on s but rather they attempt to infer s from the actual state of r. Such an inference is feasible since profitable projects are more likely to receive a good market signal.[11] Therefore, operational managers who have profitable projects rationally assign a higher probability to the state $s = S_H$ and have an incentive to invest more frequently (i.e., select a higher σ). In equilibrium, the market expects such an investment choice of operational managers and regards the investment itself as a positive signal about the project's profitability.

To better illustrate this intuition, consider the interim price $u(1, s)$ formed at $t = 2$. For notational convenience, we denote by σ_R (resp. σ_0) the investment strategy chosen by operational managers who have profitable (resp. unprofitable) projects. From Bayes' rule, the posterior probabilities $\mu(1, S_H)$ and $\mu(1, S_L)$ can be written as

$$\mu(1, S_H) = \frac{pq\sigma_R}{pq\sigma_R + (1-p)(1-q)\sigma_0} \tag{3}$$

$$\mu(1, S_L) = \frac{p(1-q)\sigma_R}{p(1-q)\sigma_R + (1-p)q\sigma_0}. \tag{4}$$

Notice that for any σ_R and σ_0, $\mu(1, S_H) \geq \mu(1, S_L)$, i.e., the stock market rationally assigns a higher probability to the state of $r = R$ (resp. $r = 0$) after receiving the signal S_H (resp. S_L). From (2), we also find that this result implies $u(1, S_H) > u(1, S_L)$, i.e., the interim price is higher when the market receives a good signal S_H.

Now we turn to the expected interim price, denoted by $\overline{u}_R$ (resp. $\overline{u}_0$), from the standpoint

[11] Formally, $Prob(s = S_H | r = R) = q > Prob(s = S_H | r = 0) = 1 - q$.

of operational managers who invest in profitable (resp. unprofitable) projects. From (2), the expected interim price can be written as:

$$\overline{u}_i = \mathrm{E}_i[\mu(1,s)]R,$$

where $\mathrm{E}_i[\mu(1,s)] = Prob(s = S_H|r = i)\mu(1,S_H) + [1 - Prob(s = S_H|r = i)]\mu(1,S_L)$ for $i \in \{0,R\}$. Notice that $\mathrm{E}_R[\mu(1,s)] > \mathrm{E}_0[\mu(1,s)]$ since the actual state of r is informative about the market signal s, i.e., $Prob(s = S_H|r = R) > Prob(s = S_H|r = 0)$. Therefore, $\overline{u}_R > \overline{u}_0$, which implies that operational managers expect a higher interim price when they invest in profitable projects. To illustrate the signaling effect of investment, we can decompose $\overline{u}_R$ as follows:

$$\overline{u}_R = \overline{u}_0 + \underbrace{R(\mathrm{E}_R[\mu(1,s)] - \mathrm{E}_0[\mu(1,s)])}_{\text{signaling benefit}}. \tag{5}$$

Equation (5) shows that myopic managers with unprofitable projects should invest less frequently since the market is more likely to receive a bad signal about their investment. In this regard, we can interpret the increment in the expected interim price from investment in profitable projects, $R(\mathrm{E}_R[\mu(1,s)] - \mathrm{E}_0[\mu(1,s)])$, as the "signaling benefit".

As formally shown in section 3.1.2, full separation does not occur in our setting since, if the market regards the investment as a perfect signal about $r = R$ in equilibrium, managers could fool the market by investing in unprofitable projects.[12] The partially revealing equilibrium implies that the signaling mechanism cannot fully address the inefficiency that arises from managerial myopia. Furthermore, partial revelation also implies that the market signal s is still informative about the project's payoff r in equilibrium. If signals were not informative in equilibrium, there would be no wedge between interim prices $u(1,S_H)$ and $u(1,S_L)$. Such a wedge is necessary for credible signaling to take place, otherwise both low- and high-type managers would face the same expected interim price, and there would be no scope for credible signaling. This discussion also makes it straightforward that stock-market

[12]See Kedia and Phillipon (2009) for other models that produce a partially revealing equilibrium.

informativeness q cannot be too close to 1/2 for separation to be possible, otherwise the wedge between $u(1, S_H)$ and $u(1, S_L)$ becomes very small.

3.1.2 Characterizing equilibrium

Now we formally solve the operational-manager subgame and characterize the equilibrium, which confirms our intuition discussed in section 3.1.1. As is usual in signaling games, multiple Perfect Bayesian equilibria exist in our setting. While in other models the popular refinement proposed by Cho and Kreps (1987) (the intuitive criterion) significantly reduces the size of the equilibrium set, such technique has no bite in our model. This follows from the fact that there are no type-dependent (exogenous) costs associated with investing, which implies that an action that is not equilibrium-dominated for the high type is necessarily not equilibrium-dominated for the low type. This feature of the model makes our setting closer to the cheap-talk game in Crawford and Sobel (1982).

The above discussion notwithstanding, we still focus on separating equilibria whenever possible. The rationale for this choice is that if operational managers play a pooling equilibrium, then financial experts (weakly) dominate from the perspective of long-run shareholders and thus the analysis becomes uninteresting. This happens because, as we will show shortly, financial experts make investment decisions based on the signal s. Since this signal is informative, then pooling—i.e., never or always investing—obviously does not work as well as s-based decisions.[13] Ideally, we would then focus only on separating equilibria, which turns out are unique and, furthermore, dominate pooling equilibria. Unfortunately, separating equilibria do not always exist. In these instances we select the most-efficient pooling equilibrium (i.e., investing or not).

A relatively simple equilibrium selection procedure that is consistent with our objectives is to simply focus on the most efficient equilibrium, as described in assumption 1. Moreover,

[13] Furthermore, we also note that pooling equilibria in mixed strategies trivially do not exist: Given the "signaling benefit" argument made in the previous section, both types cannot be both indifferent between investing or not.

an efficiency criterion also seems intuitive in itself, especially given the absence of alternative refinements. For consistency we later use the same criterion for the financial-expert subgame.

Assumption 1 *For each managerial-style subgame, we select the most efficient Perfect Bayesian Equilibrium, i.e., the equilibrium where the firm's expected value at $t = 0$ is maximized.*

Proposition 1 below provides an initial equilibrium characterization.

Proposition 1 *In equilibrium, the following is the case:*

1. *If $R \geq \overline{R}_{OM} := \frac{[pq+(1-p)(1-q)][p(1-q)+(1-p)q]}{pq(1-q)}$, the manager invests in all projects with certainty. Otherwise, the manager always invests in profitable projects and randomly invests in unprofitable projects with a non-zero probability. Formally,*

$$\begin{cases} \sigma_R = \sigma_0 = 1 & \text{if } R \geq \overline{R}_{OM} \\ \sigma_R = 1, \sigma_0 \in (0,1) & \text{otherwise.} \end{cases} \tag{6}$$

2. *Equilibrium beliefs $\mu(k, s)$ are given by*

$$\begin{cases} \mu(1, S_H) = \frac{pq}{pq+(1-p)(1-q)\sigma_0} \\ \mu(1, S_L) = \frac{p(1-q)}{p(1-q)+(1-p)q\sigma_0}, \end{cases} \tag{7}$$

   which implies $\mu(1, S_H) > \mu(1, S_L)$ (i.e., S_H is strictly good news when investment takes place).

3. *If $\sigma_0 \in (0, 1)$ in equilibrium, the market forms higher interim price for investment than for no-investment only when it receives S_H, i.e., $u(1, S_H) > 1 > u(1, S_L)$.*

Proposition 1 shows that equilibria are one of two (mutually-exclusive) categories, depending on parameter region: (i) pooling, in which the manager always invests in both types of projects; and (ii) separating, in which the manager invests more frequently in profitable projects. As discussed in section 3.1.1, the manager invests in unprofitable projects with a non-zero probability in the separating equilibrium. The equilibrium market belief described in (7) shows how the market rationally discounts the value of investments for the possibility that the manager invests in unprofitable project (i.e., $\sigma_0 > 0$). As we discuss later, this mechanism is important in deterring the manager from over-investing in unprofitable projects. Given the equilibrium strategies taken by operational managers, the expected value of the firm at $t = 0$ can be written as:

$$\begin{aligned} \overline{v}_{OM} &:= \mathrm{E}_{t=0}\left[v|m = OM\right] \\ &= pR + (1-p)(1-\sigma_0). \end{aligned} \tag{8}$$

Equation (8) shows that the "cost" associated with appointing operational managers corresponds to the expected loss from investing in unprofitable projects (i.e., $(1-p)\sigma_0$). Notice that while the market is not fooled in equilibrium, the manager is "trapped" in the inefficient action which is to invest in unprofitable projects with some probability. In most of the analysis below, we will focus on the separating equilibrium, since the pooling equilibrium is trivially dominated by the financial-expert subgame equilibrium.

To solve for the equilibrium strategy σ_0, we use the standard indifference condition that the investment in unprofitable projects does not affect the manager's expected utility (i.e., the expected interim price). Formally, this condition corresponds to

$$(1-q)\, u(1, S_H) + q\, u(1, S_L) = 1 \Leftrightarrow \mathrm{E}_0\left[\mu(k=1, s)\right] R = 1. \tag{9}$$

Using the results from proposition 1 together with condition (9), we fully characterize the equilibrium as described in proposition 2:

Proposition 2 *If $R < \overline{R}_{OM}$, there always exists a unique separating equilibrium in which*

σ_0 is the largest root to the quadratic equation below:

$$\sigma_0^2(1-p)^2q(1-q)+\sigma_0 p(1-p)\left[q^2+(1-q)^2-q(1-q)R\right]-p^2q(1-q)(R-1)=0. \quad (10)$$

It is also the case that

$$\lim_{R\to\overline{R}_{OM}}\sigma_0=1 \quad (11)$$

$$\lim_{R\to 1}\sigma_0=0. \quad (12)$$

Equations (11) and (12) in proposition 2 show that lower R reduces the managerial incentive to invest in unprofitable projects. This occurs because, as R approaches 1, the investment in profitable projects gets barely economic and therefore the extent to which managers can attempt to influence the interim price by investing in unprofitable projects becomes very limited. In line with proposition 1, which states that managers always invest in unprofitable projects for $R \geq \overline{R}_{OM}$, proposition 2 shows that, as R increases to $\overline{R}_{OM}$, the equilibrium investment strategy for unprofitable projects also increases to 1.

3.1.3 Project characteristics and the performance of operational managers

In this section we perform some comparative statics exercises and show how the investment behavior and performance of operational managers vary with project characteristics (propositions 3 and 4). We also show that operational managers always create shareholder value relative to the benchmark case of no-investment (proposition 5). This last result plays an important role in the later comparison of operational managers to financial experts.

Proposition 3 *If $R \geq \overline{R}_{OM}$, i.e., the separating equilibrium exists, the equilibrium investment strategy σ_0 varies locally with each parameter as follows:*

$$\frac{\partial\sigma_0}{\partial R} > 0 \quad (13)$$

$$\frac{\partial \sigma_0}{\partial q} < 0 \quad (14)$$

$$\frac{\partial \sigma_0}{\partial p} > 0 \quad (15)$$

The economic intuition for why σ_0 increases in R has been discussed in the preceding section: a higher average productivity increases the incentive for the manager to attempt to influence the interim stock price by investing in unprofitable projects. Likewise, proposition 3 shows that higher p, which increases the average productivity of projects, makes the manager invest in unprofitable projects more frequently, i.e., higher σ_0. Finally, the relationship between σ_0 and q is also straightforward. The more informative the market signal, the more weight the manager with unprofitable projects places on the event that the stock-market received a negative signal, which reduces the incentive to mimic the high type.

Proposition 4 *If $R < \overline{R}_{OM}$, i.e., the separating equilibrium exists, shareholder ex-ante welfare $\overline{v}_{OM}$ varies locally with each parameter as follows:*

$$\frac{\partial \overline{v}_{OM}}{\partial R} > 0 \quad (16)$$

$$\frac{\partial \overline{v}_{OM}}{\partial q} > 0 \quad (17)$$

$$\frac{\partial \overline{v}_{OM}}{\partial p} > 0 \quad (18)$$

Results in proposition 4 parallel those of the previous proposition. The result is trivial for the case of q, since it follows directly from the fact that higher q induces less-frequent investment in low-type projects. However, for p and R, two offsetting effects are present: on one hand, the higher p or R, the higher the quality of the average project; on the other hand, following the results in proposition 3, an increase in p or R also leads to more-frequent investment in bad projects. In the end, the positive effect dominates.

Proposition 5 *Shareholder ex-ante welfare $\overline{v}_{OM}$ (or average firm value) is always bigger than* 1*, the benchmark firm value if investment never takes place.*

To understand the intuition for the result in proposition 5, note that either the manager does not invest (in which case firm value is 1), or the manager invests and average firm value is a convex combination of $\overline{u}_0$ and $\overline{u}_R$ (the expected interim prices from the perspective of each type of manager). Since the indifference condition of low-type managers implies $\overline{u}_0 = 1$ and it is also the case that $\overline{u}_R > \overline{u}_0$, average firm value conditional on investment is strictly greater than 1. This implies that unconditional average firm value is also strictly greater than one. Intuitively, it would be impossible in equilibrium to have low-type managers invest so frequently that they destroyed value on average, since this value destruction would show up in rational-expectations interim prices and disincentivize managers from doing so.

3.2 Financial-expert subgame

Now consider the subgame in which shareholders hire financial experts at $t = 0$. As with operational managers, financial experts may desire to use investment as a signal for $r = R$. The signaling mechanism however does not work in this case, since financial experts are also informed about s. It turns out that for the non-trivial equilibria that we focus on, which generate expected firm value bigger than 1 (cash value), s is a sufficient statistic for determining the strategy of myopic managers. In other words, financial experts ignore true project quality in equilibrium, a result contained in proposition 6 below.[14] This result is in line with other literature on myopic managerial behavior, e.g., Stein (1989) or Aghion and Stein (2008).

Proposition 6 *Under the equilibrium-selection assumption 1, all equilibria are dominated (sometimes weakly) by an equilibrium where the investment strategy of financial experts does not depend on the realization of r.*

Proposition 6 shows that investment does not convey information, and therefore posterior

[14]The proof of the proposition contains some additional discussion regarding technical details, that we chose to omit here.

probabilities that $r = R$ are simply

$$\mu(k, s) = \begin{cases} \frac{pq}{pq+(1-p)(1-q)} & \text{if} \quad s = S_H \\ \frac{p(1-q)}{p(1-q)+(1-p)q} & \text{if} \quad s = S_L. \end{cases} \tag{19}$$

Combining the above with the expression for interim stock price (2), we obtain the optimal strategy for the manager:

$$\sigma(S_H) = \begin{cases} 1 & \text{if } R > \underline{R}_{FE} := \frac{pq+(1-p)(1-q)}{pq} \\ 0 & \text{otherwise,} \end{cases} \tag{20}$$

and

$$\sigma(S_L) = \begin{cases} 1 & \text{if } R > \overline{R}_{FE} := \frac{p(1-q)+(1-p)q}{p(1-q)} \\ 0 & \text{otherwise.} \end{cases} \tag{21}$$

Consider the interesting case where $\underline{R}_{FE} < R < \overline{R}_{FE}$ and, thus, the manager invests only after observing S_H. Then, the expected value of the firm at $t = 0$ when appointing financial experts is given by

$$\begin{aligned} \overline{v}_{FE} &:= \mathrm{E}_{t=0}\left[v|m = FE\right] \\ &= pqR + p(1-q) + (1-p)q, \end{aligned} \tag{22}$$

which naturally increases in q, since higher informativeness of the market signal makes it less likely for the manager to invest in unprofitable projects. The expected value of the firm $\overline{v}_{FE}$ also increases in R and p, since the expected value of projects is positively associated with the two parameters.

4 Operational managers vs. financial experts

The previous section characterized the equilibrium investment strategies of each managerial style. In this section, which contains the key analysis of the paper, we compare the performance of financial experts and operational managers, measured by the expected value of the firm at $t = 0$, and examine how their performance is affected by the parameters R, p and q. The comparison of managerial styles is non-trivial, since both financial experts and operational managers create more value for higher R, p, and q, as shown above.

Before analyzing comparative statics in detail, it is worthwhile to frame the trade-off across managerial styles in general terms. Consider the case of profitable projects, i.e., $r = R$. In this case operational managers always invest, which is in the interest of shareholders. They do so because the stock market positively reacts to investment after receiving a positive signal S_H (i.e., $u(1, S_H) > 1$), and managers who have profitable projects assign a high probability to the event $s = S_H$. That is, the fact that operational managers are imperfectly informed about s makes them not want to pass up *any* profitable project. This mechanism does not work with financial experts once they know $s = S_L$ to be the case: whenever these managers face a price $u(1, s_L) < 1$, they prefer not to invest even if $r = R$. In short, operational managers are always desirable whenever projects are profitable. The less straightforward part of the trade-off has to do with unprofitable projects, where both managers do not act in the full interest of shareholders: operational managers invest in these projects with unconditional probability $(1 - p)\sigma_0$, and financial experts do so when $s = S_H$, which occurs with unconditional probability $(1 - p)(1 - q)$. For unprofitable projects, it is therefore not clear which managerial style is preferred.

4.1 Variation in average project quality

This section investigates the effects of R (payoff conditional on success) and p (success probability) in the determination of optimal managerial style. Both parameters have similar associated comparative statics, which is intuitive, since both determine overall average project quality. The left (right) panel of figure 1 shows how the performance of each manager style varies with R (p).

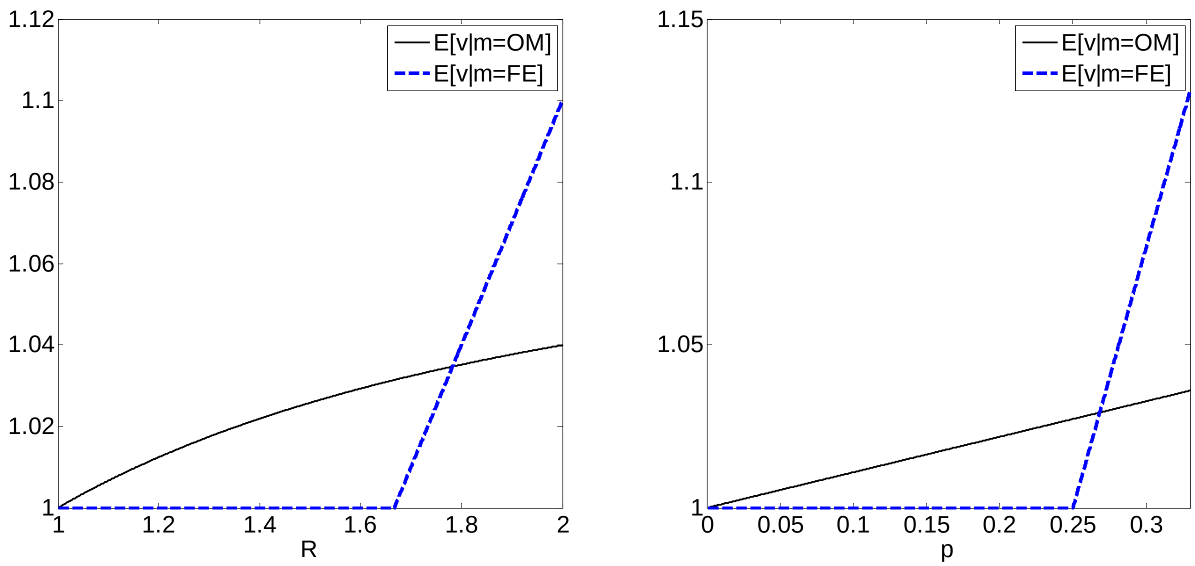

Figure 1: Manager Performance and Variation in Average Project Quality. The figure plots the ex-ante expected value of firms at $t = 0$ in two cases: (i) operational managers (solid black line) and (ii) financial experts (dashed blue line). The left panel varies success payoff R (choice of remaining parameters: $p = 0.5$, $q = 0.6$). The right panel varies success probability p (choice of remaining parameters: $R = 3$, $q = 0.6$).

Figure 1 shows that operational managers are preferred by shareholders for lower R and lower p. Propositions 7 and 8 show that this observation is the case in general.

Proposition 7 *Suppose that $R < \overline{R}_{OM}$, i.e., there exists a separating equilibrium in the operational-manager subgame. Then there always exists a unique threshold $\overline{R}^* \in (\underline{R}_{FE}, \overline{R}_{OM})$ such that $\overline{v}_{OM} > \overline{v}_{FE}$ if and only if $R < \overline{R}^*$.*

Proposition 8 *There always exists a unique threshold $\overline{p}^*$ such that $\overline{v}_{OM} > \overline{v}_{FE}$ if and only if $p < \overline{p}^*$.*

The intuition for the existence of thresholds for R and p that make a particular managerial style optimal is related to each style's "disadvantage". In the choice of investment strategies, financial experts care only about the market signal s. For any level of stock-market signal precision q, there is always a sufficiently low average project quality (i.e., low R and/or low p), such that these managers never invest. Lower average project quality, on the other hand, leads operational managers to invest more efficiently since, as shown in propositions 3 and 4, the lower payoff of profitable projects reduces the managerial latitude to influence the interim price by investing in unprofitable projects. Therefore, for lower average quality projects, shareholders prefer operational managers who do not pass up profitable projects. As average project quality increases, however, operational managers invest in unprofitable projects more frequently and at some point, their investment distortion becomes severe enough to make shareholders prefer financial experts who follow only stock-market signals.

4.2 Variation in stock market informativeness

Next we turn to the effect of stock-market signal precision q on the performance of each manager style. Figure 2 shows how the expected firm values at $t = 0$, i.e., $\overline{v}_{OM}$ and $\overline{v}_{FE}$, vary with q. Specifically, the left (resp. right) panel represents the case in which the unconditional expected return from investing is negative (resp. positive), i.e., $pR < 1$ (resp. $pR > 1$). As mentioned before, both managers improve with q: financial experts act on more accurate signals about project quality, and operational managers have less leeway to pretend that bad projects are good (see proposition 3 for the effect of q on σ_0). In the extreme case in which the market signal is perfectly informative, i.e., $q = 1$, the performance of both styles of managers converges to first-best.

The left panel of figure 2 shows that operational managers perform better for low q. This result obtains because $pR < 1$: when q is small it is better for the financial expert to pass up all projects, since on average they are low-quality; the operational manager, on the other hand, acts on true project quality (although over-investing) and always delivers some shareholder value, as discussed in the previous section. As q increases beyond a certain threshold, the left panel of figure 2 shows that financial experts start investing and tem-

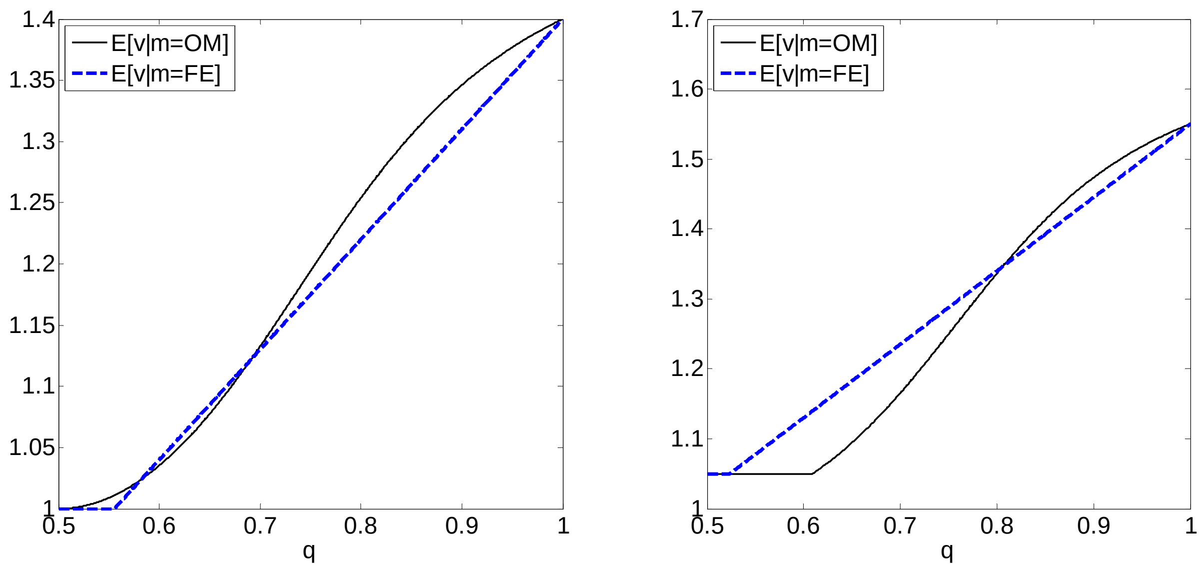

Figure 2: Manager Performance and Variation in Stock Market Informativeness. The figure plots the ex-ante expected value of firms at $t = 0$, for varying stock-market informativeness q, in two cases: (i) operational managers (solid black line) and (ii) financial experts (dashed blue line). In the left panel uninformed NPV is negative, i.e., $pR < 1$ (choice of parameters: $p = 0.5$, $R = 1.8$). In the right panel uninformed NPV is positive, i.e., $pR > 1$ (choice of parameters: $p = 0.5$, $R = 2.1$).

porarily outperform operational managers.[15] However, once q is large enough, operational managers dominate once more. This result obtains in general as stated in proposition 9.

Proposition 9 *If $R < \overline{R}_{OM}$, there always exists $\overline{q}^* < 1$ such that*

$$\forall q \in [\overline{q}^*, 1) : \overline{v}_{OM} > \overline{v}_{FE}. \tag{23}$$

To understand the result in proposition 9, it is useful to focus on the right panel of figure 2, where the average project is valuable. First we note that both managers perform the same at the extremes of $q = 1/2$ and $q = 1$. With $q = 1/2$, both types of managers always invest, the financial expert because there is no information to differentiate projects, the operational manager because the absence of a wedge between the high interim price $u(1, S_H)$ and the low interim price $u(1, S_L)$ eliminates the possibility of credibly signaling project quality via investment behavior. With $q = 1$, on the other hand, the stock market knows the true

[15]This not need obtain in general. For low enough pR, operational managers will dominate financial experts for any q.

quality of every project, and both managerial styles have a clear incentive to only invest in good projects.

The interesting question, then, is why do financial experts dominate for relatively low levels of stock-market informativeness (say $q = 0.7$ in the right panel of figure 2), but the situation reverses for relatively high q (say 0.9)? To answer this question, we first comment on how the performance of financial experts responds to q. As q increases from 1/2, at some point financial experts start investing only after a high signal S_H is generated. Once these managers act in this fashion, their performance improves linearly with q, reflecting the ever greater accuracy of the signal in terms of picking the right projects.

Operational managers' performance responds in a more complex way to q. To understand how this works, recall the indifference condition of the low-type operational manager:

$$(1-q)\, u(1, S_H) + q\, u(1, S_L) = 1,$$

i.e., the expected interim price, from the perspective of a manager who observes $r = 0$, needs to be 1 (the payoff of not investing) in equilibrium. Suppose we set q at moderate levels and determine the equilibrium rate of investment in low projects (σ_0) induced by the expression above. What happens if we slightly increase q, and how does this relate to the notion that the informed market is disciplining the manager? There are three effects associated with increasing q (assume for a moment that we hold σ_0 fixed). First, the LHS of the indifference condition places more weight on the low price. Second, the low price $u(1, s_L)$ becomes lower, since the more-informative signal makes it more likely that the true state is $r = 0$. Finally, the high price $u(1, S_H)$ becomes higher, since the more-informative signal makes it more likely that the true state is $r = R$. Whereas the first two effects give the manager an incentive to reduce σ_0 to re-equilibrate after q increases (making both prices higher), the third effect creates a (partial) perverse incentive to mimic, since the payoff from successfully pretending, the high price, is now higher.

The problem for relatively low q is that the perverse incentive associated with a higher $u(1, S_H)$ is relatively important. This makes the frequency of investment in bad projects σ_0 relatively unresponsive to increases in q. On the other hand, financial experts' performance responds linearly to increases in q, as we explained above. Therefore, as we move away from $q = 1/2$, the financial expert initially distances herself from the operational manager. As q further increases, however, the perverse incentive is gradually shut down, since the term $(1 - q)u(1, S_H)$ is converging to zero, and σ_0 becomes very responsive to q. Indeed, this increased responsiveness is enough that it allows operational managers to "catch up" with the linear increases in financial-expert performance. For large values of q, operational managers end up outperforming financial experts. This occurs because high stock-marker informativeness is disproportionately effective at disciplining operational managers.

5 Conclusion

We propose a model where firms can be run by financial experts or operational mangers. Whereas both styles of managers have inside information about the quality of projects, financial experts can additionally retrieve informative signals about project quality from stock prices. Our analysis shows that firms may prefer operational managers, despite their informational disadvantage. Specifically, when the managers are myopic, the knowledge of the specific beliefs held by the market creates a much stronger incentive for financial experts to cater to these beliefs, ignoring valuable inside information. On the other hand, operational managers distort investment policies in an attempt to signal their private information. Our model implies that operational managers are preferred for "hard projects", characterized by either being long shots (low probability of success) or having low return conditional on success, a result that is consistent with some evidence on firm-executive matching. Finally, our analysis also delivers the counter-intuitive prediction that under certain conditions operational managers are only preferred for high enough stock-price informativeness.

Our work contributes to the literature that studies which information structures are more efficient for running a corporation, and it delivers novel testable implications for the matching of firms and executives.

Appendix – Proofs

Proof of proposition 1.

We will first show that $\sigma_R > 0$. Suppose to the contrary that $\sigma_R = 0$. Then, for any $\sigma_0 > 0$, $\overline{u}_R = \overline{u}_0 = 0$, which implies that the manager who observes $r = 0$ strictly prefers no-investment, i.e., $\sigma_0 = 0$. Thus, there is no separating equilibrium such that $\sigma_R = 0$. Now we turn to $\sigma_0 > 0$. Suppose to the contrary that $\sigma_0 = 0$ in equilibrium. Then, since $R > 1$, $\overline{u}_R = \overline{u}_0 > 1$, which implies that the manager who observes $r = 0$ strictly prefers investment, i.e., $\sigma_0 = 1$, which contradicts the assumption $\sigma_0 = 0$. Thus, $\sigma_0 > 0$. Next, note that in equilibrium, the low-type manager either is indifferent between investing or not, in which case the expected interim price $\overline{u}_0 = 1$; or, she strictly prefers to invest, which requires $\overline{u}_0 > 1$. But since $\overline{u}_R \geq \overline{u}_0$ (see section 3.1.1), the high-type manager must at least be indifferent, i.e. $\sigma_R \geq \sigma_0$. Furthermore, $\sigma_R \geq \sigma_0 > 0$ implies $\overline{u}_R > \overline{u}_0$, so it needs to be the case that $\sigma_R = 1$ in equilibrium.

So far we have shown that in separating equilibrium $\sigma_R = 1$ and $\sigma_0 > 0$. The corresponding equilibrium beliefs in (7) follow immediately from (3) and (4). Now we will show that $\sigma_0 = 1$ if and only if $R \geq \overline{R}_{OM} = \frac{[pq+(1-p)(1-q)][p(1-q)+(1-p)q]}{pq(1-q)}$. The expected interim price $\overline{u}_0$ can be written as

$$\overline{u}_0 = \left[\frac{pq(1-q)}{pq + (1-p)(1-q)\sigma_0} + \frac{pq(1-q)}{p(1-q) + (1-p)q\sigma_0}\right] R. \qquad \text{(A.1)}$$

Notice that $\overline{u}_0$ decreases in σ_0 and increases in R. After a few steps of simple algebra, we can show that $\overline{u}_0 = 1$ at $(\sigma_0, R) = (1, \overline{R}_{OM})$. This implies that (i) if $R \geq \overline{R}_{OM}$, $\overline{u}_0 \geq 1$ for all $\sigma_0 \leq 1$ and (ii) otherwise, there always exists $\sigma_0 \in (0, 1)$ such that $\overline{u}_0 = 1$. Finally, in the separating equilibrium in which $\sigma_0 < 1$, the manager who observes $r = 0$ should be indifferent about investment, i.e., $\overline{u}_0 = 1$. Since $\overline{u}_0$ is the convex combination of two interim prices $u(1, S_H)$ and $u(1, S_L)$, and $u(1, S_H) > u(1, S_L)$, the interim prices necessarily satisfy $u(1, S_H) > 1 > u(1, S_L)$.■

Proof of proposition 2.

By plugging (A.1) into the equilibrium condition $\overline{u}_0 = 1$ and taking a few steps of simple algebra, we can show that the equilibrium investment strategy σ_0 solves the quadratic equation (10). Next, since the coefficient on the quadratic term of (10) is positive and the constant term is negative, the smallest root of (10) is negative and, thus, cannot be the equilibrium. Finally, in the proof of proposition 1, we show that $\overline{u}_0 = 1$ at $(\sigma_0, R) = (1, \overline{R}_{OM})$. By continuity, this implies that (11) holds. To prove (12), we can show that, at $R = 1$, equation (10) can be rewritten as

$$\sigma_0^2(1-p)^2 q(1-q) + \sigma_0 p(1-p)\left[q^2 + (1-q)^2 - q(1-q)\right] = 0$$

of which the largest root is $\sigma_0 = 0$. By continuity, this proves (12).■

Proof of proposition 3.

Let us denote the left-hand-side of the quadratic (10) by $H(\sigma_0)$. Since the quadratic term of $H(\sigma_0)$ is positive and the equilibrium investment strategy corresponds to the largest root, it is immediate that $\frac{\partial H}{\partial \sigma_0} > 0$ in equilibrium. Thus, by the implicit function theorem, $Sign(\frac{\partial \sigma_0}{\partial X}) = -Sign(\frac{\partial H}{\partial X})$ for each parameter $X \in \{R, q, p\}$. First, consider the derivative of H with respect to R:

$$\frac{\partial H}{\partial R} = -p(1-p)q(1-q)\sigma_0 - p^2 q(1-q) \leq 0.$$

Therefore, $\frac{\partial \sigma_0}{\partial R} \geq 0$. Next, the derivative of H with respect to q can be written, after some manipulation, as

$$\frac{\partial H}{\partial q} = (2q-1)[2p(1-p)\sigma_0 - (1-p)^2{\sigma_0}^2 + \sigma_0 p(1-p)R + p^2(R-1)]. \tag{A.2}$$

Since $H(\sigma_0) = 0$ in equilibrium, (A.2) can be further rewritten as:

$$\frac{\partial H}{\partial q} = (2q-1)\left[2p(1-p)\sigma_0 + \frac{p(1-p)(q^2 + (1-q)^2)}{q(1-q)}\right],$$

which implies that $\frac{\partial H}{\partial q} > 0$ and therefore $\frac{\partial \sigma_0}{\partial q} < 0$. Finally consider the derivative of H with respect to p:

$$\frac{\partial H}{\partial p} = -q(1-q)[2(1-p){\sigma_0}^2 + (2p + \sigma_0(1-2p))R - 2p] + (1-2p)(q^2 + (1-q)^2)\sigma_0.$$

By multiplying $(1-p)$ with $\frac{\partial H}{\partial p}$,

$$\begin{aligned}(1-p)\frac{\partial H}{\partial p} &= -2(1-p)^2 q(1-q){\sigma_0}^2 - (1-p)q(1-q)(2p + \sigma_0(1-2p))R \\ &\quad +2p(1-p)q(1-q) + (1-p)(1-2p)(q^2 + (1-q)^2)\sigma_0.\end{aligned}$$

Since $H(\sigma_0) = 0$ in equilibrium, $(1-p)\frac{\partial H}{\partial p}$ can be rewritten, after simplification, as:

$$(1-p)\frac{\partial H}{\partial p} = -\frac{(1-p)^2}{p} q(1-q){\sigma_0}^2 + pq(1-q) - pq(1-q)R.$$

Since $R > 1$ and $p < 1$, $\frac{\partial H}{\partial p} < 0$ and hence $\frac{\partial \sigma_0}{\partial p} > 0$.■

Proof of proposition 4.

First we show that $\frac{\partial \overline{v}_{OM}}{\partial R} > 0$. From (8), we can derive

$$\frac{\partial \overline{v}_{OM}}{\partial R} = p - (1-p)\frac{\partial \sigma_0}{\partial R}.$$

Using the derivatives of H (see proof of proposition 3) with respect to R and σ_0, we can rewrite $\frac{\partial \overline{v}_{OM}}{\partial R}$ as

$$\begin{aligned}\frac{\partial \overline{v}_{OM}}{\partial R} &= p - \frac{p(1-p)q(1-q)(p + (1-p)\sigma_0)}{2(1-p)^2 q(1-q)\sigma_0 + p(1-p)(q^2 + (1-q)^2) - p(1-p)q(1-q)R} \\ &= \frac{X}{Y},\end{aligned}$$

where

$$X := p(1-p)[(1-p)q(1-q)\sigma_0 + p(q^2 + (1-q)^2 - q(1-q)(1+R))]$$

$$Y := 2(1-p)^2 q(1-q)\sigma_0 + p(1-p)(q^2 + (1-q)^2) - p(1-p)q(1-q)R.$$

Notice that $Y = \frac{\partial H}{\partial \sigma_0}$, which is positive in equilibrium (see the proof of proposition 3) and, thus, $\frac{\partial \overline{v}_{OM}}{\partial R} > 0$ if and only if $X > 0$. Since $H(\sigma_0) = 0$ in equilibrium, X can be written as

$$X = \frac{p^2 q(1-q)[p(R-1) - (1-p)\sigma_0]}{\sigma_0},$$

which is positive since $\overline{v}_{OM} - 1 = p(R-1) - (1-p)\sigma_0 > 0$ in equilibrium as proved in proposition 5.

The result that $\frac{\partial \overline{v}_{OM}}{\partial q} > 0$ follows directly from the fact that $\frac{\partial \sigma_0}{\partial q} < 0$.

Finally we show that $\frac{\partial \overline{v}_{OM}}{\partial p} > 0$, which differentiating expression (8) is equivalent to

$$R - (1-\sigma_0) - (1-p)\frac{\partial \sigma_0}{\partial p} > 0 \Leftrightarrow \frac{\partial \sigma_0}{\partial p} < \frac{R - 1 + \sigma_0}{1-p}. \tag{A.3}$$

Using H together with the implicit function theorem it is straightforward to obtain

$$\frac{\partial \sigma_0}{\partial p} = \frac{2\sigma_0^2(1-p)q(1-q) + \sigma(2p-1)[(1-q)^2 + q^2 - q(1-q)R] - 2pq(1-q)(1-R)}{2\sigma_0(1-p)^2 q(1-q) + p(1-p)[(1-q)^2 + q^2 - q(1-q)R]} \tag{A.4}$$

Inserting (A.4) into expression (A.3), and after some tedious but simple algebra, one can write

$$\frac{\partial \overline{v}_{OM}}{\partial q} > 0 \Leftrightarrow \sigma_0 > \frac{p(1-R)}{1-p}\left[\frac{(1-2q)^2 - q(1-q)R}{(1-2q)^2 + q(1-q)R}\right] \tag{A.5}$$

After some simplification, one can write the explicit expression for σ_0 as

$$\sigma_0 = \frac{p\left[\sqrt{(1-2q)^2 - 2q(1-q)(1-2q)^2 R + q^2(1-q)^2 R^2} - (1-q)^2 - q^2 + q(1-q)R\right]}{2(1-p)q(1-q)} \tag{A.6}$$

Inserting equation (A.6) into expression (A.5), and after much simplification, one can write

$$\frac{\partial \overline{v}_{OM}}{\partial q} > 0 \Leftrightarrow (1-q)^2 + 4q(1-q)R > 1.$$

Since $R > 1$, to show that the above expression holds it is enough to show

$$(1-2q)^2 + 4q(1-q) \geq 1 \Leftrightarrow 1 \geq 1,$$

which concludes the proof.■

Proof of proposition 5.

In equilibrium, $\overline{v}_{OM} = p\overline{u}_R + (1-p)\sigma_0\overline{u}_0 + (1-p)(1-\sigma_0)$. From the separating equilibrium condition that $\overline{u}_R > \overline{u}_0 = 1$, it is immediate that $\overline{v}_{OM} > 1$.■

Proof of proposition 6.

Suppose that the investment decision of financial experts is contingent on r. For $s = S_i$ $(i = H, L)$, if $\mu(1, S_i)R > 1$, financial experts who observe S_i would choose $k = 1$ regardless of r; similarly, if $\mu(1, S_i)R < 1$, the manager would choose $k = 0$ regardless of r. Thus, the equilibrium condition would have to be $\mu(1, S_i)R = 1$ for all S_i, where both interim prices are 1. This in turn implies that ex-ante average firm value is 1, which is the benchmark value of not investing. On the other hand, managers using strategies that are contingent just on s is straightforward to rationalize in equilibrium, with off-equilibrium-path beliefs that assign high enough likelihood that managers deviating from these strategies have bad projects. If such equilibria are more efficient (which is the case for many parameter regions), then under assumption 1 we should select these equilibria.

On a more technical note, there does exist a continuum of equilibria satisfying the condition $\mu(1, S_i)R = 1$, i.e., where posteriors are the same and equal to $1/R$. For the sake of completeness, we next characterize these equilibria. Denote by $\sigma(r, s)$ the strategy of financial experts, i.e., the likelihood that they choose $k = 1$ with information set (r, s). Then stock-market posteriors (after observing signal and investment) are now written as

$$\mu(1,S_H) = \frac{pq\sigma(R,S_H)}{pq\sigma(R,S_H)+(1-p)(1-q)\sigma(0,S_H)}$$
$$\mu(1,S_L) = \frac{p(1-q)\sigma(R,S_L)}{p(1-q)\sigma(R,S_L)+(1-p)q\sigma(0,S_L)}.$$

To illustrate that this type of equilibrium can exist, suppose we set $\sigma(R,.)=1$ (although there are other equilibria where this is not the case). Furthermore, to assure existence, let us choose a small R:

$$R < \frac{pq}{pq+(1-p)(1-q)}.$$

Then we can always find $\sigma(0,S_H)\in(0,1)$ such that $\mu(1,S_H)R=1$, since setting $\sigma(0,S_H)=1$ yields

$$\mu(1,S_H)R<1,$$

and setting $\sigma(0,S_H)=0$ yields

$$\mu(1,S_H)R=R>1.$$

Similarly we can find the appropriate $\sigma(0,S_L)$.■

Proof of proposition 7.

To prove the proposition, we take the following three steps: we first show that $\overline{v}_{OM}>\overline{v}_{FE}$ for $R\leq\underline{R}_{FE}$; then show that $\overline{v}_{OM}<\overline{v}_{FE}$ at $R=\overline{R}_{OM}$; and finally prove that there exists a unique value of $\overline{R}^{*}\in[\underline{R}_{FE},\overline{R}_{OM}]$ such that $\overline{v}_{OM}=\overline{v}_{FE}$ if and only if $R=\overline{R}^{*}$. By continuity of $\overline{v}_{OM}-\overline{v}_{FE}$ in R, these three properties are sufficient to prove the proposition. First, for $R\leq\underline{R}_{FE}$, financial experts never invest and therefore $\overline{v}_{FE}=1$. By proposition 5, $\overline{v}_{OM}>1$ for all $R>1$ and thus $\overline{v}_{OM}>\overline{v}_{FE}$ for all $R\in(1,\underline{R}_{FE}]$. Now we turn to the case in which $R=\overline{R}_{OM}$. In this case, operational managers take $\sigma_0=1$ as shown in proposition 1 while financial experts invest only when $s=S_H$, since $\overline{R}_{OM}<\overline{R}_{FE}$. By (8) and (22), the investment decisions of each style of managers imply that

$$\begin{aligned}\overline{v}_{OM} - \overline{v}_{FE} &= p(1-q)\overline{R}_{OM} - p(1-q) - (1-p)q \\ &= \frac{1}{q}[-p(1-p)(1-q)(2q-1) - (1-p)^2 q(2q-1)]\end{aligned}$$

Therefore, $\overline{v}_{OM} - \overline{v}_{FE} < 0$ at $R = \overline{R}_{OM}$. Now we will show that there exists a unique value of $\overline{R}^* \in [\underline{R}_{FE}, \overline{R}_{OM}]$ such that $\overline{v}_{OM} = \overline{v}_{FE}$ if and only if $R = \overline{R}^*$. From (8) and (22), it is immediate that

$$\overline{v}_{OM} > \overline{v}_{FE} \Leftrightarrow \sigma_0 < \overline{\sigma} := 1 - q + \frac{p(1-q)(R-1)}{1-p}.$$

Since the equilibrium strategy σ_0 is the largest root of the quadratic equation $H(\sigma_0) = 0$ and the coefficient on the quadratic term of $H(\sigma_0)$ is positive, the above condition can be rewritten as

$$\overline{v}_{OM} > \overline{v}_{FE} \Leftrightarrow H(\overline{\sigma}) > 0. \tag{A.7}$$

By inserting $\sigma_0 = \overline{\sigma}$ into (10) and taking a few steps of algebra, we obtain a quadratic equation in R:

$$\begin{aligned}F(R) &:= -p^2q^2(1-q)(R-1)^2 + p(1-q)[(1-p)q(1-2q) + p(1-3q)](R-1) \\ &\quad +(1-p)[p(3q^2-3q+1) + (1-p)q(1-q)^2] \\ &= 0. \end{aligned} \tag{A.8}$$

Notice that $F(R) = \frac{H(\overline{\sigma})}{1-q}$ and thus $F(R) > 0 \Leftrightarrow H(\overline{\sigma}) > 0$. By (A.7), the previous two findings (i.e., $\overline{v}_{OM} > \overline{v}_{FE}$ at $R = \underline{R}_{FE}$ and $\overline{v}_{OM} < \overline{v}_{FE}$ at $R = \overline{R}_{OM}$) imply that $F(\underline{R}_{FE}) > 0$ and $F(\overline{R}_{OM}) < 0$, which in turn implies that the quadratic equation $F(R) = 0$ must have a solution $\overline{R}^* \in (\underline{R}_{FE}, \overline{R}_{OM})$ and such a solution is unique. By construction, $\overline{v}_{OM} > \overline{v}_{FE}$ at $R = \overline{R}^*$. ■

Proof of proposition 8.

First, $F(R)$ in (A.8) is a quadratic function of p and we denote it as $I(p)$. As shown in the proof of proposition 7,

$$\overline{v}_{OM} > \overline{v}_{FE} \Leftrightarrow I(p) > 0.$$

For any q,

$$\frac{\partial \overline{R}_{OM}}{\partial p}, \frac{\partial \underline{R}_{FE}}{\partial p} < 0$$

and therefore there always exist $\overline{p}_{OM}, \underline{p}_{FE} \in (0,1)$ such that

$$\begin{aligned} p = \overline{p}_{OM} &\Leftrightarrow R = \overline{R}_{OM} \\ p = \underline{p}_{FE} &\Leftrightarrow R = \underline{R}_{FE}. \end{aligned}$$

Furthermore, since $\overline{R}_{OM} > \underline{R}_{FE}$, $\overline{p}_{OM} > \underline{p}_{FE}$. In the proof of proposition 7, we show that $F(\overline{R}_{OM}) < 0$ and $F(\underline{R}_{FE}) > 0$ which implies that $I(\overline{p}_{OM}) < 0$ and $I(\underline{p}_{FE}) > 0$, respectively. Therefore, there always exists a unique value $\overline{p}^* \in (\underline{p}_{FE}, \overline{p}_{OM})$ such that

$$p > \overline{p}^* \Leftrightarrow I(p) < 0,$$

which concludes the proof (see the proof of proposition 7 for more details).■

Proof of proposition 9.

Proposition 7 implies that for any (R, p) there always exists a set of q such that $\overline{v}_{FE} > \overline{v}_{OM}$. Hence, to prove the claim in the proposition, it is enough to show that

$$\overline{v}_{OM}|_{q=1} = \overline{v}_{FE}|_{q=1} \tag{A.9}$$

$$\left.\frac{\partial \overline{v}_{OM}}{\partial q}\right|_{q=1} < \left.\frac{\partial \overline{v}_{FE}}{\partial q}\right|_{q=1}, \tag{A.10}$$

which implies the existence of a neighborhood around $q = 1$ where the operational manager is strictly preferred. The equilibrium condition (10) implies that σ_0 approaches to 0 as q increases to 1. From equations (22) and (8), it is then straightforward to show that the equality (A.9) holds. Next we turn to showing (A.10), by computing the relevant derivatives. By the implicit function theorem, we have

$$\left.\frac{\partial \sigma_0}{\partial q}\right|_{q=1} = -\left.\frac{\partial H/\partial q}{\partial H \partial/\sigma}\right|_{q=1} = \frac{p(1-R)}{1-p},$$

and so

$$\left.\frac{\partial \overline{v}_{OM}}{\partial q}\right|_{q=1} = -(1-p)\left.\frac{\partial \sigma}{\partial q}\right|_{q=1} = p(R-1). \tag{A.11}$$

Turning to financial experts, we have

$$\frac{\partial \overline{v}_{FE}}{\partial q} = p(R-1) + (1-p), \tag{A.12}$$

and thus (A.10) holds.■

References

Aghion, Philippe, and Jeremy C. Stein, 2008, Growth versus margins: Destabilizing consequences of giving the stock market what it wants, *Journal of Finance* 63, 1025–1058.

Antia, Murad, Christos Pantzalis, and Jung Chul Park, 2010, CEO decision horizon and firm performance: An empirical investigation, *Journal of Corporate Finance* 16, 288–301.

Bertrand, Marianne, and Antoinette Schoar, 2003, Managing with style: The effect of managers on firm policies, *Quarterly Journal of Economics* 118, 1169–1208.

Bond, Philip, Alex Edmans, and Itay Goldstein, 2012, The real effects of financial markets, *Annual Review of Financial Economics* 4, 339–360.

Booth, James R., and Daniel N. Deli, 1999, On executives of financial institutions as outside directors, *Journal of Corporate Finance* 5, 227–250.

Brandenburger, Adam, and Ben Polak, 1996, When managers cover their posteriors: making the decisions the market wants to see, *Rand Journal of Economics* 27, 523–541.

Byrd, Daniel T., and Mark S. Mizruchi, 2005, Bankers on the board and the debt ratio of firms, *Journal of Corporate Finance* 11, 129–173.

Chen, Qi, Itay Goldstein, and Wei Jiang, 2007, Price informativeness and investment sensitivity to stock price, *Review of Financial Studies* 20, 619–650.

Cho, In-Koo, and David M. Kreps, 1987, Signaling games and stable equilibria, *The Quarterly Journal of Economics* 102, 179–221.

Crawford, Vincent P., and Joel Sobel, 1982, Strategic information transmission, *Econometrica* 50, 1431–1451.

Custódio, Cláudia, and Daniel Metzger, 2014, Financial expert CEOs: CEO's work experience and firm's financial policies, *Journal of Financial Economics* 114, 125–154.

Dow, James, and Gary Gorton, 1997, Stock market efficiency and economic efficiency: Is there a connection?, *Journal of Finance* 52, 1087–1129.

Ferreira, Daniel, Miguel A. Ferreira, and Clara C. Raposo, 2011, Board structure and price informativeness, *Journal of Financial Economics* 99, 523–545.

Fu, Richard, and Ajay Subramanian, 2011, Leverage and debt maturity choices by undiversified owner-managers, *Journal of Corporate Finance* 17, 888–913.

Grossman, Sanford J., and Joseph E. Stiglitz, 1980, On the impossibility of informationally efficient markets, *American Economic Review* 70, 393–408.

Holmström, Bengt, 1999, Managerial incentive problems: A dynamic perspective, *Review of Economic Studies* 66, 169–182.

Jensen, Michael C., 2004, The agency costs of overvalued equity and the current state of corporate finance, *European Financial Management* 10, 549–565.

Kedia, Simi, and Thomas Phillipon, 2009, The economics of fraudulent accounting, *Review of Financial Studies* 22, 2169–2199.

Kyle, Albert S., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315–1335.

Kyle, Albert S., 1989, Informed speculation with imperfect competition, *The Review of Economic Studies* 56, 317–355.

Spence, Michael, 1973, Job market signaling, *Quarterly Journal of Economics* 87, 355–374.

Stein, Jeremy C., 1989, Efficient capital markets, inefficient firms: a model of myopic corporate behavior, *Quarterly Journal of Economics* 104, 655–669.

Titman, Sheridan, and Avanidhar Subrahmanyam, 1999, The going-public decision and the development of financial markets, *Journal of Finance* 54, 1045–1082.