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How Does Competing Against Strategic Investors Alter the Signaling Role of Corporate Venturing Decisions?

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Abstract: *This paper develops a signaling model to examine firms' corporate venturing decisions when the incumbent firm has private information about the quality of a project proposed by the current employee. Differing from the earlier studies, the analysis focuses on competition among firms, which are inherently strategic investors as the spillovers from the proposed project to their core businesses are crucial to their corporate venturing decisions. The signaling aspect of corporate venturing decisions provides the incumbent firm with an incentive to distort the implementation decision in order to conceal information from rival firms. The analysis shows that the presence of distortion depends primarily upon the opportunity cost of the employee not working in the firm's core business and the informational rents associated with the distortion in project implementation.*

Keywords: Corporate Venturing, Signaling, Employee Entrepreneurship, Project Implementation, Strategic Investors

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1. Introduction

Employees engage in entrepreneurial activities in addition to performing their daily tasks assigned by the firm. As a result, a considerable number of employee projects are implemented in new startups, financed either by the incumbent firm or by its competitors. Agarwal and Shah (2014) report that 24% of startups in the legal services industry are founded by former employees of established firms, while the same figure is over 80% in the information technology and communications and high-tech manufacturing industries.

Employee entrepreneurship is a double-edged sword for the firm. On the one hand, the firm benefits from employee ideas, especially in innovation-intensive industries. On the other hand, employee entrepreneurship may be detrimental to the firm's profits for the following reasons. First, the employee with talent and information critical to the firm's core business may separate to commercialize her idea outside the firm (Campbell et al., 2012). Second, employees may choose, at the firm's expense, to focus on conceiving and exploring new ideas rather than performing the tasks assigned by the firm (Hellmann, 2007b).

To internalize profits from employee projects, a growing number of large firms have launched formal programs to encourage their employees to explore new ideas. Such programs grant employees discretion in choosing the ideas to explore in a portion of their paid time. For example, *Google*'s "20% off" policy allowed employees to spend 20% of their time on creative side projects (Krasteva et al., 2015). Similarly, *3M* applies a "15%" rule that allows its employees to use 15% of their paid time to pursue ideas of their own interests (Govindarajan and Srinivas, 2013). As the main goal of such programs is to identify ideas with good prospects,

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firms form committees, usually consisting of senior executives and experts, to evaluate the viability of the proposed idea and to decide whether the firm should provide support in commercializing the idea.

In this paper, we study the firm's *corporate venturing* decision (i.e., its decision about implementing employee projects). Focusing on the informational asymmetry between the incumbent firm and rival firms concerning the quality of the employee's project, we build a theoretical model to examine the signaling role of corporate venturing decisions. The informational asymmetry, which is essential to the developed theory, arises through two channels. First, as in the asymmetric employer learning literature (Waldman, 1984; Kahn, 2013), the incumbent firm has better information about the employee's unobserved characteristics, which may affect the potential success of the proposed project. Second, the evaluation conducted by the incumbent firm may generate information that is hard to be acquired by other potential financiers.

We build a two-period model with identical firms and a single worker. In the beginning of period one, a firm hires the worker and assigns her to its core business. While performing the tasks related to the firm's core business, the worker also conceives a project idea that generates a positive return only if the quality of the project is good. The true quality of the project is unknown, but all players have the same prior concerning the project's quality. To seek financing for her project, in the beginning of the second period, the worker approaches the incumbent firm, which then performs a costly evaluation that generates a private signal about the quality of the project. The acquired signal is not perfectly informative, but its precision depends on how much the firm invests in the evaluation process. More specifically, the firm can increase the signal's precision by investing more, but it also incurs a higher evaluation cost as the signal becomes more precise. After observing the private signal, the incumbent firm decides between *corporate venturing* (i.e., implementing the worker's project in a new venture to which the worker is assigned as a manager) and assigning the worker to the core business, thereby skipping the project. Using the incumbent firm's corporate venturing decision, rival firms update their beliefs concerning the quality of the worker's project and then bid for the worker. After observing the rival firm's offer, the incumbent firm makes a counteroffer, and the worker chooses one of these offers based on utility maximization.

The key aspect of the model is spillovers generated by the project. As in de Bettignies and Chemla (2008) and Ekinci (2022), the project's implementation generates a spillover effect on the core businesses of both the incumbent firm and the rival firm. In other words, firms are *strategic investors*, using the terminology of Hellmann (2002), because they take into account the spillover on their core businesses as well as the surplus directly generated by the project. Hence, the spillover effect has a crucial role in equilibrium behavior, particularly in the incumbent firm's corporate venturing decision. As will be explained below, the equilibrium turnover hinges on whether the spillovers are larger for the incumbent firm or for the rival firm. At the time of hiring the worker in period one, none of the players knows for which firm the spillovers from the project would be larger. However, it is common knowledge that with positive probability, the rival firm experiences larger spillovers from implementing the project. The uncertainty is resolved before the incumbent performs an evaluation of the project.

The model yields two key tradeoffs that concern the incumbent firm's corporate venturing decision. First, because the worker who proposes the project is indispensable for implementation, the incumbent firm loses the worker's "talent" in its core business when it implements the project or when the worker moves to the rival firm. Second, once the incumbent firm's intention to implement a project is observed by the market, it incurs a higher cost to retain the worker. The reasoning behind this result is as follows. Because the incumbent firm has better information about the quality of the worker's project, its decision to implement the project conveys additional information to the market. Using the firm's decision as a signal of superior quality, the rival firm increases its bid for the worker; consequently, the incumbent firm either loses the worker or incurs a higher retention cost.

The analysis consists of two parts. In the first part, we provide a benchmark analysis that concerns what happens when the incumbent firm does not observe a private signal. Due to informational symmetry, the incumbent firm's corporate venturing decision has no signaling value. Therefore, the corporate venturing decision is determined by the first tradeoff described above. When the spillover effect is more substantial for the rival firm, the equilibrium entails turnover. Specifically, the worker switches to the rival firm if her project's expected quality exceeds a threshold and is retained in the incumbent firm's core business otherwise. In other words, the incumbent firm never finds it optimal to implement the project but retains the worker in the core business if the project's expected quality is sufficiently low. By contrast, there is no turnover when the spillover effect is larger for the incumbent firm. Specifically, the incumbent firm retains the worker in the core business if the project's expected quality is below a quality threshold; otherwise, it implements the project.

In the second part, we analyze what happens if the incumbent firm performs an evaluation of the project prior to its corporate venturing decision. Because the evaluation process generates a private signal for the incumbent firm, its corporate venturing decision serves as a signal of quality. Thus, the firm's decision about implementing the project is determined jointly by the two tradeoffs described above. To examine the extent to which informational asymmetry results in distortion in project implementation, we focus on the case in which the project would be implemented by the rival firm in the absence of an internal evaluation (i.e., the case in which the project's prior expected quality is sufficiently high and the spillover effect is greater for the rival firm). The size of the project return determines how much the incumbent firm invests in the evaluation process and, this, in turn, determines whether and by whom the project is implemented. If the project return is sufficiently high, the incumbent firm invests for low precision and chooses to implement the project regardless of the type of signal it observes, but it matches the rival firm's offer if and only if it observes a good signal. Therefore, using its informational advantage, the incumbent firm may implement the project, thereby retaining the worker who would otherwise move to the rival firm. Notably, although there is no distortion in the job assignment decision, the incumbent firm reduces the worker's probability of separation. By contrast, if the project return is sufficiently low, the incumbent firm invests for high precision and assigns the worker to the core business irrespective of the signal type. By distorting the corporate venturing decision, the incumbent firm conceals favorable information about the project, and therefore, in equilibrium, it achieves to retain the worker in the core business.

The current paper is closest in spirit to de Bettignies and Chemla (2008) and Ekinci (2022), both of which investigate the incumbent firm's decision between corporate venturing and retaining the worker in the core business. de Bettignies and Chemla (2008) consider a symmetric information environment in the sense that all market participants have the same information about the quality of the worker's project. Thus, the main tradeoff facing the incumbent firm is determined by returns to implementing the project and retaining the worker in the core business. By contrast, Ekinci (2022) develops an asymmetric learning model in which the incumbent firm is better informed, relative to other potential financiers, about the worker's entrepreneurial ability, which, in turn, affects the successful implementation of the proposed project. Notably, he considers venture capitalists as outside parties that are willing to finance the worker's project. The current paper differs in that it studies how the competition from rival firms alters the corporate venturing decision of the informationally advantaged incumbent firm. As noted by Hellmann (2002), the crucial difference between firms and venture capitalists is that the former are *strategic investors* in the sense that they consider how implementing a project affects their ongoing businesses as well as the return generated by the project itself, whereas the latter are *passive investors* since they do not own any assets on which undertaking the project generates spillovers. Hence, the current analysis is complementary to that of Ekinci (2022).

The rest of the article is organized as follows. Section 2 discusses the related work in the literature. Section 3 presents the model setup. Section 4 provides a benchmark analysis in which all firms have the same information about the worker's project. Section 5 analyzes the asymmetric information case in which the incumbent firm has better information relative to the rival firm concerning the project's quality. Section 6 concludes the article.

2. Related Literature

The paper mainly relates to the literature on learning in labor markets. Starting with the classic papers by Greenwald (1986) and Gibbons and Katz (1991), the ramifications of asymmetric information structure in labor markets have been examined thoroughly. More recently, Schonberg (2007), Pinkston (2009), and Kahn (2013) build theoretical models to derive testable implications of asymmetric learning in labor markets. In general, their results support the idea that current employers have better information, vis-à-vis potential employers, about workers' productivity.

The model developed in the paper is reminiscent of the studies in which job assignments serve as a signal of worker productivity. Starting with Waldman (1984), a large body of papers has examined the role of job assignments in workers' careers (e.g., Bernhardt, 1995; Zabojnik & Bernhardt, 2001; Ekinci et al., 2019). In their setting, because the current employer has better information about the productivity of workers, its job assignment decision serves as a signal of productivity. Therefore, the informational asymmetry provides the current employer with an incentive to distort the promotion decision to conceal favorable information about the worker's productivity from outside firms.

The idea that the firm invests to increase the precision of its private signal has also been used by Milbourn et al. (2001) and Mukherjee (2008). Milbourn et al. (2001) examine how a manager's career concern incentives affect her decision about how much to learn about a project before implementing it, whereas Mukherjee (2008) examines how a firm's disclosure policy affects the interaction between career concern incentives and implicit incentives.

In the context of corporate venturing, Hellmann (2007a) builds a model in which firms acquire information concerning the quality of an entrepreneur's project. However, the evaluation process does not lead to any informational asymmetry in his setting. Specifically, he considers an entrepreneur who approaches two parties that can provide complementary resources to increase the return from the project. However, before committing to providing any resources, one of the parties must perform a costly evaluation that reveals the true quality of the project. Since the result of the evaluation process is publicly observed, each partner has an incentive to wait to free ride on the other's evaluation. Finally, a small set of papers investigate project implementation decisions when potential financiers observe signals about the quality of the project with varying levels of precision. For example, Ueda (2004) considers a scenario in which the venture capitalist can evaluate an entrepreneur's project more accurately than the bank, but, unlike the bank, it can also steal the project. Hvide (2009) assumes that while large firms are more efficient in implementing projects, they are less informed, relative to small firms, about the quality of projects.

3. Model Setup

We consider a two-period model with risk-neutral players and no discounting. There are identical firms and a single worker. At the beginning of period 1, firms compete against each other to hire the worker. The firm that hires the worker is referred to as the incumbent firm (hereafter, *F*), whereas other firms are referred to as rival firms (hereafter, *R*).

In period 1, the worker is assigned to *F*'s core business, where she produces $\phi\eta$. Here η is the worker's "ability," and $\phi > 0$ measures return to ability at *F*'s core business. While the worker performs the assigned tasks at the firm's core business, she also engages in an entrepreneurial activity. In particular, she conceives a project whose quality, μ, is either "high" ($\mu = \mu^H$) or "low" ($\mu = \mu^L$). While the true quality of the project is not observed by any players, they share a common prior belief that $\Pr(\mu = \mu^H) = p$ is drawn from a continuous probability density function $f(\rho)$, where $\overline{p} \equiv E[p]$ and $\sigma^2 \equiv V[p]$. The implementation of the project requires an initial investment of I, $I > 0$, and if the project is of high quality, it yields a return of Π, where $\Pi \in [\Pi_{min}, \infty)$ and $\Pi_{min} > 0$, whereas it yields zero return if the quality of the project is low.

As indicated, the project generates a positive return only if it is of high quality. In addition, implementing the project generates a spillover effect on firms' core businesses. Specifically, firm *k*'s core business generates a return of $(1 + \mathrm{S}_{\mathrm{k}}^{+})\phi$ if the project is implemented by firm *k*, $k \in \{F, R\}$. Similarly, the spillover effect on firm *k*'s core business is $(1 + \mathrm{S}_{\mathrm{k}}^{-})\phi$ if the project is implemented by firm *j*, $j \neq k$ and $j, k \in \{F, R\}$. Following de Bettignies and Chemla (2008) and Ekinci (2022), we assume that $(\mathrm{S}_{\mathrm{k}}^{+}, \mathrm{S}_{\mathrm{k}}^{-}) \in \mathbb{R}^2$, and $\Delta S^k = \mathrm{S}_{\mathrm{k}}^{+} - \mathrm{S}_{\mathrm{k}}^{-} > 0$, so that both negative and positive externalities from the project are captured. For example, $\mathrm{S}_{\mathrm{k}}^{+} > 0$ means that there are complementarities between firm *k*'s core business and the proposed project. By contrast, $S_k^+ < 0$ implies that that the project cannibalizes firm k's ongoing businesses. Importantly, the spillover effect differs across firms. Specifically, $\Delta S^R = \Delta S^F + \kappa$, where $\kappa = \overline{\kappa} > 0$ with probability Γ and $\kappa = \underline{\kappa} < 0$ with the complementary probability. At the end of period 1, the value of κ is realized and publicly observed before *F* performs an evaluation about the project. Note that positive values of κ imply that the spillover effect is larger on *R*'s core business, whereas negative values imply a larger spillover effect on *F*'s core business.

The information structure of the game is as follows. The worker's ability, η, is public information. Initially, all market participants have the same information about the project's quality, μ; but *F* performs a costly evaluation that generates a private signal s, $s \in \{s^L, s^H\}$, which is informative with probability ψ:

$$\psi = \Pr(s = s^H | \mu = \mu^H) = \Pr(s = s^L | \mu = \mu^L), \tag{1}$$

where $\psi \in (1/2, 1)$. The precision of the signal, ψ, depends on the amount of resources invested by *F* in the evaluation process. That is, *F* can increase the signal's precision by dedicating more resources to the evaluation process, but this also increases the cost of evaluation borne by the firm. Specifically, the cost of acquiring a signal with precision ψ is given by $C(\psi)$, a strictly increasing convex function that satisfies the Inada conditions.

In the beginning of period 2, the worker approaches *F* to request financing for her project. Observing private signal s, *F* updates its belief concerning the quality of the project and then decides whether to implement it. Specifically, *F* decides between assigning the worker to the firm's core business, thereby skipping the project, and implementing the project in a new venture through *corporate venturing*. *R* observes *F's* decision and then submits a bid to provide financing for the project. After observing *R's* offer, *F* makes a counteroffer, and finally, the worker accepts one of these offers based on utility maximization.

While the worker is paid a fixed salary at the firm's core business, her period-2 contract depends on whether her project is implemented. If the worker is employed at *F*'s core business in period t, she is offered salary α_t. If her project is implemented, the worker is assigned as a manager to the venture responsible for implementation and offered an ownership stake in the venture. Specifically, firm k, $k \in \{F, R\}$, offers a contract with equity share λ^k.

To solve the model, we focus on the pure strategy perfect Bayesian equilibrium of the game in which beliefs are derived from Bayes' rule given the equilibrium strategies, and the equilibrium strategies are optimal for firms and the worker in each period of the game given the beliefs. Further, we impose certain restrictions on the off-the-equilibrium path beliefs to focus on equilibria that survive trembling-hand perfection. As indicated, in period 2, *F* is allowed to make a counteroffer after observing the offers made by *R*. We assume that *F* fails to make a counteroffer with probability $\epsilon > 0$ when it is optimal to retain the worker (i.e., with probability $1 - \epsilon$ *F* matches the rival firm's offer to retain the worker when matching is optimal given the equilibrium beliefs) and consider the equilibrium as ϵ approaches zero. In other words, *R* anticipates that it can successfully raid the worker with a small probability. Therefore, the winner's curse mechanism prevails in equilibrium, meaning that *R* does not make a bid that is higher than the project's net value. That is, the outside offers will be consistent with the belief that the worker's value is the minimum possible among the workers with the same publicly observed signals.

4. Symmetric Information Case

This section provides a benchmark analysis in which the incumbent firm does not perform an evaluation so that all firms have the same information about the quality of the worker's project. Due to informational symmetry, the incumbent firm's job assignment decision does not convey any information about the value of the project, and therefore, players' optimal behavior is determined by the common prior. The following result describes the equilibrium in period 2.

Proposition 1: Suppose that the value of κ is realized and publicly observed. There exist critical levels of quality p' and p'' such that the equilibrium behavior in period 2 is described by i) through iii):

i) R offers a contract with an equity stake $\lambda^{*R} = 1 + \frac{\phi(\Delta S^F + \kappa) - I}{\overline{p}\Pi}$, where $\kappa \in \{\underline{\kappa}, \overline{\kappa}\}$.

ii) Suppose $\kappa = \overline{\kappa}$. If $\overline{p} \leq p'$, *F* retains the worker in the core business and pays her $\alpha_2^* = \overline{p}\Pi - \mathrm{I} + \phi(\Delta S^F + \overline{\kappa})$. Otherwise, *F* does not match R's offer, and the worker moves to R.

iii) Suppose $\kappa = \underline{\kappa}$. If $\overline{p} < p''$, *F* retains the worker in the core business and pays her $\alpha_2^* = \overline{p}\Pi - \mathrm{I} + \phi\left(\Delta S^F + \underline{\kappa}\right)$. Otherwise, *F* matches R's offer with an equity stake $\lambda^{*F} = 1 + \frac{\phi(\Delta S^F + \underline{\kappa}) - I}{\overline{p}\Pi}$ and the project is implemented by *F*.

Since competition among the rival firms dissipates all the rents associated with the implementation of the project, the offer made by *R* is characterized by a zero-expected-profit condition. As a result, *R* does not earn any profits from implementing the project even when it raids the worker successfully. That is, the worker reaps all the expected net surplus generated by the project's implementation should she move to *R*. Notably, these rents include not only the net return generated by the project itself but also spillovers generated on *R*'s core business.

Whether the spillover effect is more substantial for *F* or for *R* is decisive for turnover and project implementation. Consider the case of $\kappa = \overline{\kappa}$, meaning that the spillover effect is more substantial for *R.* As indicated in i), the worker is offered a larger equity stake as spillovers on *R*'s core business increase. As a result, the worker's outside option gets better, and it becomes costlier for *F* to retain the worker. As stated in ii), *F* retains the worker in the core business if the project has a sufficiently low level of quality (that is, if $\overline{p} \leq p'$). On the contrary, it does not find it optimal to retain the worker if the project is of sufficiently high quality (that is, if $\overline{p} > p'$), in which case the worker accepts the offer made by *R*. Hence, the equilibrium entails turnover when the rival firm experiences a more substantial spillover effect than does the incumbent firm and the quality of the project is sufficiently high. In contrast, there is no turnover when the spillover effect is more substantial for *F* (i.e., when $\kappa = \underline{\kappa}$). In this case, *F* retains the worker at the core business if the quality of the project is lower than a threshold (i.e., if $\overline{p} < p''$), whereas it implements the project through corporate venturing if the project's quality exceeds the same threshold.

The following result shows how the two quality thresholds, p' and p'', depend on the parameters of the model.

Corollary 1: The critical level of project quality is higher when the spillover effect is more substantial for *F*, i.e., $p' < p''$. Both p' and p'' increase with ϕ, η, and I, whereas they decrease with Π and S_F^+.

Because turnover is possible only if $\kappa = \overline{\kappa}$, the essential difference between p' and p'' is that the former determines at which firm the worker is employed in period 2 (and her job assignment in that firm) while the latter determines the worker's job assignment inside the incumbent firm. However, in either case, the quality threshold refers to the highest-quality project that *F* finds it optimal to skip. When the spillovers are more substantial for *R*'s core business (i.e., when $\kappa = \overline{\kappa}$), it is more expensive for *F* to retain the worker in the core business since *R* offers the worker a larger equity stake than it does when $\kappa = \underline{\kappa}$. Therefore, the highest-quality project *F* finds it optimal to skip is lower when $\kappa = \overline{\kappa}$, that is, $p' < p''$.

To interpret how each parameter affects the quality threshold, consider the opportunity cost of implementing the project—thereby, losing the worker's talent in the core business. For example, when the project return, Π, or spillover effect, S_F^+, get larger, the opportunity cost decreases, and therefore, the quality threshold decreases as well. By contrast, higher values of ϕ or η indicate a higher opportunity cost; thus, the quality threshold increases with them.

Finally, the equilibrium period-1 wage, α_1^*, is characterized by a zero-expected-profit condition due to competition to hire the worker for the initial period. Note that the period-1 wage depends on the worker's period-2 job assignment, which, in turn, determines the size of expected rents associated with retaining the worker in period 2. If the worker's project is of low quality (i.e., $\overline{p} \leq p'$), *F* retains the worker in its core business regardless of the realization of κ. Thus, the period-1 wage includes the worker's output in period 1 and *F*'s rents from retaining her in the core business in period 2. When the quality of the project is at the intermediate levels (i.e., $p' < \overline{p} < p''$), the worker's period-2 job assignment depends on whether or not the spillover effect is more substantial for *F*. Because this is not known in the beginning of period 1, the period-1 wage includes the period-2 rents when the worker is retained by *F* in the core business and the rents when the worker switches to *R* to implement her project, where each event is multiplied by the probability of occurrence. Finally, if the project's quality is high (i.e., $\overline{p} > p''$), it will always be implemented, but the firm financing the project depends on the realization of κ. The following result formally states the period-1 equilibrium wage.

Proposition 2: Let $\hat{\kappa} = \Gamma\overline{\kappa} + (1-\Gamma)\underline{\kappa}$. In period 1, F hires the worker, and she is paid $\alpha_1^* = \phi\eta + \hat{\alpha}$, where

$$\hat{\alpha} = \begin{cases} \phi\eta - E_{\kappa}[\alpha_2^*] - \phi(1+S_F^-), & \text{if } \overline{p} \le p' \\ (1-\Gamma)[\phi\eta - \alpha_2^* - \phi(1+S_F^-)] + \Gamma\phi(1+S_F^-), & \text{if } p' < \overline{p} < p'' \\ (1-\Gamma)[-\phi\underline{\kappa}] + \Gamma\phi(1+S_F^-), & \text{if } \overline{p} > p'' \end{cases}$$

5. Asymmetric Information Case

This section provides an analysis of the asymmetric information case in which the incumbent firm performs a costly evaluation that yields a private signal about the quality of the worker's project. To reduce the number of cases to be analyzed, we assume that $\overline{p} > p''$ and $\kappa = \overline{\kappa}$. That is, in the absence of any private signal, the worker switches to *R* to implement her project. The analysis of this case illustrates the extent to which the informational asymmetry distorts labor turnover and project implementation.

Before proceeding with the analysis, we introduce additional notation. Let U_k^j and U_k denote, respectively, the period-2 expected utility of *k* when the project is implemented by j and the period-2 expected utility of *k* when the worker is assigned to the core business of F, where $j \in \{F, R\}$ and $k \in \{F, R, i\}$. Also, let $\sigma^F(s,\psi)$ denote *F*'s corporate venturing decision upon observing signal s with precision ψ, where $\sigma^F(s,\psi) = C$ if the worker is assigned to *F*'s core business in period 2 and $\sigma^F(s,\psi) = CV$ if *F* decides to implement the worker's project. Let $\mathrm{p}_1^{\mathrm{R}}(\sigma^F)$ denote the *R*'s belief concerning the quality of the project after observing *F*'s corporate venturing decision, σ^F.

To solve the model, we first derive the posterior of the project's quality, which depends on the signal's type and precision.

Lemma 1: For any $\psi \in (1/2,1)$ and given prior $\overline{p}$, $E[p|s^H,\psi] > \overline{p} > E[p|s^L,\psi]$. Moreover, a higher ψ leads to higher $E[p|s^H,\psi]$ and lower $E[p|s^L,\psi]$.

As expected, observing a good signal raises the expected quality of the project, whereas observing a bad signal reduces it. More importantly, the degree of upward or downward revisions is determined by the signal precision. In particular, the posterior mean conditional on a good signal increases with signal precision, while the posterior mean conditional on a bad signal decreases with it. This aspect of the posterior mean is the key to the determination of equilibrium behavior.

Let $\widetilde{\psi_l}$ and $\widetilde{\psi_h}$ be arbitrary levels of low and high precision, respectively, such that $E\left[p|s^L,\widetilde{\psi_h}\right] < p' < E\left[p|s^L,\widetilde{\psi_l}\right]$. First, suppose that *F* invests in a low level of precision, $\widetilde{\psi_l}$. Since the posterior mean is above the threshold for both signal types, *F* chooses to implement the project. Observing *F*'s corporate venturing decision, *R* submits a bid consistent with the belief that the worker has the lowest-quality project with the same public signal. That is, it offers the worker an equity stake $\lambda^{*R} = 1 + \frac{\phi(\Delta S^F + \overline{\kappa}) - I}{\mathrm{p}_1^{\mathrm{R}}(\mathrm{CV})\Pi}$, where $\mathrm{p}_1^{\mathrm{R}}(\mathrm{CV}) = \mathrm{E}\left[\mathrm{p}|s^{\mathrm{L}},\widetilde{\psi_l}\right]$. Because the spillover effect is more substantial for *R*, *F* does not match the offer unless it earns some informational rents. In other words, it does not match the offer if it observes a bad signal about the project's quality. By contrast, if *F* observes a good signal, it matches the offer if and only if $U_F^F \ge U_F^R$, i.e., $I\left[\frac{E[p|s^H,\widetilde{\psi_l}]}{E[p|s^L,\widetilde{\psi_l}]} - 1\right] \ge \phi\left[\Delta S^F\left[\frac{E[p|s^H,\widetilde{\psi_l}]}{E[p|s^L,\widetilde{\psi_l}]} - 1\right] + \overline{\kappa}\right]$. This condition is satisfied when *F*'s informational rents from implementing the project are large enough to bid up the worker's expected utility to the level induced by the offer made by *R*. Assuming that this condition is satisfied, *F*'s expected profits from corporate venturing are given by

$$E_s[U_F^F(\psi_l^*,s)] = E_s\left[\frac{E[p|s^H,\widetilde{\psi_l}]}{E[p|s^L,\widetilde{\psi_l}]}\left(I-\phi(\Delta S^F+\overline{\kappa})\right)+\phi(1+S_I^+)-I-C(\psi_l^*)\right], \quad (2)$$

where the optimal choice of signal precision ψ_l^* is determined by the condition $\frac{\partial E_s[U_F^F(\psi_l^*,s)]}{\partial \psi_l^*}=0$.

Next, suppose that F invests for high signal precision, $\widetilde{\psi_h}$. In this case, the posterior mean is below the quality threshold if and only if the observed private signal is bad. Thus, to conceal favorable information from the market, *F* assigns the worker to the core business even if it observes a good signal. Consequently, *R* lowers its bid to a level consistent with the belief that *F* has observed a bad signal. To retain the worker in the core business, *F* matches the offer and earns an expected profit of

$$E_s[U_F(\psi_h^*,s)] = \phi\eta-\left[E\left[p|s^L,\widetilde{\psi_h}\right]\Pi-\mathrm{I}+\phi(\Delta S^F+\overline{\kappa})\right]-C(\psi_h^*), \quad (3)$$

where the optimal choice of signal precision ψ_h^* is determined by the condition $\frac{\partial E_s[U_F(\psi_h^*,s)]}{\partial \psi_h^*}=0$.

To derive the incumbent firm's optimal choice of signal precision, we define $\Delta\mathrm{P}(\Pi)=E_s[U_F(\psi_h^*,s)]-E_s[U_F^F(\psi_l^*,s)]$, which is the incumbent firm's rents from investing for high precision. Since $\Delta\mathrm{P}(\Pi_{min})>0$ and $\Delta\mathrm{P}(\Pi)$ decreases with Π, there exists a critical level, Π', such that *F* finds it optimal to invest for the high precision if and only if $\Pi<\Pi'$.

The following results describe the equilibrium behavior in period 2.

Proposition 3: Suppose $\overline{p}>p'$ and $\kappa=\overline{\kappa}$. There exists a critical level of project return $\Pi'>\Pi_{min}$ such that the equilibrium behavior in period 2 is described by i) through v):

i) If $\Pi\geq\Pi'$, *F* invests for ψ_l^* and implements the worker's project, i.e., $\sigma^F(s,\psi_l^*)=CV$ for $s\in\{s^L,s^H\}$.

ii) If $\Pi<\Pi'$, *F* invests for ψ_h^* and assigns the worker to the core business, i.e., $\sigma^F(s,\psi_l^*)=C$ for $s\in\{s^L,s^H\}$.

iii) *R* offers the worker an equity stake $\lambda^{*R}=1+\frac{\phi(\Delta S^F+\overline{\kappa})-I}{\mathrm{p}_1^{\mathrm{R}}(\sigma^F)\Pi}$, where the offer is consistent with the belief

$$\mathrm{p}_1^{\mathrm{R}}(\sigma^F)=\begin{cases}E\left[p|s^L,\widetilde{\psi_l}\right], & \text{if } \sigma^F=CV \text{ and } \Pi\geq\Pi' \\ E\left[p|s^L,\widetilde{\psi_h}\right], & \text{if } \sigma^F=C \text{ and } \Pi<\Pi'\end{cases}$$

iv) *F* matches *R*'s offer with an equity stake $\lambda^{*R}=1+\frac{\phi(\Delta S^F+\overline{\kappa})-I}{E[p|s^L,\widetilde{\psi_l}]\,\Pi}$ if $\Pi\geq\Pi'$ and $s=s^H$, and with period-2 wage $\alpha_2^*=E\left[p|s^L,\widetilde{\psi_h}\right]\Pi-\mathrm{I}+\phi(\Delta S^F+\overline{\kappa})$ if $\Pi<\Pi'$ and $s\in\{s^L,s^H\}$. *F* does not match the offer if $\Pi\geq\Pi'$ and $s=s^L$.

v) The worker accepts *F*'s offer whenever it matches *R*'s offer.

This result demonstrates the extent of the incumbent firm's ability to hinder turnover. As indicated, if the incumbent firm did not perform an evaluation of the project, which results in an informational asymmetry, the project under consideration would be implemented by the rival firm. To discuss the equilibrium behavior from this perspective, let us evaluate the results under two categories of project returns: "high-return" and "low-return" projects, where a given project is categorized as a high-return project when its return, Π, exceeds the threshold, Π', and as a low-return project otherwise.

For high-return projects, the incumbent firm dedicates a small amount of resources to the evaluation process, which yields a relatively less precise private signal. Interestingly, the incumbent firm may still find it optimal to retain the worker even though it does not distort the job assignment decision. This follows since the rival firm cannot distinguish the projects with a good signal from the projects with a bad signal, as the incumbent firm assigns the worker to a new venture to implement her project irrespective of the type of signal generated by the evaluation process. Consequently, the rival firm makes a bid consistent with the belief that the signal that concerns the quality of the project is bad. If the project's signal is bad, the incumbent firm does not match the offer because its informational rents are zero, and the rival firm's contract is more efficient as the spillover effect is larger for its core business. In contrast, when the signal is good, the incumbent firm matches the offer and implements the project as long as the informational rents are large enough to offset its overpayment to the worker due to its spillover disadvantage vis-à-vis the rival firm. Hence, the evaluation process may help the incumbent firm retain the worker (although not in the core business) even when the project has a high return.

The result is stronger for low-return projects. The incumbent firm incurs a higher evaluation cost to increase the precision of its private signal. As opposed to the high-return projects, the incumbent can cover the cost of higher precision in this case because it distorts the job assignment decision. Specifically, it assigns the worker to the core business, which results in the rival firm downgrading its assessment of the quality of the worker's project. As a result, the incumbent firm retains the worker in the core business regardless of the type of signal it observes.

Proposition 4: Suppose $\overline{p} > p''$. In period 1, *F* hires the worker with a wage $\alpha_1^* = \phi\eta + \zeta$, where ζ denotes *F*'s expected period-2 rents.

As in the analysis of the symmetric information case, due to competition in period 1, the incumbent firm does not earn any rent from hiring the worker in this period. Instead, the worker captures all the rents through her period-1 wage, which include her period-1 output in *F*'s core business, $\phi\eta$, and *F*'s expected period-2 rents, ζ.

6. Conclusion

This paper provides a theoretical analysis of corporate venturing decisions in an asymmetric information environment. While the financing of entrepreneurial projects has been studied extensively, both in economics and management literature, the role of informational asymmetries inherent in corporate venturing decisions has been overlooked. The current analysis fills this gap by developing a signaling model in which the incumbent firm's decision to implement an employee project serves as a signal of quality.

The developed model extends the theory in Ekinci (2022), who also investigates the role of informational asymmetry on corporate venturing decisions. Different from his analysis, the current model considers the incumbent firm's competition against rival firms, rather than against venture capitalists, in financing the worker's project. As all firms are assumed to be strategic investors (i.e., they consider the spillover effect in assessing the value of the project), the equilibrium behavior hinges on the relative size of spillovers across firms.

The analysis shows that the incumbent firm can utilize its informational advantage to retain its employees, although these employees conceive lucrative projects. More specifically, we consider a scenario in which the worker would leave the incumbent firm to implement her project using financing provided by the rival firm when all firms have the same information about the project's quality. Introducing informational asymmetry into this case illustrates how the incumbent firm can make corporate venturing decisions strategically to hinder turnover. In particular, if the potential return from the worker's project is low, the incumbent firm invests in acquiring a precise signal and assigns the worker to its core business even though the project is a lucrative one. In equilibrium, the rival firm makes a bid consistent with a bad signal, and the incumbent firm retains the worker at its core business.

In terms of future research, it would be worthwhile to investigate how the signaling aspect of corporate venturing decisions affects the formation of new firms. In that sense, the current analysis provides testable implications concerning how the incumbent firm's informational advantage over its competitors alters the corporate venturing dynamics. As discussed, the firm's incentive to distort the implementation decision is closely related to the project's potential return and the spillovers to the firm's ongoing businesses. Finding plausible measures for these variables and conducting an empirical analysis of the signaling argument would generate further insights into the firm's corporate venturing decisions.

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Appendix

This section presents the proofs omitted in the text.

Proof of Proposition 1: Fix κ and consider *R*'s offer for the worker. Since *R* operates in a competitive market, its offer is characterized by a zero-expected-profit condition. Thus, *R* offers the worker equity stake $\lambda^{*R} = 1 + \frac{\phi(\Delta S^F + \kappa) - I}{\overline{p}\Pi}$, which gives the worker utility $U_i^R = \overline{p}\Pi - \mathrm{I} + \phi(\Delta S^F + \kappa)$ if she accepts the offer.

To show ii), consider *F*'s offer when $\kappa = \overline{\kappa}$. Assume, for contradiction, that *F* matches *R*'s offer to implement the project. In this case, *F* must offer λ^F that satisfies the worker's participation constraint, $E[\lambda^F p\Pi] \geq U_i^R$. Solving for λ^F yields $\lambda^F = \lambda^{*R}$, in which case *F* earns $U_F^F = E[(1-\lambda^F)\overline{p}\Pi - \mathrm{I} + \phi(1 + S_F^+)]$. Substituting λ^F into U_F^F yields $U_F^F = -\phi(\Delta S^F + \overline{\kappa}) + \phi(1 + S_F^+)$. Since implementing the project is optimal, by assumption, one must have $U_F^F \geq U_F^R = \phi(1 + S_F^-)$. This leads to a contradiction since the inequality does not hold. Hence, it is not optimal for *F* to implement the project.

Suppose now that *F* makes an offer to retain the worker in the core business. In this case, it offers period-2 wage α_2 that satisfies $\alpha_2 \geq U_i^R$, where U_i^R is given above. Since *F*'s payoff decreases with α_2, it sets $\alpha_2^* = \overline{p}\Pi - \mathrm{I} + \phi(\Delta S^F + \overline{\kappa})$. This is optimal for *F* if and only if the expected payoff from retaining the worker in the core business is higher than its payoff when the worker leaves, i.e., $\phi\eta - \alpha_2^* \geq \phi(1 + S_F^-)$. Substituting α_2^* into this inequality gives $\phi\eta - [\overline{p}\Pi - \mathrm{I} + \phi(\Delta S^F + \overline{\kappa})] \geq \phi(1 + S_F^-)$. Note that the left-hand-side of the inequality decreases with $\overline{p}$, whereas the right-hand-side does not change with it. Therefore, there exists a threshold quality level p' such that F finds it optimal to retain the worker in the core business if and only if the quality of the worker's project satisfies $\overline{p} \leq p'$.

To show iii), consider *F*'s counteroffer when $\kappa = \underline{\kappa}$. Suppose that *F* matches the offer to implement the project. As shown above, this means that *F* offers the worker equity stake λ^F which yields the worker utility U_i^R. In this case, *F* earns $U_F^F = -\phi\left(\Delta S^F + \underline{\kappa}\right) + \phi(1 + S_F^+)$. Note that $U_F^F > U_F^R$ since $\underline{\kappa} < 0$. Thus, F always matches *R*'s offer. Next, consider *F*'s counteroffer if it retains the worker in the core business. Like the case above, it offers a period-2 wage constraint α_2 that satisfies $\alpha_2 \geq U_i^R$. Thus, *F*'s payoff of retaining the worker in the core business equals $U_F = \phi\eta - \left[\overline{p}\Pi - \mathrm{I} + \phi\left(\Delta S^F + \underline{\kappa}\right)\right]$. Because *F* implements the project rather than letting the worker go, given the project's expected quality, it chooses between retaining the worker at core business and implementing the project. Note that U_F decreases monotonically with $\overline{p}$, whereas U_F^F does not depend on it. Therefore, there exists a threshold p'' such that F finds it optimal to retain the worker in the core business if and only if $\overline{p} < p''$.

Proof of Corollary 1: Suppose $\kappa = \overline{\kappa}$. As shown in the Proof of Proposition 1, p' is defined by the condition $U_F = U_F^R$, i.e., $\phi\eta - [p'\Pi - \mathrm{I} + \phi(\Delta S^F + \overline{\kappa})] = \phi(1 + S_F^-)$. Solving for p' yields $p' = [\phi\eta - \phi(1 + S_F^+ + \overline{\kappa}) + I]/\,\Pi$. Next, suppose $\kappa = \underline{\kappa}$. As shown in the Proof of Proposition 1, p'' satisfies $U_F = U_F^F$, i.e., $\phi\eta - \left[p''\Pi - \mathrm{I} + \phi\left(\Delta S^F + \underline{\kappa}\right)\right] = \phi\left[(1 + S_F^+) - \left(\Delta S^F + \underline{\kappa}\right)\right]$. Solving for p'' yields $p'' = [\phi\eta - \phi(1 + S_F^+) + I]/\,\Pi$. Differentiating p' and p'' with respect to the parameters yields the comparative statics results. Finally, note that $p' < p''$ since $\overline{\kappa} > 0$.

Proof of Proposition 2: Competition in period 1 drives up the worker's wage to a level such that the expected rents from hiring the worker in this period equal zero. This means that the period-1 equilibrium wage includes the period-1 output produced by the worker at *F*'s core business, $\phi\eta$, and *F*'s expected period-2 rents, $\hat{\alpha}$. As shown in Proposition, *F*'s period-2 expected rents depend on the prior expected quality of the project, $\overline{p}$. More specifically, the worker's job assignment and the size of the incumbent firm's period-2 rents are determined according to where $\overline{p}$ lies on the interval with respect to the two quality thresholds, p' and p''. If $\overline{p} \leq p'$, *F* retains the worker in the core business and earns $\phi\eta - [\overline{p}\Pi - \mathrm{I} + \phi(\Delta S^F + \kappa)]$, where $\kappa = \overline{\kappa}, \underline{\kappa}$. Therefore, the expected rents equal $\phi\eta - [\overline{p}\Pi - \mathrm{I} + \phi(\Delta S^F + \hat{\kappa})] - \phi(1 + S_F^-)$, where $\hat{\kappa}$ is defined as in the text. If $p' < \overline{p} < p''$, the worker switches to *R* to implement her project when $\kappa = \underline{\kappa}$, but she is retained by *F* in the core business when $\kappa = \underline{\kappa}$. Therefore, F's period-2 rents equal $(1 - \Gamma)[\phi\eta - \alpha_2^* - \phi(1 + S_F^-)] + \Gamma\phi(1 + S_F^-)$. Finally, if $\overline{p} > p''$, the worker's project is implemented by *R* when $\kappa = \underline{\kappa}$ and by F when $\kappa = \underline{\kappa}$. Thus, *F*'s expected rents are $(1 - \Gamma)\left[-\phi\underline{\kappa}\right] + \Gamma\phi(1 + S_F^-)$.

Proof of Lemma 1: Consider a fixed value of ψ. We use Bayes' rule to obtain $f(p|s^H) = \frac{f(s^H|p)f(p)}{\int_0^1 f(s^H|p)f(p)dp} = \frac{[\psi p+(1-\psi)(1-p)]f(p)}{[\psi\overline{p}+(1-\psi)(1-\overline{p})]}$ and $f(p|s^L) = \frac{f(s^L|p)f(p)}{\int_0^1 f(s^L|p)f(p)dp} = \frac{[(1-\psi)p+\psi(1-p)]f(p)}{[(1-\psi)\overline{p}+\psi(1-\overline{p})]}$. Using these conditional distribution functions, one can derive $E[p|s^H] = \overline{p} + \frac{\sigma^2[2\psi-1]}{\overline{p}[2\psi-1]+[1-\psi]}$ and $E[p|s^L] = \overline{p} - \frac{\sigma^2[2\psi-1]}{\overline{p}-[2\overline{p}-1]\psi}$. Since $\psi > 1/2$, we have $E[p|s^H,\psi] > \overline{p} > E[p|s^L,\psi]$ for any ψ. Differentiating $E[p|s^H,\psi]$ and $E[p|s^L,\psi]$ with respect to ψ yields $\frac{\partial E[p|s^H,\psi]}{\partial\psi} = \frac{\sigma^2}{[\overline{p}[2\psi-1]+[1-\psi]]^2} > 0$ and $\frac{\partial E[p|s^L,\psi]}{\partial\psi} = \frac{-\sigma^2}{[\overline{p}-[2\overline{p}-1]\psi]^2} < 0$, respectively.

Proof of Proposition 3: Suppose $\overline{p} > p'$ and $\kappa = \overline{\kappa}$. Start with *R*'s offer. Since *R* operates in a competitive market, its optimal contract is characterized by a zero-expected-profit condition. That is, given $\mathrm{p}_1^{\mathrm{R}}(\sigma^F)$, R offers the worker equity stake $\lambda^{*R} = 1 + \frac{\phi(\Delta S^F+\overline{\kappa})-I}{\mathrm{p}_1^{\mathrm{R}}(\sigma^F)\Pi}$ and the worker earns $U_i^R = [\mathrm{p}_1^{\mathrm{R}}(\sigma^F)\Pi - I + \phi(\Delta S^F + \overline{\kappa})]$ if she accepts the offer.

Now, consider *F*'s optimal strategy. Suppose that *F* chooses precision $\widetilde{\psi_l}$ such that $p' < E[p|s^L,\widetilde{\psi_l}] < E[p|s^H,\widetilde{\psi_l}]$. Because the posterior mean is always above the threshold, p', *F* finds it optimal to implement the project. Thus, $\sigma^F(s,\widetilde{\psi_l}) = CV$ for $s \in \{s^L, s^H\}$. Observing σ^F, *R* forms a belief that *F* has observed a bad signal, i.e., $\mathrm{p}_1^{\mathrm{R}}(CV) = E[p|s^L,\widetilde{\psi_l}]$, and then submits its bid accordingly. To match *R*'s offer, *F* must offer an equity stake λ^F that equals λ^{*R}. In this case, *F* earns $U_F^F(\widetilde{\psi_l},s) = \frac{E[p|s,\widetilde{\psi_l}]}{E[p|s^L,\widetilde{\psi_l}]}\left(I - \phi(\Delta S^F + \overline{\kappa})\right) + \phi(1 + S_F^+) - I - C(\widetilde{\psi_l})$, where $s \in \{s^L, s^H\}$. Note that when $s = s^L$, the payoff simplifies to $-\phi(\Delta S^F + \overline{\kappa}) + \phi(1 + S_F^+) < \phi(1 + S_F^-)$, where the inequality follows from the fact that $\overline{\kappa} > 0$. Thus, *F* does not match *R*'s offer when it observes a bad signal. In contrast, *F*'s payoff from matching the offer is greater than the payoff from letting the worker leave if and only if the condition $I\left[\frac{E[p|s^H,\widetilde{\psi_l}]}{E[p|s^L,\widetilde{\psi_l}]} - 1\right] \geq \phi\left[\Delta S^F\left[\frac{E[p|s^H,\widetilde{\psi_l}]}{E[p|s^L,\widetilde{\psi_l}]} - 1\right] + \overline{\kappa}\right]$ is satisfied. As discussed in the text, the equilibrium behavior is characterized under this condition. Finally, because *F* performs the evaluation before observing signal s, its expected profits are $E_s[U_F^F(\psi_l^*, s)]$ and the optimal precision ψ_l^* is determined by the condition $\frac{\partial E_s[U_F^F(\psi_l^*,s)]}{\partial\psi_l^*} = 0$.

Next, suppose that *F* invests in precision $\widetilde{\psi_h}$ such that $E[p|s^L,\widetilde{\psi_h}] < p' < E[p|s^H,\widetilde{\psi_h}]$. To conceal the type of its private signal, *F* assigns the worker to the core business regardless of the signal type, i.e., $\sigma^F(s,\widetilde{\psi_h}) = C$ for $s \in \{s^L, s^H\}$. Observing *F*'s decision, *R* forms a belief that the worker's project has the lowest quality among projects not implemented by *F* and then submits its bid accordingly. To match *R*'s offer, *F* sets $\alpha_2^* = U_i^R$ and retains the worker. Consequently, *F*'s retention payoff is $U_F(\psi_h^*, s) = \phi\eta - [E[p|s^L,\widetilde{\psi_h}]\Pi - \mathrm{I} + \phi(\Delta S^F + \overline{\kappa})] - C(\psi_h^*)$ for $s \in \{s^L, s^H\}$, where the optimal precision choice ψ_h^* is determined by the condition $\frac{\partial E_s[U_F(\psi_h^*,s)]}{\partial\psi_h^*} = 0$. Note that *F* earns the same payoff regardless of the type of signal it observes.

Note that $E_s[U_F(\psi_h^*, s)]$ decreases with Π, whereas $E_s[U_F^F(\psi_l^*, s)]$ does not depend on it. Given that $E_s[U_F(\psi_h^*, s)] > E_s[U_F^F(\psi_l^*, s)]$ for $\Pi = \Pi_{min}$, there exists a critical level $\Pi' > \Pi_{min}$ such that $E_s[U_F(\psi_h^*, s)] > E_s[U_F^F(\psi_l^*, s)]$ if and only if $\Pi < \Pi'$.

Proof of Proposition 4. Due to competition in period 1, *F* earns zero-expected rents from hiring the worker in the same period. Therefore, the worker's period-1 wage includes her period-1 output at *F*, $\phi\eta$, and its expected period-2 rents, ζ.

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