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STRATEGIC INCENTIVES TO HUMAN CAPITAL

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Motivating human capital in knowledge-intensive activities is a serious managerial challenge because it is difficult to link rewards to actions or performance. Firms instead might motivate knowledge workers by offering them opportunities to increase personal benefits (e.g., learning, satisfaction) through autonomy in the decision-making process. Our model shows that firms can offer less autonomy in projects closer to their core business: Because firm specialization raises the value of the project's outcomes, it also increases the benefits for knowledge workers, who derive motivation even though they make fewer decisions to support their realization of personal goals. Projects farther from the core offer weaker firm contributions, so firms can motivate knowledge workers by allowing them to benefit from greater autonomy. We discuss several implications of our analysis.

INTRODUCTION

Human capital is a key determinant of firms' success (Castanias and Helfat, 1991, 2001), but human capital management involves several dilemmas. In particular, motivating skilled people to perform in knowledge-intensive activities, to create a sustainable competitive advantage for the firm, is a widely recognized challenge in both academic literature (e.g., Coff, 1997; Gambardella, Giarratana, and Panico, 2010; Manso, 2011) and managerial practice (Kaplan, Khan, and Roberts, 2012; *The Economist*, 2013). As Zenger (1994) highlights, because the contribution of human capital to knowledge-intensive activities depends on difficult-to-observe effort and intangible capability, firms face problems in designing an appropriate incentive system because of their inability to observe actions or key individual characteristics (e.g., skills). His empirically supported claim indicates that, when it comes to R&D, small firms are better positioned to motivate and attract human capital than large firms. Small firms can better measure and implement performance-contingent rewards because of the shorter organizational distance between managers and researchers and their simpler organizational structure.

This article proposes a framework to help firms effectively manage human capital, even when actions are hidden, performance is difficult to measure, and performance-based rewards cannot be used. We cast our argument in general terms, but our findings should be particularly relevant for large organizations (Zenger, 1994). We posit that firms can motivate knowledge workers (Davenport, 2005; Drucker, 1999) by conferring "decision rights" on them—that is, the rights to make decisions during the implementation of a project. The more decisions knowledge workers make, the more they can direct their activities toward their own goals, granting greater weight to the pursuit of objectives that interest them more, such as problems they are more confident or passionate about or actions that are instrumental to other worker goals (e.g., future career, external visibility). In

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addition, autonomy is intrinsically valuable to some workers (Bartling, Fehr, and Herz, 2013). Although autonomy implies that some worker actions will not benefit the firm directly, the firm will nonetheless derive benefits because autonomy helps motivate knowledge workers to participate in the project and expend greater effort.

We present a formal agency model that captures several key features of human capital management in knowledge-intensive activities when the firm cannot rely on verifiable measures of performance and effort. For the sake of simplicity, we focus on the realization of a specific project within the firm, using R&D as a central example. However, our analysis can extend to other knowledge-intensive projects or contexts, such as the development or launch of new products. The key model ingredients are the extent to which knowledge workers hold decision rights over the implementation of the project and monetary compensation. We also focus on autonomy as an incentive to create motivation. The literature has typically treated delegation as a tool to enhance efficiency because, for example, knowledge workers better understand the problems at stake (e.g., Sauermann and Cohen, 2010). Yet, the role of autonomy as an incentive tactic is not well understood. To focus on incentives, the model rules out any impact of autonomy on efficiency: It assumes that the allocation of decision rights only affects the personal benefits workers obtain relative to the firm, without affecting the overall benefits from the project.

As an illustration, consider the employment of Wallace Carothers by DuPont in the late 1920s—which led to one of the most important discoveries of the last century—nylon. Carothers, a young scientist at Harvard, chose to leave academia to work at DuPont only after receiving repeated assurances that he could pursue independent research. He would not have accepted the job if he had to sacrifice his autonomy, even if DuPont had offered a much higher salary. The broad lesson from this is that firms can use two instruments (i.e., salary and autonomy), rather than just one (i.e., salary), when designing incentive schemes. Firms then can achieve better results to attract, retain, and encourage the efforts of knowledge workers. Carothers's story also is a good example of the importance of autonomy for incentives, not just for efficiency. DuPont offered him considerable autonomy to induce him to accept the job and possibly to encourage him to exert more effort, not because he knew better than the firm which research directions would be most fruitful for the company. As Smith and Hounshell (1985: 436) note, "DuPont Chairman Lammot du Pont clearly" ... denied that "the best direction of research is not to direct it."

Our model shows that the firm relinquishes to workers fewer decision rights, and also pays them less, when the project resides in its core business or generates fewer spillovers to other firm activities. This contribution is novel because it suggests that salary and autonomy are substitutes (see Stern, 2004). Intuitively, when a project is closely related to a firm's core business, the firm contributes more to the value of the project. Thus, it owns more and better assets, has accumulated a great amount of learning, is specialized, or employs several other knowledge workers who can contribute to the project directly or indirectly. The knowledge worker then enjoys significant benefits from participating in the project because the scale of all these complementary assets contributes, along with his or her effort, to produce high value. As a result, the worker accepts fewer decision rights because control over the project is not crucial. In contrast, for projects outside the core, the scale of complementary assets is much smaller, and the worker must be endowed with more autonomy to obtain a comparable level of personal benefits. Similarly, if a project generates many spillovers, the firm suffers less from granting extensive autonomy because, even if the worker's effort is not perfectly aligned with the interests of the firm, his or her actions might still benefit other firm projects. Our model also shows that, if the costs of providing incentives, whether through decision rights or monetary premiums, become too high, firms may decide not to engage the most knowledgeable workers in the project.

In the late 1920s, DuPont had just begun investing in basic research. The company had practically no history of basic research projects, and Carothers could not benefit from interactions with leading firm scientists. Thus, he had few incentives to join as a means to capture personal benefits from DuPont's basic research tradition or environment. As our model predicts, DuPont could only offer extensive autonomy, along with a salary. In contrast, many young scientists and engineers were thrilled to join a project at Bell Labs or Intel during their dominant years, even if they had to work on established projects under tight supervision

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(Moore and Davis, 2004; Nelson, 1962). The basic research nature of Carothers's projects also implied that whatever he was going to produce could affect several downstream activities of the firm. Before Carothers, DuPont tried to hire more reputed scientists (Smith and Hounshell, 1985), but as our model predicts, the cost of providing them with incentives was too high, and in the end the firm turned to a younger, less reputed scientist.

This study is germane to recent literature on strategic human capital, in several ways. First, we shed light on the managerial problem of motivating workers in knowledge-intensive activities by relinquishing decision autonomy in firms' projects (Coff, 1997; Zenger, 1994). Our approach emphasizes the allocation of decision rights rather than property rights over firms' assets (Grossman and Hart, 1986) as a means to provide incentives (Coff, 1999; Kim and Mahoney, 2005). The allocation of decision rights over a project, without change in property rights, is a more compatible and widespread tool that firms can use to motivate a wide range of employees.

Second, we identify the relationship between the firm's core assets and capabilities and a worker's skills as a key determinant of the allocation of decision rights in knowledge-intensive activities. In our model, complementarity always exists between the firm's assets and capabilities in a project and the worker's skills in that project. However, the scale of the firm's asset can be high or low. If high (core projects), given the worker's contribution, the value produced by the combination of the firm's and worker's contributions is high—as are the personal benefits of the worker. If low (non-core projects), the value produced by the combination is low; as a result, the firm needs to provide the worker with greater autonomy to enable him or her to enjoy personal benefits and thus become motivated to participate in the project. In this respect, our analysis follows Campbell, Coff, and Kryscynski (2012), who argue that high complementarity between a firm's assets and capabilities and workers' knowledge does not necessarily derive from workers' specialized knowledge, it can also stem from better or larger firm capabilities, which depend on workers' general skills.

Third, we demonstrate how the relationship between worker knowledge and a firm's core capabilities should be exploited in project management. Along with several recent contributions (e.g., Makadok, 2003; Wang, Jinyu, and Mahoney, 2009), we show that the available resource base and the effectiveness of the incentive system jointly influence organizational performance. The ability to design incentive systems to manage human capital can be central to gaining a sustainable advantage (Coff, 1997), and some scholars have indicated that the practice of talent management offers the greatest opportunity for improvement in shaping the performance of R&D labs (Aghina, de Jong, and Simon, 2011). Overall, we thus respond to the recent calls for examination of the foundations of human capital-based advantages (Coff and Kryscynski, 2013; Teece, 2007).

In the next section, we provide the background for our analysis. We then develop our formal model and derive its main propositions. Finally, we discuss our key results and their implications. All proofs appear in the Appendix.

BACKGROUND AND RELATED LITERATURE

Decision rights and misaligned objectives

Knowledge-intensive activities have multiple targets and require several decisions during their implementation; in turn, knowledge workers have a desire for autonomy processes (Davenport, 2005). To organize these activities, a firm usually defines the extent to which a manager or researcher can control some physical assets or a group of employees, as well as budget authorizations and other rules or regulations. For example, most R&D projects comprise several activities, and there are many situations that demand a decision. For each activity, the firm must decide who is in charge, which external partners to engage, how to address a specific problem, what to do with the prospective outcome of the activity, and so on (Cassiman, Di Guardo, and Valentini, 2010). In general, firms can establish the extent of workers' autonomy by sharing control and decision rights with them.

Evidence that decisions rights can be shared also appears in the formal contracts that underlie interfirm collaborations. Lerner and Merges (1998) provide an example in the context of R&D alliances between pharmaceutical firms and biotechnology companies, which include decisions about when to patent a drug compound or submit it to clinical trials, when to stop the clinical trials, and so forth. The alliance contract establishes which

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party is in charge of each decision, such as who decides whether a compound is patented, whether the trial is terminated, or when the drug is to be marketed. Most important for our purposes, these decision rights are allocated beyond and independently of the allocation of property rights (Panico, 2011, 2012). A similar context, and a similar allocation of decision rights, can be envisaged for a knowledge worker.

We study the extent to which the firm should permit the worker to make autonomous decisions in a given project, and we assume that this autonomy depends on the share of decision rights in the project the firm allocates to the worker. A decision can be controlled by the worker or by the firm (or some top manager), and when we aggregate the decisions about a project under the control of each party, it leads to a particular share of decision rights granted to each party.

Unlike alliances, for which contracts often explicitly list decision rights, in the case of knowledge workers, we are agnostic about whether decision rights are formally listed in the contract. They may be, but a more typical context in this case is whether the "culture" of the firm favors delegation and autonomy, which has implications for the share of decisions made by the knowledge worker. A cultural predisposition toward delegation often depends on the attitude of individual managers. As suggested by a recent article in the *Financial Times* (Shragai, 2013), and confirmed by interviews we conducted with R&D managers, some managers delegate more and others delegate less, largely according to their personalities. However, within some range based on managers' personalities, the culture of the firm likely sets some important baseline attitudes. In some firms, the prevailing managerial culture is to centralize decisions, while in others, attitudes toward delegation are more open. This culture then affects the share of decision rights that knowledge workers expect to receive, which in turn determines their incentives.

Our assumption with respect to autonomy is twofold. First, we assume that the worker uses autonomy to enhance his or her personal benefits. Second, we posit that these benefits are "private" or noncontractible and depend not only on the ability of the worker and the effort exerted but also on the firm's assets and capabilities. In this respect, owning decision rights in the project creates benefits for both the knowledge worker and the firm, though the benefits do not necessarily coincide. Basic research is a classic example: Both the firm and the scientist may benefit from it, but the scientist may prefer to undertake more research to gain a better basic understanding of a phenomenon, whereas the firm's best interest is to move on to innovation development and exploit the spillovers to other activities. As Smith and Hounshell (1985) recount, after discovering nylon, Carothers wanted to understand the fundamental properties of the material better, but the firm was interested in further developments of the fiber.

Knowledge workers also want to reveal the intermediate results of their research to gain visibility within the scientific community, but doing so can expose the firm to the risk of information leakage. Individual workers might also prefer to invest in more generic knowledge, to retain their options outside the firm, whereas the firm benefits more from firm-specific investments (e.g., Coff and Kryscynski, 2013). Substantial evidence indicates a lack of full alignment of firm objectives with the objectives of its most skilled employees: One-quarter of the workers with the highest potential believe that their personal aspirations differ from the organization's plans for them (Martin and Schmidt, 2010).

These differences create tension. On the one hand, giving knowledge workers more autonomy can create a loss for the firm from misaligned objectives; on the other hand, autonomy creates personal benefits for workers, and leveraging their intrinsic motivations may help the firm correct agency problems (Frey, 1997). Scarpello and Campbell (1983) find that pay satisfaction is not the most important factor for scientists, and their intrinsic motivation is highly correlated with their decision rights (Baylin, 1985). Accordingly, job offers to workers with a science orientation typically involve some degree of autonomy, such as time to conduct independent research (e.g., Stern, 2004).

Unverifiable output, unobserved input

When the output of a process is verifiable, incentives can be provided in standard pay-for-performance schemes. However, measuring knowledge-intensive activities or verifying their output is difficult. In this respect, our assumption is not that output cannot be observed but that it is difficult to verify, which means that it cannot be used as a contractual term. Even

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if output could be observed, there are several reasons it cannot be employed in a contract for a knowledge-intensive job. For example, the firm can observe the number of inventions or papers a researcher produces, but whether a third party can make unambiguous statements about their value is not obvious. Such an independent assessment of the value of these inventions may require evaluations and entail ambiguities that can make the verification too costly, thus discouraging its use in the contract. Zenger (1994) notes that, in larger firms, knowledge outputs stem from complex and intertwined activities that involve many individuals and units. As a result, it is difficult to measure the contributions of individual units to such outputs, let alone those of individual workers. In addition, larger firms tend to feature greater sociopsychological resistance among employees to differentiated rewards.

Furthermore, the outcome of knowledge-intensive activities often becomes observable only over time. A lag of two or three years, as is typical in research or managerial plans, may be too long to motivate a knowledge worker with *ex post* rewards that are available only after this verification. Knowledge-intensive activities also produce many fuzzy outcomes that are difficult to quantify, such as the development of absorptive capacity or learning applicable to related projects. This challenge is especially pertinent for companies with a broad technological base, which can benefit from research that is not directed to a specific goal and take advantage of knowledge outcomes that would be difficult to specify in a contract.

To emphasize that our framework depends on unverifiable output, we acknowledge that this assumption might not apply to top managers. Employees at the upper echelons of organizations can be evaluated by synthetic performance measures that can be contracted, such as profits or productivity. Thus, the focus of our analysis is on middle managers and researchers who perform knowledge-intensive but partial tasks, including initial scientific discoveries and technological prototypes, and whose contributions to firm-level outcomes intertwine with those of other activities. The partial nature of these outcomes (e.g., specific monetary outcomes that contribute to the firm's profit) makes it difficult to define them in the short run. The increasing importance of knowledge in business activities implies that such tasks now permeate many organizational layers, and knowledge-intensive workers occupy many different levels, functions, and departments. At these levels, tasks are particularly difficult to determine with synthetic indicators. In addition, knowledge-intensive activities are generally characterized by unobserved inputs. Because the key input to these activities is knowledge and brain-intensive effort, they are by definition difficult to monitor (Davenport, 2005).

THE MODEL

We investigate a firm that has an opportunity to start a new project by engaging a knowledge worker. In our setting, firms must enlist workers in a new knowledge-intensive project that they want to launch, and they must properly motivate them through the design of their incentive scheme. This challenge is not necessarily a new employment problem; the knowledge workers could be current employees working on other activities. Risk, innovativeness, project team composition, and broader organizational aspects matter for the formal design of projects (Cardinal, 2001). We acknowledge these factors but leave them in the background.

The setting of our problem is research, though our model also has implications for a broad range of situations in which firms must manage knowledge workers in a project. All the variables we introduce are at the project level. Furthermore, we focus on the short run, in that we assume that the project itself, the firm's capability, and the worker's human capital are given. The firm must decide whether to start the project and how to optimally manage it when engaging the worker.

We model the firm–worker relationship as an agency relationship, assuming that the firm F, which acts as the principal, makes an offer to the worker W (the agent), specifying a few elements that we discuss subsequently. For the purposes of this study, we employ functional forms that allow us to skip the technicalities of a more general analysis and stress closed-form solutions, though the results are broadly general and robust to less stringent information specifications (Panico, 2012).

The research process

We assume that the worker W has project-specific skills $s \geq 0$ and that she exerts an effort, $e \geq 0$, that produces some disutility for her but also generates

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benefits for both her and firm F, as we describe subsequently. The contribution of firm F is summarized by a factor A. The three factors are complementary, and we specify that the total value of the project is esA, where we weight the three variables equally for simplicity. As we already noted and also show subsequently, what is crucial for our model is not whether A and s fit with each other. They always do, as implied by complementarity. Rather, given e and s, a higher A implies a higher scale of the firm's complementary asset that raises the value of the project. To keep with our example in the Introduction, Carothers's skills were complementary with DuPont's basic research assets. However, the scale of DuPont's basic research assets was limited, with implied lower potential value of DuPont's basic research projects.

In A, we lump several elements. The firm may hold a higher quantity or quality of assets to carry out the project, it may have conducted many projects in the same domain and therefore has accumulated significant learning in the field, or it could employ a large stock of research personnel or scientists who participate in the project or work on related projects that produce spillovers to the focal project. Typically, A is high when a project resides within the boundaries of the firm's core business activities, and it is low when the project is distant from the firm's core. For example, in the energy sector, a company that usually does research on boiling water reactors might have fewer assets or capabilities on research projects related to pressurized water reactors. In addition, a high value of A might serve as a proxy for the availability of general assets that can be used for different purposes; for example, in pharmaceutical research, having a more or less developed center for high-throughput screening, which supports scientists in the screening and identification of millions of compounds in many therapeutic classes, might significantly influence the output of a research project.

A decision is under someone's control if he or she has the right to make that decision, and we let λ be the portion of decision rights in a project controlled by W and $1-\lambda$ be the portion controlled by F. We make the simplifying assumption that the share of decisions controlled by W only creates value that accrues to W's personal benefits, whereas the share of decisions controlled by F only creates value for F. Thus, the share of the project's value to W is λesA, and the share of the project's value to F is $(1-\lambda)esA$. This assumption rules out efficiency effects produced by autonomy; that is, the total value of the project does not change according to λ. As noted previously, this enables us to focus on the effects of autonomy (λ) on incentives. If, for example, the total value of the project is increasing (decreasing) with λ for some combination of e, s, and A, for efficiency reasons, the firm will relinquish (retain) decision rights. We further assume that, when obtaining the same level of profits, F prefers to retain decision rights rather than relinquishing it to W.

Payoffs

Both F and W obtain benefits from the project. In an established company, workers are likely to benefit from large and expensive equipment or can rely on extensive funding or technical personnel. Along with outputs that enhance the profits of the company, these factors produce outputs that provide greater personal benefits to the worker and thus are an advantage of leading companies. For example, a scientist might attain greater visibility or better scientific outcomes by working for a firm with up-to-date equipment, advanced research labs, and extensive research personnel.

Both the firm's and the worker's benefits are greater if they have more control over the project. We then assume that F and W obtain benefits from the project, equal to

$$b^F = (\alpha + 1 - \lambda)\, esA,$$

$\alpha > 0$, and

$$b^W = \lambda esA.$$

Thus, while the benefit of W is equal to her share of the value of the project, the benefit of F is equal to F's share of the value of the project plus spillovers to other firm projects and activities, as captured by the parameter $\alpha > 0$. We assume that the spillovers are also proportional to esA. This assumption is natural, because a more valuable project is likely to produce higher spillovers. Note also that, due to the spillover effects, the overall benefits for the firm are positive even if the worker has full autonomy, $\lambda = 1$. Moreover, $b^F + b^W$ still does not depend on λ, which allows us to focus on incentive-based explanations.

Worker W has a disutility from effort $\frac{1}{2}e^2$ and is compensated by F with a payment $p \geq 0$. If W does not accept F's offer to engage in the

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project, she obtains an outside option $\frac{s^{2+\gamma}}{2}, \gamma \geq 0$. Thus, our model acknowledges that a more knowledgeable worker can obtain a larger payoff in the market. The parameter γ measures how quickly the worker's outside option increases relative to the payoff from the project (in equilibrium), which we show to be quadratic in s. Instead, F's baseline payoff is constant and normalized to 0.

Ultimately, the payoffs for F and W are, respectively,

$$\pi = esA\left(\alpha + 1 - \lambda\right) - p,$$

and

$$u = p + esA\lambda - \frac{1}{2}e^2.$$

Information and contractibility assumptions

When engaging the worker for the project, the firm can set both the payment and the allocation of control, choosing $p \geq 0$ and λ. At the same time, neither b^F and b^W nor the project outcome can be verified *ex post*. We focus on the case in which the worker's effort e is hidden, such that there is a moral hazard concern.[1] Operationally, F's problem is to establish the ingredients λ and p of the offer to make to W that will connect the decision rights and payment (and the unobserved effort) with the project-specific skills s. Worker W can either accept F's offer to be engaged in the project or choose the outside option. The comparison between alternative scenarios allows us to highlight the different limitations a firm encounters when managing knowledge workers according to the assets that it owns, the extent of the spillovers, and the opportunities the worker has outside the firm.

HOW TO MANAGE THE PROJECT

Managing a project with complete information

We begin by setting the benchmark of complete information, when F observes W's effort e and skills s, to which we compare F's optimal decisions when W's effort is hidden. F can relate λ, e, and p to s, with the only constraint that W's payoff when accepting F's offer is not lower than the outside option, or

$$p + \lambda esA - \frac{e^2}{2} \geq \frac{s^{2+\gamma}}{2} \quad (PC)$$

We define $\lambda^*(s), e^*(s)$, and $p^*(s)$ as the equilibrium values of control, effort, and payment, respectively; $\Pi^*(s)$ as F's equilibrium payoff; and $s^*(A,\alpha) = A^{\frac{2}{\gamma}}\left(1+\alpha\right)^{\frac{2}{\gamma}}$. We can prove the following proposition.

Proposition 1: Consider the case in which the firm has complete information. Then,

1 *If* $s \leq s^*(A,\alpha)$, *the firm keeps all the decision rights,* $\lambda^*(s) = 0$; *the worker exerts an effort* $e^*(s) = sA(1+\alpha)$ *and receives a payment* $p^*(s) = \frac{s^2}{2}\left[A^2\left(1+\alpha\right)^2 + s^{\gamma}\right] > 0$; *and the firm obtains an optimum payoff* $\Pi^*(s) = \frac{s^2}{2}\left[A^2\left(\alpha+1\right)^2 - s^{\gamma}\right]$.
2 *If* $s > s^*(A,\alpha)$, *the project is not started, and the worker takes the outside option.*

Proposition 1 sets the benchmark for our analysis. Note that, even with complete information, the firm might prefer not to start the project and the worker leaves, if she is too skilled. It is important to clarify how negative profits $\Pi^*(s)$ when $s \geq s^*$ connect with the greater knowledge possessed by workers with a higher s. From the expression that defines π, a higher s always implies higher firm profits. However, if we take the participation constraint (PC) into account, the extra profits from greater effort that can be demanded from a knowledgeable worker with a higher s may not be enough to compensate for the additional payoff to the worker, $\frac{s^{2+\gamma}}{2}$, to keep him or her inside the firm. This outcome happens if the firm does not own enough complementary assets in comparison with the worker's skills or does not enjoy enough spillovers, such that $s \geq s^*(A,\alpha)$. Also note that, in this benchmark case, the firm does not need to allocate decision rights to the worker when the project starts, $\lambda^*(s) = 0$, because it can observe her effort and command $e^*(s)$, such that it is sufficient to compensate the worker for her cost of effort, paying her $p^*(s)$.

This benchmark result is important. Under complete information, the firm does not need to

[1] The main results of our analysis hold with hidden information as well. The hidden information model is available from the authors on request.

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relinquish control over the project, because it does not need to motivate the worker. In this case, the firm can simply set effort to its optimal level, $e^*(s)$, and collect all decision rights, $\lambda = 0$. The firm attracts the worker by using only one instrument—the salary $p^*(s)$. Moreover, in this context, the worker never obtains a payoff that is greater than her outside option.

Managing a project with hidden effort

We now study the case in which F does not observe W's effort. In addition to the participation constraint (PC), F must also provide the right incentives to W to induce her to exert a certain level of effort. Because of this additional constraint, the firm now relinquishes decision rights to the worker; in this way, the worker obtains benefits that are linked to the exerted effort. Let $\hat{\lambda}$, $\hat{e}\,(s)$, and $\hat{p}\,(s)$ be the equilibrium level of autonomy, effort, and payment for the case of hidden effort. Different scenarios emerge according to the combination of the firm's complementary assets, how they compare to the worker's skills, the spillovers, and the environment outside the firm boundaries. We define $\underline{s}\,(A) = A^{\frac{2}{\gamma}} \leq \overline{s}\,(A, \alpha) = A^{\frac{2}{\gamma}}\,(2\alpha + 1)^{\frac{1}{\gamma}} \leq s^*(A,\,\alpha)$. We can prove the following:

Proposition 2: If the worker's effort is hidden, then

1 *If* $s < \underline{s}\,(A)$ *and* $\alpha < 1$, *the firm shares decision rights with the worker*, $\hat{\lambda} = \frac{1+\alpha}{2}$, *who exerts an effort* $\hat{e}\,(s) = \frac{sA(1+\alpha)}{2}$ *and receives the minimum payment* $\hat{p}\,(s) = 0$.
2 *If* $s < \underline{s}\,(A)$ *and* $\alpha \geq 1$, *the firm transfers all the decision rights to the worker*, $\hat{\lambda} = 1$, *who exerts an effort* $\hat{e}\,(s) = sA$ *and receives the minimum payment* $\hat{p}\,(s) = 0$.
3 *If* $\underline{s}\,(A) \leq s \leq \overline{s}\,(A, \alpha)$, *the firm transfers all the decision rights to the worker*, $\hat{\lambda} = 1$, *who exerts an effort* $\hat{e}\,(s) = sA$ *and receives a payment* $\hat{p}\,(s) = \frac{s^2}{2}\left(s^{\gamma} - A^2\right) > 0$.
4 *If* $s > \overline{s}\,(A, \alpha)$, *the project is not started*.

Proposition 2 covers the different cases for the constellation of parameters A, s, and α. In all possible scenarios, the worker exerts a suboptimal effort. As is standard in agency theory, the additional incentive compatibility constraint the firm faces when the worker's effort is hidden makes it more costly for the firm to induce the worker to exert an effort, and, therefore, in equilibrium effort is lower than $e^*(s)$. In addition, the firm now allocates (some) decision rights to the worker to better motivate her to exert an effort. Finally, because additional agency cost is incurred by providing the incentives, the firm obtains lower optimum profits, and therefore the project is started less often than in the benchmark. We address the different cases separately to highlight the intuition behind the formal results.

Strong assets and moderate spillovers—shared decision rights

We consider first the case in which A is relatively high compared with s, and α is moderate, which is point 1 of Proposition 2. As noted, this is typically the case in which the research project is in the core business of the firm. Thus, the major contribution to the project comes from the firm's related capabilities, which are relatively high. Although $\hat{e}\,(s)$ is only half the optimal effort $e^*(s)$, due to the strong complementary assets and capabilities, the resulting benefits $\hat{e}\,(s)\,sA$ are such that the firm can share the benefits with the worker, transfer the majority of decision rights $\hat{\lambda} > \frac{1}{2}$, and let her obtain a payoff $\hat{\lambda}\hat{e}\,(s)\,sA$ larger than the outside option $\frac{s^{2+\gamma}}{2}$. Thus, when the firm holds strong capabilities in the project domain, the personal benefits are sufficient to compensate the worker, and there is no need to provide an additional payment, $\hat{p}\,(s) \equiv 0$. In other words, to motivate these workers, the firm should not release full autonomy to them, nor does it need to offer them a high salary. Knowledge workers are happy to work on problems in the core business of the firm, which grants them enough personal benefits, even if they lack autonomy in decision making.

An illustration is Thomas Edison's "Invention Factory," a complex of a laboratory, machine shop, office, and library, which he created during his most inventive years. The factory was an exciting place for anyone with passion for invention. Over the years, the factory was responsible for the development of the telephone transmitter, phonograph, incandescent lamp, dynamo, electrical distributing systems from central stations, electric railway, ore milling, cement, motion pictures, and a host of other minor inventions. Edison was very much engaged in "directing" the creativity of his lab: Results had to be reported daily, and Edison

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insisted on maintaining direct control of all the experiments carried out in the factory (Dyer and Commerford Martin, 1910).

However, these restrictions did not prevent a team of talented workers from assisting Edison all hours of the day and night. These men, who had the skills to transform Edison's ideas and sketches into real devices, came from all over the world, including Charles Batchelor, Edison's chief mechanical assistant from England; Ludwig Boehm, a German glassblower; John Kruesi, a Swiss clockmaker; and Francis Upton, a mathematician; as well as carpenters, machinists, and general laboratory helpers (http://www.hfmgv.org/exhibits/edison/). Many years later, Edison's employees would say that these were the happiest years of their lives.[2] The assets, capabilities, and the general atmosphere of the factory provided an important contribution to the individual projects and, therefore, to the personal benefits of the individuals working on them. As a result, they were happy to work on these projects, even if Edison did not offer them full autonomy.

Strong assets and high spillovers, or moderate assets—full autonomy to the worker

We now consider the case in which either high spillovers occur or the project is outside the firm's core. In both cases 2 and 3, the worker receives all the decision rights, $\hat{\lambda} = 1$, and the effort is still smaller but closer to the benchmark level $e^*(s)$. In case 2, the firm grants to the worker full autonomy, because it benefits anyway from strong spillovers effects, which are higher when the worker exerts a greater effort. Moreover, because strong firm capabilities are in place, the worker receives enough personal benefits that there is no need to provide her with extra payment. In case 3, even when the worker fully controls the project, the personal benefits are smaller than the outside option. Thus, the overall benefits created by the worker are not large enough for the firm to share them and provide the optimal incentives. The best the firm can do to motivate effort is transfer all the decision rights to the worker, $\hat{\lambda} = 1$, and still compensate an additional payment, $\hat{p}\,(s) > 0$.

This scenario describes Carothers's story. DuPont did not have large basic research assets or capabilities. Thus, Carothers could not enjoy high personal benefits. The only option available to the firm to attract him, and motivate him to exert a high level of effort, was to offer him full control of his projects. Why was DuPont interested in employing him even if $\lambda = 1$? The reason is the spillovers α. Smith and Hounshell (1985) also reveal that Carothers was offered a good salary, though not much higher than the salary he earned at Harvard ($5,000 vs. $3,200 per year). Moreover, DuPont did not have a long-standing tradition, learning, or employees doing basic research, but it provided resources: "Regarding funds, the sky is the limit. I [Carothers] can spend as much as I please" (Smith and Hounshell, 1985: 438). This suggests that we are closer to case 2 than case 3.

To summarize, DuPont could only attract Carothers by offering him $\lambda = 1$. DuPont's commitment to investing resources in basic research made $\lambda = 1$ a sufficiently attracting incentive, and Carothers joined, even without being offered a considerably higher salary.

Weak complementary assets—the project does not start

Finally, we consider the case in which, because of the costs of motivating the knowledge worker, the firm may find it optimal not to engage him or her. If $s > \overline{s}\,(A, \alpha)$, when providing the optimal incentives to the worker, the firm is not able to obtain positive profits because, in addition to fully transferring decision rights to let the worker obtain high personal benefits, it incurs a monetary payment that produces negative profits. Thus, the firm prefers not to hire a highly knowledgeable worker. Moreover, because $\overline{s}\,(A, \alpha) \leq s^*(A, \alpha)$, the project is started less often than in the benchmark case.

This reasoning explains why firms may not be able to hire knowledgeable workers for activities far from their core business. Typically, strategy literature suggests that the cost of diversifying the firm's core stems from diseconomies associated with a lack of synergies and specialization. We suggest that an additional penalty is the cost of providing incentives. For highly knowledgeable workers, these costs can be very high because of an upper bound on the use of autonomy as an instrument to provide incentives. After the firm

[2] http://invention.smithsonian.org/centerpieces/edison/000_story_02.asp

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has offered $\lambda = 1$, it can only attract workers by raising the salary p—that is, the firm's policy can no longer be perfected by maneuvering two instruments. We are back to the case when the firm can use only one instrument (i.e., salary), which must be increased considerably to capture knowledge workers with higher s, who have increasingly higher outside options. As noted previously, DuPont tried to hire older and more reputed scientists by offering them full autonomy like Carothers; however, they probably would only be attracted by a much higher salary, which was not profitable for DuPont. A younger researcher, with less experience and possibly a lower s, was the only available option.

DISCUSSION

The results of our model suggest several testable implications that might constitute worthwhile avenues for future empirical efforts. At the same time, they put forth novel explanations for observed empirical regularities, which complement and perhaps even challenge existing theories and explanations.

The first general implication is that when, through their assets, firms do not significantly contribute to the value of a project, perhaps because the project is outside the firm's core, they need to relinquish control and allow knowledge workers to make more decisions. The intuition is that, when the firm contributes significantly to the value of the project, knowledge workers enjoy many personal benefits, even if they cannot influence the direction of the project with their decisions.

More specifically, our model posits that, for a given level of γ, s, and α, there should be a negative correlation between the scale of the firm's contribution to the value of project outcomes (i.e., high value of A) and the degree of decentralization, that is, knowledge workers' autonomy (λ). At a broad level of abstraction, this negative correlation should hold across industries, within the same industry across firms, and within the same firm across projects. Empirically, we thus expect that the allocation of decision rights to knowledge workers is more frequent in industries in which the firm's assets, resources, or stock of employees is less important for determining the success of projects relative to the contribution of talented individuals. We lack specific data on knowledge-intensive projects, but Hambrick and Abrahamson (1995) measure managerial discretion across industries. They find a strong negative correlation between an industry's average managerial discretion and industry capital expenditure intensity, which can serve as a proxy for the importance of a firm's complementary assets relative to human capital. For example, the petroleum/natural gas production sector is characterized by low managerial discretion, whereas computer programming and computer equipment managers generally display a considerably higher level of latitude of action.

Similarly, we expect that within the same industry, firms with sizable assets should allocate fewer decision rights to workers. This prediction is consistent with the stylized fact that large firms delegate less to knowledge workers than small or young firms. Although other reasons for this correlation may exist, it is possible that to attract knowledge workers, smaller firms, which cannot provide them with sizable complementary assets to enhance their personal benefits, must offer them more autonomy.

At the same time, Zenger (1994) argues that small firms have better opportunities to enhance performance-based rewards, which explains why smaller firms may be more effective in attracting human capital and motivating them to conduct greater effort. Zenger argues that, in large firms, performance is intertwined across people and units, making it difficult to single out individual contributions. Moreover, sociopsychological factors create tensions whenever individuals are treated differently, especially in terms of remuneration. The solution is not easy, and Zenger points out that the inability of large firms to implement performance-based incentives is a structural problem of these companies. For example, if these firms divided themselves into smaller independent units, to ease the measurement of performance, they would lose the advantages of joint governance and other synergies. Thus, solving one problem means giving up other advantages associated with size, and large firms cannot benefit from performance-based incentives.

In contrast, our model suggests that large firms can provide incentives to human capital, though in a different form. In particular, they can provide higher personal benefits to knowledge workers in projects close to the firm's core. Because the firm is large, the scale of its contributions in

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core projects in which it is specialized is sizable. In these areas, the firm thus can provide significant personal benefits to knowledge workers. Moreover, when projects are not in the core, or when they produce spillovers to other internal activities, firms can maneuver the workers' control of the project to provide such incentives. In this respect, our findings also explain variation in the allocation of decision rights across different research projects within the same firm. Specifically, projects in the core business of the firm should be characterized by lower worker autonomy, while the opposite is true of projects distant from the core.

This last implication is consistent with the established idea that workers' autonomy and exploration in novel knowledge domains are correlated. However, we offer a different explanation from the standard argument that firms do not know about such new domains and therefore rely on the workers' knowledge; rather, our model suggests that the firm optimally delegates more in projects that are *ex ante* further from its core and, thus, its knowledge domain. Along similar lines, Siggelkow and Rivkin (2006: 780) note that some "studies report a positive correlation between decentralization and innovation. The studies do not, however, compellingly rule out other paths of causation. Unobserved heterogeneity across firms and contexts, for example, may induce a non-causal association." Thus, *ex ante* autonomy might not necessarily lead to *ex post* exploration. Conversely, our model suggests that executives should grant more autonomy when pursuing projects that (*ex ante*) are related less to their core business, as extensive literature on organizational ambidexterity has argued (e.g., Benner and Tushman, 2003; O'Reilly and Tushman, 2004).

In summary, we suggest that autonomy does not necessarily lead to *ex post* distant search, but when the firm *ex ante* pursues projects far from its current domain, autonomy might be a key ingredient to motivate knowledge workers. An effective empirical test of the expected negative correlation between A and the degree of delegation of decision rights could exploit exogenous shocks that change the relative value of the firm's different complementary assets, to determine how allocation of decision rights switches across different projects. Another possibility is to test whether, following these shocks, the autonomy offered to knowledge workers changes compared with that for less knowledge-intensive employees.

Our model also predicts that, *ceteris paribus*, better workers are given more autonomy, up to a point at which the firm's contribution to the project is too low compared with the skills of the worker, so workers are not engaged in the project. Our model is therefore consistent with a theory of positive sorting in the labor market. In addition, it might provide another explanation of why firms find it difficult to explore. When the firm is moving away from its core business and A is low, it might be too costly for the firm to engage workers in such projects, and, therefore, at least in the short run, it is preferable to focus on projects related more to the core business. Again, this finding suggests that when firms aim to explore new terrains, they could face higher costs not only because of the lack of experience or assets in new realms but also to attract the right people and motivate them to do it. These higher incentive costs (both monetary and in terms of delegation of control) can be so high that the firm may choose not to carry out the project in unknown domains.

At a more general level, this result has implications for the organizational policies through which firms choose knowledge workers and decide which projects to start. Top-skilled workers may demand too much in terms of monetary compensation and autonomy. In contrast, these demands may be met if the firm can offer workers personal benefits through the use of the firm's valuable assets. Such benefit can be a key ingredient in the ability to hire high-level knowledge workers.

In addition to being consistent with several stylized facts, this result carries a normative implication. In empirical contexts characterized by the basic assumptions of our model, firms may need to invest in several factors at once if they want to move into new domains. For example, they should try to hire more talented individuals, so that each worker is compensated by the potential personal benefits of working together with other talents in the same organization. In addition, if the firm invests in complementary assets and resources, the opportunities of moving into the new domain are more likely to materialize. This investment is costly and perhaps even more costly than offering a single individual high autonomy and a high salary. In turn, entering into a new business with heavy investments in both human and physical capital is a possibility that may accrue only to large corporations that own enough resources to do so. An alternative strategy is to follow the example of DuPont and Carothers. Along with investments in resources, firms can seek younger researchers, who may not yet be skilled or reputed enough to demand a very high salary and instead may be content with the personal benefits provided by broad control over the project.

Our model also predicts that autonomy is positively associated with greater spillover effects. This is intuitive. With large spillovers, the firm is more willing to delegate because it benefits in any case from the worker's decisions. However, our model shows that this effect is particularly salient when the firm owns sizable assets or can invest significant resources in the project that complement the worker's contribution (higher A than s). Arguably, the extent of spillovers that firms receive from a given research project should be associated with the type of project, such that projects that are closer to basic research are more likely to produce spillovers to other activities, whereas projects that are closer to applied research produce less positive externalities for the firm. Therefore, our model predicts that large firms, which can offer sizable assets or resources, delegate more in basic research projects, whereas in small firms, the gap between basic and applied research projects is less pronounced.

Although our setting refers to projects carried out within the firm' boundaries, it also may apply to R&D relationship agreements between firms. Some of our testable implications thus could transfer to interorganizational arrangements, such as the extent to which control can be retained or should be relinquished in those agreements. A representative example, *inter alia*, might be found in industry–science links, in which scientists typically are motivated mostly by the possibility of using firm assets—which their university or research centers might not have—and firms seek to exploit scientists' knowledge and skills.

Finally, another normative implication of our theory is the extent to which delegation depends on manager personalities (Shragai, 2013). We argue that the culture of a company may induce a higher or lower level of delegation. Still, there is a significant individual component, and leaving delegation to the vagaries of manager personalities may be too costly for the company, in terms of the foregone opportunity to use delegation to motivate knowledge workers. Our managerial prescription, therefore, is that companies should think more carefully about how they can use delegation, whether formally in their contracts or more implicitly in their internal norms and values, as an instrument to provide incentives.

As noted, we direct our implications, including these normative recommendations, primarily to large firms. Our theory suggests that if performance cannot be directly rewarded, a firm can strategically use autonomy to attract and motivate skilled workers, provided that its relevant assets are high. However, offering autonomy may prompt negative reactions by other employees, because it may induce feelings of unequal treatment, thus raising the same sociopsychological concerns that Zenger (1994) highlighted for differential monetary payments. If so, it may not be a good alternative to offer performance-based rewards in large firms, assuming that such rewards can be measured but not implemented because of the potential distress among employees. Nonetheless, delegation may be less visible than a differential payment; it also might be accepted more easily because it is not a direct statement of a differential ability or treatment. This concern diminishes if the firm simply adopts the prescriptions of our model; that is, if the firm launches a project in its core business, it does not need to give much autonomy to skilled workers, because they can enjoy enough personal benefits if they work on that project. This point is not a trivial prescription. Firms often underestimate the "dual" value of project-specific assets in their core. They view them as assets that produce project-specific returns but do not perceive the less apparent function of producing personal benefits to the worker. As firms recognize the dual value of these assets, they should realize that they can employ their core assets and capabilities as a form of compensation and adjust knowledge workers' salaries accordingly. This tactic could help them attract more skilled workers or induce more effort. Ultimately, these strategies, directed at the firm's human capital, make the challenge of implementing performance-based incentives in large firms less severe.

CONCLUSION

Substantial variance in firm performance is still unexplained (McGahan and Porter, 2002), forcing strategy literature to look beyond traditional explanations, such as industry attractiveness or firms'

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competitive positions (Ghemawat, 2002). In particular, human capital has drawn substantial attention in recent years (e.g., Bertrand and Schoar, 2003; Castanias and Helfat, 1991, 2001; Wang, Jinyu, and Mahoney, 2009), though the importance of human capital raises new questions, especially when it comes to the serious challenge of managing knowledge workers (e.g., Coff, 1997, 1999). The output of these workers is difficult to assess, and, at the same time, it is often difficult to observe the effort they exert. The combination of these factors makes the provision of suitable incentives particularly difficult.

To address these issues, this article analyzed the decisions of a firm that must engage a worker in a new knowledge-intensive project. We investigated the combination of allocation of decision rights and compensation, with which the firm can manage and motivate knowledge workers, while acknowledging the main difficulties of knowledge-intensive processes. When output cannot be verified, and effort cannot be observed, they cannot be part of the terms of the offer the firm makes to the worker. In these cases, we suggest that the firm should use decision rights over the projects the human capital is engaged in as an alternative instrument to provide incentives. Knowledge workers obtain personal benefits when they can make decisions that favor the pursuit of their own goals. Allowing them some degree of autonomy in the implementation of a project (i.e., allocating decision rights) can be a substitute for financial compensation (e.g., Stern, 2004) and thus can make the provision of incentives less costly for the firm. In other words, firms can use control to leverage workers' incentives and devise a more effective information strategy to cope with the hazards of knowledge-based advantages.

However, this opportunity also creates a trade-off. When granted more autonomy, knowledge workers follow paths and objectives that are not fully aligned with those of the firm, such that they could decrease the firm's payoff from the project. Autonomy thus becomes a double-edged sword. When is it convenient to use it? In this study, we formally show that when the projects are in the firm's core business, the firm can retain more control. Furthermore, for core projects, the firm gets closer to the first-best solution and thus can provide more efficient and less costly incentives. Conversely, more autonomy—at the extreme, even full autonomy—is necessary to engage workers in a project outside the firm's core, for which the firm's contribution is likely to be relatively more limited.

This study is also qualified by its limitations. We focused on the incentive effect of the allocation of decision rights, ignoring other efficiency effects. Operationally, the sum of the worker's and the firm's benefits remains constant, meaning that control rights shift the distribution of benefits from one party to the other. It would be worthwhile to study the allocation of decision rights when efficiency considerations enter the picture. Researchers should also examine in more detail the patterns of exit and entry. In our propositions, very skilled workers do not accept engagement in a given project, depending on their outside option. In our model, we account for the possibility that the outside option grows with s at different rates, as the internal impact of s (when accounting for the optimal effort). For example, if the outside option grows more slowly than it does inside the firm, it could be that less-skilled workers are not engaged in firm activities. This scenario might describe a firm at the technological frontier, in which more-skilled knowledge workers are valued more than in the outside market. In this case, the less-skilled workers inside the firm might not accept the offer, because the firm has an incentive to make offers that satisfy its top workers, even if that implies the loss of the least-skilled workers.

In addition, we provided little information on the specific firm-level factors that contribute to the value of the project. We differentiate between activities in the firm's core and those outside the core, and we suggest that, for several reasons (more and better assets, greater firm learning, specialization, stock of specialized employees), firms contribute to the value of projects relatively more than the worker's effort and skills when these projects are in their core. Moreover, we argue that for large firms, the scale of such factors may be another element that raises the relative contribution of the firm. Thus, all other things being equal, large firms may be better equipped to provide personal benefits to knowledge workers in the core and possibly outside the core if they can invest relatively substantially in such other activities as well. However, different firm-level factors may have different nuances or implications for our theory or any developments of it. We hope that further research takes up this point to clarify issues our analysis has left obscure.

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Finally, the study of how to implement the allocation of decision rights in practice remains an intriguing and useful line of research. We can conceive of a broader setting, moving away from the focus on offers to the individual workers—for example, when researchers discover the rules within a company that *de facto* function as norms, which reflects an implicit contract setting. Companies adopting and implementing certain rules may attract certain types of workers. Such forms of attraction could help explain why companies that are more lenient with their workers, and enable them to enjoy personal benefits with their own assets, may end up paying less in terms of monetary compensation to attract high skill types.

In summary, much work remains to be done to explain how firms can create and appropriate the value that results when combining assets and human capital. Yet, we believe that with this study we have contributed to a stronger understanding of the threats and opportunities that the management of knowledge-intensive projects entails.

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APPENDIX

Proof of Proposition 1

F solves the following problem:

$$\max_{p,\lambda,e} \quad esA\,(\alpha + 1 - \lambda) - p$$

$$\text{s.t.} \quad p + \lambda esA - \frac{1}{2}e^2 \geq \frac{s^{2+\gamma}}{2} \qquad (PC)$$

$$p \geq 0, \;\; \lambda \in [0,1]\,.$$

Assume for a moment that F can freely set the payment, such that (PC) is binding; then,

$$p = \frac{s^{2+\gamma}}{2} + \frac{1}{2}e^2 - \lambda esA. \qquad \text{(A1)}$$

We can solve the problem by substitution, obtaining the reduced problem

$$\max_{e} \; esA\,(1+\alpha) - \frac{1}{2}e^2 - \frac{s^{2+\gamma}}{2}$$

Note that the allocation of decision rights in the benchmark case is irrelevant, so the firm can collect all the decision rights. The optimal effort is

$$e^*(s) = sA\,(1+\alpha)\,, \qquad \text{(A2)}$$

and by substituting Equation A2 into Equation A1, the payment reduces to

$$p^*(s) = \frac{s^2}{2}\left[(1+\alpha)^2 A^2 + s^\gamma\right] > 0. \qquad \text{(A3)}$$

Finally, F's optimal payoff is

$$\Pi^*(s) = \frac{s^2}{2}\left[(1+\alpha)^2 A^2 - s^\gamma\right], \qquad \text{(A4)}$$

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which is nonnegative provided that $s \leq s^*(A,\alpha) = A^{\frac{2}{\gamma}}(1+\alpha)^{\frac{2}{\gamma}}$.

Proof of Proposition 2

F solves the following problem:

$$\max_{p,\lambda,e} \quad esA(\alpha+1-\lambda) - p$$

$$\text{s.t.} \quad p + esA\lambda - \frac{1}{2}e^2 \geq \frac{s^{2+\gamma}}{2} \qquad (PC)$$

$$e = sA\lambda \qquad (ICC)$$

$$p \geq 0, \lambda \in [0,1].$$

The worker exerts an effort e defined by the constraint (ICC), and when substituted in the objective function and in the constraint (PC), F's problem reduces to

$$\max_{p,\lambda,e} \quad \lambda s^2A^2(\alpha+1-\lambda) - p$$

$$\text{s.t.} \quad p + \frac{(sA\lambda)^2}{2} \geq \frac{s^{2+\gamma}}{2} \qquad (PC)$$

$$p \geq 0, \lambda \in [0,1].$$

Assume first that $p \geq 0$ in equilibrium. Then, F can set

$$p(s) = \frac{s^2}{2}\left(s^\gamma - A^2\lambda^2\right), \qquad \text{(A5)}$$

and the problem reduces to

$$\max_{\lambda} \ \lambda s^2A^2(\alpha+1-\lambda) + \frac{(sA\lambda)^2}{2} - \frac{s^{2+\gamma}}{2}$$
$$= s^2A^2\left(\lambda(\alpha+1-\lambda) + \frac{\lambda^2}{2}\right) - \frac{s^{2\gamma}}{2},$$

such that solving for λ, we have a corner solution, $\hat{\lambda} = 1$. By Equation A5, $\hat{p}(s) = \frac{s^2}{2}\left(s^\gamma - A^2\right)$, which is positive provided that $s \geq A^{\frac{2}{\gamma}} = \underline{s}(A)$; by ($ICC$), $\hat{e}(s) = sA$, and the profits at the optimum are

$$\alpha s^2A^2 + \frac{s^2A^2}{2} - \frac{s^{2+\gamma}}{2} = \frac{s^2}{2}\left[(2\alpha+1)A^2 - s^\gamma\right], \qquad \text{(A6)}$$

which are nonnegative provided that $s \leq A^{\frac{2}{\gamma}}(2\alpha+1)^{\frac{1}{\gamma}} = \overline{s}(A,\alpha)$. Thus, we have characterized the solution for the case in which $s \geq \underline{s}(A)$, showing that the firm begins the project if the worker to be engaged is not too skilled, or $s \leq \overline{s}(A,\alpha)$.

Assume instead that $s < \underline{s}(A)$, such that $\hat{p}(s) = 0$ in equilibrium. F's problem reduces to

$$\max_{\lambda} \ \lambda s^2A^2(\alpha+1-\lambda),$$

such that the profits are maximized when $\lambda = \frac{1+\alpha}{2}$. If $\alpha < 1, \hat{\lambda} = \frac{1+\alpha}{2}$, $\hat{e}(s) = sA\frac{1+\alpha}{2}$, and the optimal profits are equal to $\left(\frac{1+\alpha}{2}\right)^2 s^2A^2 > 0$. If instead $\alpha \geq 1$, $\hat{\lambda} = 1$, $\hat{e}(s) = sA$, and the optimal profits are $\alpha s^2A^2 > 0$.