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Rewarding Idleness

by

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Abstract

Market wages reflect expected productivity by using signals of past performance and past experience. These signals are generated at least partially on the job and create incentives for agents to choose high-profile and highly visible tasks. If agents have private information about the profitability of different tasks, firms may wish to prevent over-investment in visible tasks by increasing their opportunity costs. Firms can do so, for instance, by using employee perks. Heterogeneity in employee types induces substantial diversity in organizational and contractual choices, particularly regarding the extent to which conspicuous activities are tolerated or encouraged, the use of employee perks, and contingent wages.

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1 Introduction

Many studies have documented the existence of within-industry heterogeneity in organizational choice, corporate infrastructure, and contractual choice (see, e.g., Gibbons, 2010, for a survey). This heterogeneity can be seen, for instance, in attitudes towards idleness at work as embodied in corporate investments in perks. Employees at Google have at their disposal a wide variety of on site services and sports facilities, such as tennis courts, a climbing wall, free catering in high-profile restaurants and cafeterias, and various entertainment facilities (such as table football). Additionally, they are allowed to use one workday per week for personal projects.[1]

However, even within the same industry the provision of employee perks is by no means homogeneous. Google's founders state:

> We provide many unusual benefits for our employees, [...] We believe it is easy to be penny wise and pound foolish with respect to benefits that can save employees considerable time and improve their health and productivity.[2]

In contrast, Chad Little, a former Apple employee, states the following:

> [At Apple] The cafe costs, [...] Every floor has a vending machine, which also costs [...] The gym also isn't free, [...] I recall one person asked Steve why these benefits were so low, and the main response was 'it's my job to make your stock go up so you can afford these things.'[3]

This paper argues that such heterogeneity arises through firms' optimal responses to their employees' career concerns. If employees are heterogeneous in their career concerns, companies that are very similar in technology and employee characteristics may nevertheless choose substantially different organizations, as shown, for instance,

[1] Microsoft and Yahoo! also provide access to substantial perks, including free cafeterias, a game room, massage services, or lake access. Blizzard Entertainment is supposed to outfit its employees with digital equipment for its online game World of Warcraft.

[2] Larry Page and Sergey Brin, *Letter from the Founders: "An Owner's Manual" for Google's Shareholders*, accessed from http://investor.google.com/corporate/2004/ipo-founders-letter.html

[3] Retrieved from http://www.quora.com/Apple-Inc-2/What-is-the-internal-culture-like-at-Apple

in their investments in employee perks. Idleness can be desirable for a principal if, because of career concerns, employees have an incentive to over-invest in complex, visible tasks that generate signals about the agent's ability. This issue is of particular concern in creative professions, if the agent has private information about the profitability of different tasks, that is, the agent has expert knowledge.

To balance their employees' bias toward visible tasks, firms may distort their organizational investments toward employee perks that are complementary to idleness. That is, employee perks that seem to encourage idleness are actually meant do so. However, for agents who derive high value from generating signals on the job, the reward for idleness necessary to balance incentives may be very costly. In this case the optimal organizational form looks substantially different, and encourages agents to work on conspicuous projects while discouraging idleness, though it occasionally results in inefficient task choices. Therefore small differences in the strength of employees' career concerns can generate substantial variety in firms' organizational choices and in the extent to which they tolerate and reward idleness.

Perlow and Porter (2009) provide empirical support for the relevance of career concerns on employees' tasks choice. They report on a four-years experiment at several offices of the Boston Consulting Group, where "people believe that a 24/7 work ethic is essential for getting ahead, so they work 60-plus hours a week and are slaves of their BlackBerry."[4] The treatment consisted of forcing people to take time off. Each member of the treatment teams had to leave the office without access to email or BlackBerry for a period of either one full day or one evening per week, depending on the version of the treatment. The paper describes at length the strong resistance toward the project from the consultants, who would have preferred to continue working. The effect of the treatment was that participants reported "more open communication, increased learning and development, and a better product delivered to the client."[5] That is, incentives to generate signals appear to have determined working behavior and a task choice, and may affect output.

This reasoning applies to areas other than corporate organizational choice. For example, some health care plans in the United States explicitly reward physicians for

[4] Perlow and Porter (2009) page 1.
[5] Ibid. page 4.

inactivity by way of bonuses, fee withholds, and expanded capitation (see Orentlicher, 1996).[6] In addition to contracts that reward inactivity, other forms (e.g., capitation or fee-for-service) are also widely used, generating substantial contractual heterogeneity. The argument also extends to cases where agents, instead of remaining idle, may pursue other productive tasks that do not generate any signal about the agents' abilities. Interpreting teaching as such a non-visible task, academia seems to be a case in point; universities have substantial organizational heterogeneity with respect to incentives for teaching and research.

To formalize our argument we use a principal-agent model. The agents' productivities are unknown, but their expected values are publicly observable. An agent chooses to perform one of two tasks. One task is routine and its outcome is independent of the agent's productivity; it may be interpreted as idleness. The other task is complex, its outcome is uncertain, and its probability of success depends on the agent's productivity. Its expected return is known only to the agent and may exceed or fall short of the profit of the routine task. Hence, the visible task can be interpreted as starting a new project, initiating a merger, or launching a marketing campaign. The task is visible: its outcome is publicly observable and generates a signal about the agent's productivity.

Principals invest in two types of corporate infrastructure: *productive perks* (e.g., large office space or a powerful computer) that are complementary to the visible task, and *employee perks* (e.g., a swimming pool or a free cafeteria) that are complementary to idleness. Labor contracts need to respect limited liability and fall into one of two regimes: *flexible contracts* induce the agent to choose a task conditional on the tasks' expected profitabilities, while *rigid contracts* induce the agent to choose a specific task independently of its profitability.

Because an agent lives for two periods, choosing the visible task when young affects the agent's expected productivity and payoff when old. That is, agents have career concerns, which are stronger the less informative the prior belief about their

[6] Physicians may be motivated by their reputation among patients to over-prescribe treatments in the hope of increasing future revenue, a form of career concern. Bonuses, fee withholds, and expanded capitation work roughly as follows: if the total cost of treatments prescribed by a physician falls short of the prespecified amount, the physician receives a bonus payment.

productivity is. In the labor market equilibrium the type of contract offered and the level and composition of corporate infrastructure depend on the market value and the strength of the agent's career concerns. Higher market value affects organizational choice because being able to generate signals on the job is part of an agent's compensation. Stronger career concerns increase the cost of satisfying incentive compatibility in a flexible contract. Hence, all old agents (who have no career concerns) obtain flexible contracts that maximize expected output. For young agents (who have career concerns), satisfying incentive compatibility may require the composition of corporate investments to be distorted. Given a young and an old agents of equal productivity who both obtain flexible contracts, employee perks are higher and productive perks are lower for the young agent than for the old agent.

Career concerns generate heterogeneity in contractual and organizational choice for the young. Young agents who have high market value, high expected productivity, and thus relatively low career concerns ("proven talents") receive flexible contracts. These contracts implement the profit-maximizing task choice and efficient investment. Young agents of intermediate expected productivity ("high potentials") have intermediate market value and derive high value from generating a signal. For these agents, a flexible contract that rewards idleness to balance incentives is very costly to implement. They receive rigid contracts that implement the visible task regardless of its return. This regime corresponds to organizations with strong emphasis on long working hours, where idleness is discouraged. Finally, agents with low expected productivity and low market value but strong career concerns ("hidden gems") receive flexible contracts. Low market value and limited liability cause corporate investment to be distorted downwards, particularly for productive perks. The value of generating a signal may be high enough for these agents, such that using rigid instead of flexible contracts increases aggregate surplus. However, limited liability makes it impossible to compensate the principal for the loss in expected profit caused by switching to a rigid contract. Because the different regimes are determined by cutoff productivity levels, corporate investment in perks is discontinuous in employees' expected productivity.

1.1 Related Literature

Previous work has attributed the use of perks to their productive characteristics, as in the case of high-quality office equipment or access to corporate jets (see Marino and Zábojník, 2008, Rajan and Wulf, 2006). Some studies have also interpreted perks as non-monetary remuneration substituting for cash payments (see, e.g., Rosen, 1986).[7] In addition to these explanations, we argue that the composition of perks is likely to affect an employee's optimal choice of tasks. Finally, perks have been attributed to managerial discretionary power over free cash flow (see, e.g., Jensen, 1986, Bebchuk and Fried, 2004), which applies if decisions on perks are made by the ones who benefit. However, this possibility does not arise in our setup.

This paper is related to the literature on career concerns and incentives started by Gibbons and Murphy (1992). Within this literature, several authors describe distortions in principal-agent settings due to career concerns, such as excessive or too little risk taking (Hermalin, 1993, Hirshleifer and Thakor, 1992), over-investment in or under-usage of information (Scharfstein and Stein, 1990, Milbourn et al., 2001), over-provision of effort (Holmström, 1999), or distorted project choice (Holmström and Ricart i Costa, 1986, Narayanan, 1985). Kaarbøe and Olsen (2006) analyze the effects of career concerns on optimal contracts in a multi-task setting where the principal knows the tasks' productivities, whereas we are concerned with the case when tasks' productivities are private information. Harstad (2007) analyzes a similar setting where a firm's organizational choice affects the transparency of the managers' signals. By design firms extract the full value of signaling and therefore profit from increasing transparency and charging the manager. Because of heterogeneity in career concerns, in our model some firms discourage generating signals while others encourage it. Raith (2008) examines an agency setting with private information on task productivity and determines the optimal use of input and output monitoring without career concerns.

Oyer (2008) and Kvaløy and Schöttner (2011) also examine the use of non-

[7] In a similar vein Holmström and Milgrom (1991) find that allowing for over-investment in less productive tasks in a multi-tasking environment can be optimal in the presence of risk aversion, if the agent's participation constraint binds.

monetary rewards to create incentives for workers. Oyer (2008) focuses on the use of benefit packages, and Kvaløy and Schöttner (2011) are concerned with "motivational effort": costly actions that decrease the worker's disutility of effort. Both use a single-task environment and remain silent on issues of task choice.

This paper also connects to the literature on delegation and experts. The study closest to ours is probably Prat (2005), where an expert with career concerns has an incentive to report untruthfully to conform with the market's prior expectation (see also Prendergast, 1993). Prat (2005) concludes that avoiding full transparency on the agent's action may be desirable. This paper is concerned with investments complementary to tasks as a response to distortions of incentives due to career concerns.

Heterogeneity of organizational forms and productivities is also a result in Gibbons et al. (2011) and Legros and Newman (2012). Their focus is on organizational choice in terms of ownership and control rights. The output market price determines firms' organizational choices, which in turn affect the price. In Gibbons et al. (2011) the market price conveys a signal about the aggregate state of the world, which leads some firms to choose organizational forms that generate information and others to free-ride on the information contained in the market price. In Legros and Newman (2012), the market price determines the severity of nontransferabilities within firms, which in turn determine ownership choices. Heterogeneity in ownership is necessary to generate a continuous aggregate supply function and guarantees the existence of the competitive equilibrium. Our paper complements their analysis, exploring choices of corporate infrastructure and labor contracts in response to career concerns.

The remainder of the paper is organized as follows. Section 2 introduces the theoretical framework, Section 3 solves a simplified version of the model that highlights the intuition for our main results, Section 4 solves the full model, Section 5 discusses some possible extensions of the model, and section 6 concludes.

2 The Model

2.1 Agents

An economy is populated by a continuum of agents $i \in I$ and a continuum of homogeneous principals $j \in J$. Both agents and principals are endowed with measure 1. Agents are born with zero wealth, live for two periods, and are heterogeneous in their productivity type $p \in \{\underline{p}; \overline{p}\}$, with $0 < \underline{p} < \overline{p} < 1$. Productivity is unobservable to both agents and principals. Denote a young agent's expected productivity as

$$\tilde{p} = E[p].$$

2.2 Production

Principals and agents jointly generate output in firms of size 2. Setting up a firm requires a fixed cost F. In a firm, the agent works on one of two tasks $d \in \{a, b\}$. Task b is a routine task that yields revenue 0 for the principal.[8] In contrast, task a is complex and may be completed successfully (S) or result in a failure (F). The probability of success in task a is given by the agent's productivity p. In case of success, revenue $\overline{R}(s)$ accrues to the principal; if the agent fails, revenue is $\underline{R}(s) < \overline{R}(s)$. Revenue depends on the state of the world $s \in \{A, B\}$. Let $R(s, p) = p\overline{R}(s) + (1-p)\underline{R}(s)$ denote the expected revenue in state s given productivity p. The state of the world is the agent's private information. In other words, the agent has expert knowledge about the expected profitability of task a. For ease of exposition, suppose that the agent has full information about the state s, while the principal only knows the prior.

Task a is best interpreted as starting a new project, such as developing a new product, which requires the principal to commit some of the company's resources. These resources will be lost if the agent fails. If instead the agent succeeds, the product is launched. Its profitability depends on the firm specific, independently

[8] This extreme case, where b is unproductive and uninformative (i.e., staying idle) effectively illustrates our main point: career concerns generate diversity in organizational choice and may lead firms to reward idleness. Our results carry over qualitatively when the revenue from task b is positive, see Section 5.2 for a discussion.

drawn state s, which is A with probability q and B with $1-q$. This setup allows for an interesting case where task a maximizes revenue in state A and task b in the other. Therefore, assume that

$$R(A,p) > 0 \geq R(B,p) \text{ for all } p \in \{\underline{p};\overline{p}\}. \tag{A1}$$

This assumption captures situations where the product may flop and fail to break even, quality problems may hurt the firm's reputation, or design flaws may trigger legal actions and fines. In such cases the agent often has expert knowledge and is better informed about the expected return on the project than the principal.[9] Finally, success and failure are publicly revealed at the end of each period, as in Harris and Holmström (1982).

2.3 Corporate Investments in Infrastructure

When performing a given task, an agent incurs a utility cost c_d depending on the task chosen. As in Oyer (2008), this cost can be affected by the principal's investments, which are denoted by k_a and k_b:

$$c_b(k_b) = -k_b \text{ and } c_a(k_a) = c - k_a.$$

k_a represents investment in corporate infrastructure complementary to production, such as office space, powerful computers, and high quality furniture, which will be referred to as *productive perks*. In contrast, k_b is investment in corporate infrastructure complementary to leisure, such as swimming pools, climbing walls and game rooms, which will be referred to as *employee perks*. Note that k_a and k_b may capture investments in corporate culture, which determine, for instance, the extent to which an agent's successful performance is rewarded by social esteem. The cost of either investment is convex. Let the cost function be given by $(k_a^2 + k_b^2)/2$ for notational convenience. Assume that

$$c > q.$$

[9] Note that this case is also consistent with interpreting s as the agent's physical state (which, for instance, may reflect health or alertness) if the agent has private information about the state, conditional on all observables such as previous workload.

This assumption guarantees that performing task a is costly for the agent in an efficient allocation. Finally, suppose that the setup cost F is high enough to render idle firms unprofitable in the sense that the total surplus is negative if the agent chooses task b with certainty: $F \geq 1/2$.

2.4 Contractual Environment and Payoffs

In a firm (i, j), contracts specify the principal's investments (k_a, k_b) and payments $w_d \geq 0$ contingent on tasks $d = a, b$. Because agents have no wealth, contracts must respect limited liability and induce non-negative payments. Task choice and the outcome of task a are publicly observable.[10] Individuals can only sign short-term contracts (equivalently, parties can renegotiate any long-term contract). Contracts may condition on whether an agent is young or old.

That is, in each period a matched agent obtains payoff $u = w_b + k_b$ if the task chosen was b and $u = w_a - c + k_a$ if it was a. Correspondingly, a principal's payoff is $\pi = -w_b - \kappa$ if task b was chosen and $E\pi = R(s, \tilde{p}) - w_a - \kappa$ otherwise, where $\kappa = F + (k_a^2 + k_b^2)/2$. There is no discounting.

2.5 Timing of Events

In each period, events in this economy unfold as follows:

1. Principals and agents match in a frictionless labor market, and sign binding short-term contracts.

2. Principals invest as specified in the contract.

3. Within each match (i, j), a state of the world $s \in \{A, B\}$ is realized.

4. The agent chooses task a or task b.

[10] Making payment conditional on the outcome of task a will typically not be profitable, because agents do not choose effort in this model. Exploring the relation between incentive power and the generation of signals on the job is left to future research. Conditioning payments on revenue (that is, the state) will leave our results qualitatively unchanged, because limited liability limits the principal's ability to punish the agent.

5. Successes and failures in task a are realized, revenue accrues, and payments are made.

A labor market equilibrium is an individually rational, stable allocation of pairs of one principal and one agent, such that there is no pair of principal and agent who can obtain a strictly higher joint payoff if they match and sign a contract of the form (k_a, k_b, w_a, w_b).

In each period t, a measure 1 of principals competes for a measure 1 of agents, with measure 1/2 of young and old agents each. Suppose that the distribution of young agents' expected productivities $\tilde{p}$ has full support on $[\underline{p}, \overline{p}]$. This assumption suffices to guarantee the stationarity of our simple labor market.

3 A Benchmark without Limited Liability

We start by examining a simplified version of the model without imposing limited liability. That is, payments w_a and w_b can be negative. In this case, investments and task choice are efficient conditional on agents' career concerns, as we will show. Hence, this simple version serves as an efficiency benchmark of a social planner who maximizes aggregate utility but cannot observe agents' productivities.[11]

In the benchmark, firms' contractual and organizational choices respond to agents' career concerns, which yields substantial organizational heterogeneity, and allows for organizations that tolerate and organizations that reward idleness. These results carry over to the full model with limited liability. However, under limited liability, corporate investments need not be efficient, which adds another source of organizational heterogeneity and causes some firms to reward idleness by changing the composition of corporate investments.

Consider the optimal choice of a contract (w_a, w_b, k_a, k_b) by a principal in a firm with a given agent who has productivity $\tilde{p}$ and outside option $\underline{u}$, which will be derived endogenously as the equilibrium market payoff. We distinguish between a *rigid* contract implementing task a independently of the state of the world and a

[11] In a first best, when agents' productivities are observable, there are neither career concerns nor contractual and organizational heterogeneity.

flexible contract implementing task a in state A and task b in state B.[12]

3.1 Old Agents

We examine the case of an old agent first, because the expected payoffs when old will determine the career concerns when young. Incentive compatibility of a flexible contract requires the agent to be indifferent between tasks a and b, that is

$$w_a - c + k_a = w_b + k_b.$$

The participation constraint for the agent is

$$q(w_a - c + k_a) + (1-q)(w_b + k_b) \geq \underline{u}.$$

Incentive compatibility implies that the payoffs in each state have to be individually rational: $w_b + k_b \geq \underline{u}$ and $w_a - c + k_a \geq \underline{u}$. The principal's expected payoff is

$$\pi = q(R(A, \tilde{p}) - w_a) - (1-q)w_b - (k_a^2 + k_b^2)/2 - F. \quad (1)$$

As the principal's payoff decreases in w_a, w_b, k_a and k_b, the participation constraint has to bind and

$$w_b + k_b = \underline{u} = w_a - c + k_a.$$

That is, payments are $w_a = \underline{u} + c - q$ and $w_b = \underline{u} - (1-q)$. Using this result on (1) yields

$$\pi = q(R(A, \tilde{p}) - c + k_a) + (1-q)k_b - (k_a^2 + k_b^2)/2 - F - \underline{u}.$$

Therefore, investment choices $k_a = q$ and $k_b = 1 - q$ maximize both the principal's payoff conditional on the agent's outside option $\underline{u}$ and the joint payoff.

Consider now a rigid contract. Incentive compatibility and individual rationality require

$$w_a - c + k_a \geq w_b + k_b \text{ and } w_a - c + k_a \geq \underline{u},$$

[12] A contract implementing task b independently of the state of the world generates negative surplus because $F > 1/2$. A contract implementing task a in state B and task b in state A generates negative expected surplus because of Assumption A1.

respectively. The principal's expected payoff is

$$\pi = qR(A,\tilde{p}) + (1-q)R(B,\tilde{p}) - c - w_a - w_b - (k_a^2 + k_b^2)/2 - F. \tag{2}$$

To maximize π, the principal chooses $k_b = 0$ and $w_b = 0$, and the participation constraint must bind. Using this on (2) implies that $k_a = 1$, which also maximizes the joint payoff of a principal and an agent, as shown above. The wage for task a is then $w_a = \underline{u} + c - 1$.

Inspecting the payoffs of a principal and an old agent, a flexible contract Pareto dominates a rigid one if $R(B,\tilde{p}) - (c-q) < 0$, which is implied by Assumption A1. The joint payoff under a flexible contract is positive only if

$$\tilde{p} \geq \frac{c - q + 1 + \frac{F}{q} - \frac{1}{2q} - \underline{R}(A)}{\overline{R}(A) - \underline{R}(A)} := \bar{p}_o^*.$$

That is, $\bar{p}_o^*$ denotes the minimum productivity required by a principal hiring an old agent with $\underline{u} = 0$. Assume that a flexible contract with efficient investments is profitable for old agents with high productivity $\overline{p}$, but not for those with low productivity $\underline{p}$:

$$R(A,\underline{p}) < c - q + 1 + F/q - 1/(2q) < R(A,\overline{p}). \tag{A2}$$

This means that old agents with $\tilde{p} < \bar{p}_o^*$ remain unmatched and that productive agents are scarce. Therefore principals compete for agents who can generate positive expected output. This competition, in turn, implies that principals obtain zero profits in equilibrium, the same as their payoff when remaining unmatched. This implication pins down the labor market equilibrium payoffs for old agents (which must equal the outside option $\underline{u}$ in each match):

$$u_o^*(\tilde{p}) = \begin{cases} q(R(A,\tilde{p}) - c) + \frac{q^2 + (1-q)^2}{2} - F & \text{if } \tilde{p} \geq \bar{p}_o^*, \\ 0 & \text{if } \tilde{p} < \bar{p}_o^*, \end{cases} \tag{3}$$

3.2 Career Concerns

In contrast to old agents, young agents have career concerns, because failing or succeeding at task a provides an informative signal about their productivity, while remaining idle – either choosing task b or remaining unmatched – does not. Consider a young agent with expected productivity $\tilde{p}$. Denote the posterior expectation of $\tilde{p}$ by $p_I(\tilde{p})$ if the agent remained idle in period 1, by $p_F(\tilde{p})$ if the agent failed at task a, and by $p_S(\tilde{p})$ if the agent succeeded. Applying Bayes's formula (see the appendix for details) yields the following statement.

Lemma 1. *An old agent's expected productivity is* $p_S(\tilde{p}) = \overline{p} + \underline{p} - \frac{\overline{p}\,\underline{p}}{\tilde{p}}$ *after task* a *was successfully completed,* $p_F(\tilde{p}) = \frac{\tilde{p}(1-\underline{p}-\overline{p})+\overline{p}\underline{p}}{1-\tilde{p}}$ *after a failure to complete task* a*, and* $p_I(\tilde{p}) = \tilde{p}$ *otherwise.*

Clearly $p_F(\tilde{p}) < p_I(\tilde{p}) = \tilde{p} < p_S(\tilde{p})$. Denote by $s^*(\tilde{p})$ the value of the signal generated by a young agent with expected productivity $\tilde{p}$ in task a. Because individuals are risk neutral, the signal value is given by

$$s^*(\tilde{p}) = \tilde{p}u_o^*(p_S(\tilde{p})) + (1-\tilde{p})u_o^*(p_F(\tilde{p})) - u_o^*(\tilde{p}). \tag{4}$$

Recall that an old agent's equilibrium payoff $u_o^*(\tilde{p}_o)$ given by (3) strictly increases, is piecewise linear and has a kink at $\overline{p}_o^*$. Therefore

$$s^*(\tilde{p}) = \begin{cases} \tilde{p}u_o^*(p_S(\tilde{p})) & \text{if } \tilde{p} \leq \overline{p}_o^* < p_S(\tilde{p}) \\ \tilde{p}u_o^*(p_S(\tilde{p})) - u_o^*(\tilde{p}) & \text{if } p_F(\tilde{p}) < \overline{p}_o^* < \tilde{p} \\ 0 & \text{otherwise.} \end{cases}$$

Hence, $s^*(\tilde{p}) \geq 0$ for all $\tilde{p} \in [\underline{p};\overline{p}]$, strictly increases on $\tilde{p} < \overline{p}_o^* < p_S(\tilde{p})$, and strictly decreases on $p_F(\tilde{p}) < \overline{p}_o^* < \tilde{p}$, implying that $s^*(\overline{p}_o^*) > 0$. That is, generating a public signal has a positive value for agents with productivity $\tilde{p}$ in the neighborhood of $\overline{p}_o^*$, which remains true even if the agents are averse to risk.

3.3 Young Agents

The contractual choice for young agents will respond to career concerns. We start again with a flexible contract. Incentive compatibility and individual rationality require

$$w_a + s^*(\tilde{p}) - c + k_a = w_b + k_b \text{ and } q(w_a + s^*(\tilde{p}) - c + k_a) + (1-q)(w_b + k_b) \geq \underline{u},$$

where $\underline{u}$ denotes again the agent's outside option. The principal's payoff is

$$\pi = q(R(A,\tilde{p}) - w_a) - (1-q)w_b - (k_a^2 + k_b^2)/2 - F. \tag{5}$$

Similar to the case of old agents, investments will be chosen efficiently, $k_a = q$ and $k_b = 1-q$. Associated payments are $w_a = c + \underline{u} - q - s^*(\tilde{p})$ and $w_b = \underline{u} - (1-q)$.

For a rigid contract incentive compatibility and individual rationality require

$$w_a + s^*(\tilde{p}) - c + k_a \geq w_b + k_b \text{ and } w_a + s^*(\tilde{p}) - c + k_a \geq \underline{u}.$$

The principal's payoff is

$$\pi = qR(A,\tilde{p}) + (1-q)R(B,\tilde{p}) - w_a - (k_a^2 + k_b^2)/2 - F.$$

As shown above, optimally $k_b = 0$, $w_b = 0$, $k_a = 1$, but $w_a = \underline{u} + c - s^*(\tilde{p}) - 1$. Compared with an old agent, the presence of career concerns lowers the monetary payment to the young agent and reduces the cost of implementing a rigid contract.

Because of the career concerns a rigid contract may Pareto dominate a flexible one for a young agent if the signal value $s^*(\tilde{p})$ is sufficiently high, that is, whenever $c - q - R(B,\tilde{p}) < s^*(\tilde{p})$. Again there is a minimum productivity $\bar{p}_y^*$ required to break even. Young agents are employed at lower productivity than old agents, $\bar{p}_y^* < \bar{p}_o^*$, because young agents with expected productivity in the neighborhood of $\bar{p}_o^*$ value the signal generated by task a, which partly compensates their effort cost c. Therefore young agents work for less remuneration than old agents of the same productivity.

The following proposition summarizes these results, see the appendix for details.

Proposition 2 (Benchmark Equilibrium Allocation)**.** *Old agents with $\tilde{p}$ are matched and receive a flexible contract if $\tilde{p} \geq \bar{p}_o^* > 0$, and remain unmatched otherwise. Their equilibrium payoffs $u_o^*(\tilde{p})$ are given by (3).*

Young agents with $\tilde{p}$ derive positive value from generating a signal, $s^*(\tilde{p}) \geq 0$, with $s^*(\tilde{p}) > 0$ for $\tilde{p}$ in the neighborhood of $\bar{p}_o^*$. They are matched to a principal if $\tilde{p} \geq \bar{p}_y^*$ with $\bar{p}_y^* < \bar{p}_o^*$. They receive a flexible contract if $c - q - s^*(\tilde{p}) \geq R(B,\tilde{p})$ and a rigid contract otherwise. Young agents with $\tilde{p} < \bar{p}_y^*$ remain unmatched.

This allocation maximizes aggregate surplus.

To assess whether rigid contracts are used in the benchmark equilibrium and, if so, who uses them, we note that $s^*(\tilde{p})$ converges to 0 as $\tilde{p}$ approaches $\overline{p}$ and that flexible contracts are used for high productivity agents. Given that both $s^*(\tilde{p})$ and $R(B, \tilde{p})$ are (piecewise) linear functions of $\tilde{p}$, and that $s^*(\tilde{p})$ attains a maximum at $\bar{p}_o^*$, we derive the following statement. Details are in the appendix.

Proposition 3 (Benchmark Organizational Choice)**.** *Suppose that $R(B, \tilde{p})$ is sufficiently close to 0 for $\tilde{p} \in [\underline{p}, \overline{p}]$ and that $q < c$ is sufficiently close to c. Then there are thresholds $\bar{p}_y^* \leq p_1^* < p_2^* < \overline{p}$ such that the optimal contract for a young agent is*

(i) flexible for $\bar{p}_y^* \leq \tilde{p} \leq p_1^*$,

(ii) rigid for $p_1^* \leq \tilde{p} \leq p_2^*$,

(iii) flexible for $p_2^* \leq \tilde{p} \leq \overline{p}$.

An agent with marginal productivity receives a rigid contract, $p_1^* = \bar{p}_y^*$, if $q \geq 1/2$.

That is, career concerns can generate organizational and contractual heterogeneity in firms that employ young agents.

4 Labor Market Equilibrium with Limited Liability

We now turn to the equilibrium behavior of principals and agents when contracts have to respect limited liability (i.e., $w_a, w_b \geq 0$). Introducing this assumption has two effects. First, compared with the benchmark investments may be distorted downwards simply because the agent cannot pay for them. More subtly, for young agents receiving a flexible contract the mix of investments may be biased towards employee perks to compensate for the signal value. That is, idleness may be rewarded by means of corporate investment. To solve for the optimal contract, we consider again a pair of principal and agent with outside option $\underline{u}$, which will later be derived endogenously as the market equilibrium payoffs.

4.1 Old Agents

As above, we start with the problem for old agents. A principal who uses a flexible contract maximizes the payoff

$$\pi = q(R(A, \tilde{p}) - w_a) - (1 - q)w_b - (k_a^2 + k_b^2)/2 - F,$$

subject to incentive compatibility and individual rationality

$$w_b + k_b = w_a - c + k_a \text{ and } q(w_a - c + k_a) + (1 - q)(w_b + k_b) \geq \underline{u}.$$

As above the participation constraint has to bind. Recall that $k_a = q$ is the efficient investment in productive perks. Compensating the agent in kind by increasing k_a is cheaper for the principal than using a cash payment whenever $k_a < q$. Because $q < c$ setting $k_a = q$ and $w_a = \underline{u} + c - q$ satisfies limited liability. In contrast, efficient investments in employee perks (that is $k_b = 1-q$ and $w_b = \underline{u}-(1-q)$) are compatible with limited liability only if $\underline{u} \geq 1 - q$. Otherwise $k_b = \underline{u}$ and $w_b = 0$.

That is, under a flexible contract both types of investments are provided, but they are provided only to the extent required to satisfy the participation constraint. Limited liability may induce under-investment in employee perks for old agents. As in the benchmark case the optimal contract takes the form of a base salary and a bonus for task a.

Consider now a rigid contract. Incentive compatibility and individual rationality require

$$w_a - c + k_a \geq w_b + k_b \text{ and } w_a - c + k_a \geq \underline{u},$$

The principal's payoff is

$$\pi = qR(A, \tilde{p}) + (1 - q)R(B, \tilde{p}) - c - w_a - w_b - (k_a^2 + k_b^2)/2 - F.$$

As above $k_b = 0$, and $w_b = 0$, and the participation constraint binds. Efficient investment in productive perks ($k_a = 1$ and $w_a = \underline{u} - 1 + c$) satisfies limited liability only if $\underline{u} \geq 1 - c$. Otherwise, $k_a = \underline{u} + c$ and $w_a = 0$.

A rigid contract thus discourages idleness and is accompanied by substantial productive perks k_a but no employee perks k_b. Under-investment in productive perks compared with the benchmark is possible for agents with low outside options.

Comparing individual payoffs under the different contractual regimes yields the following statement (see the appendix for details).

Proposition 4. *In a match of a principal and an old agent, a flexible contract Pareto* *dominates a rigid contract if $R(B, \tilde{p}) \leq 0$. An old agent is hired only if*

$$
\begin{aligned}
&q(R(A,\tilde{p}) - c) + (q^2 + (1-q)^2)/2 - F \geq \underline{u} && \text{if } \underline{u} \geq 1-q, \\
&q(R(A,\tilde{p}) - c) + q^2/2 - F \geq q\underline{u} + \underline{u}^2/2 && \text{if } \underline{u} < 1-q.
\end{aligned}
$$

Corporate investments k_a and k_b coincide with the benchmark if $\underline{u} \geq 1-q$, otherwise there is under-investment in k_b.

As in the benchmark, flexible contracts always dominate rigid ones under Assumption (A1). Old agents are employed only if their expected productivity is high enough and they all receive flexible contracts. Limited liability distorts investments for low outside options $\underline{u} < 1-q$, because employee perks alone satisfy individual rationality. Therefore, the minimum productivity required to break even in expectation is higher here than in the benchmark. Agents who are able to generate positive surplus are thus scarce, and principals obtain zero profits in equilibrium. This determines old agents' equilibrium payoffs. Details are in the appendix.

Proposition 5. *In a labor market equilibrium, all old agents with expected productivity $\tilde{p} \geq \bar{p}_o$ are employed and obtain flexible contracts, with*

$$
\bar{p}_o = \frac{c - q/2 + F/q - \underline{R}(A)}{\overline{R}(A) - \underline{R}(A)} > \bar{p}_o^* > \underline{p}. \tag{6}
$$

There is $\hat{p}_o > \bar{p}_o$, such that investments are efficient if $\tilde{p} \geq \hat{p}_o$. In equilibrium principals obtain payoffs $\pi = 0$ and old agents obtain payoffs

$$
u_o(\tilde{p}) = \begin{cases} q(R(A,\tilde{p}) - c) + \frac{q^2 + (1-q)^2}{2} - F & \text{if } \tilde{p} \geq \hat{p}_o, \\ \sqrt{2q(R(A,\tilde{p}) - c + q) - 2F} - q & \text{if } \bar{p}_o < \tilde{p} < \hat{p}_o, \\ 0 & \text{if } \tilde{p} < \bar{p}_o. \end{cases} \tag{7}
$$

In other words, under limited liability unemployment is higher than in the benchmark, and the payoffs of intermediate productivity types' are lower.

4.2 Career Concerns

As above old agents' payoffs (7) determine a young agent's signal value $s(\tilde{p})$:

$$s(\tilde{p}) = \begin{cases} \tilde{p}u_o(p_S(\tilde{p})) & \text{if } \tilde{p} < \bar{p}_o < p_S(\tilde{p}), \\ \tilde{p}u_o(p_S(\tilde{p})) - u_o(\tilde{p}) & \text{if } p_F(\tilde{p}) < \bar{p}_o < \tilde{p}, \\ \tilde{p}u_o(p_S(\tilde{p})) + (1-\tilde{p})u_o(p_F(\tilde{p})) - u_o(\tilde{p}) & \text{if } \bar{p}_o < p_F(\tilde{p}) < \hat{p}_o, \\ 0 & \text{otherwise.} \end{cases}$$

Note here that, in contrast to the benchmark, $s(\tilde{p})$ may be negative because old agents' payoffs are a concave function of $\tilde{p}$ for $\bar{p}_o < \tilde{p} < \hat{p}_o$. Differentiating $u_o(\tilde{p})$, $p_S(.)$, and $p_F(.)$ implies the following properties.

Lemma 6 (Signal Value)**.** *Given old agents' equilibrium payoffs the signal value* $s(\tilde{p})$

(i) is strictly positive and strictly increases for $\overline{p}\,\underline{p}/(\overline{p}+\underline{p}+\bar{p}_o) < \tilde{p} < \bar{p}_o$,

(ii) strictly decreases for $\bar{p}_o < \tilde{p} < (\bar{p}_o - \overline{p}\underline{p})/(1-\overline{p}-\underline{p}-\bar{p}_o)$,

(iii) increases for $\tilde{p} > \bar{p}_o$ *and* $\tilde{p} > (\bar{p}_o - \overline{p}\underline{p})/(1-\overline{p}-\underline{p}-\bar{p}_o)$.

Figure 1 illustrates these properties and compares the equilibrium signal value to the benchmark. Note that because $\bar{p}_o^* < \bar{p}_o$ the signal value is higher for expected productivities close to $\bar{p}_o$ and lower for expected productivities close to $\underline{p}$ under limited liability than in the benchmark.

4.3 Young Agents

The contracting problem of a principal and a young agent with expected productivity $\tilde{p}$ is complicated both by limited liability and career concerns. As above, we take as given the signal value $s(\tilde{p})$ and the agent's outside option $\underline{u}$.

With career concerns $s(\tilde{p})$, the incentive compatibility constraint of a flexible contract requires

$$w_a + s(\tilde{p}) - c + k_a = w_b + k_b.$$

The agent's participation constraint is given by

$$q(w_a + s(\tilde{p}) - c + k_a) + (1-q)(w_b + k_b) \geq \underline{u}. \tag{8}$$

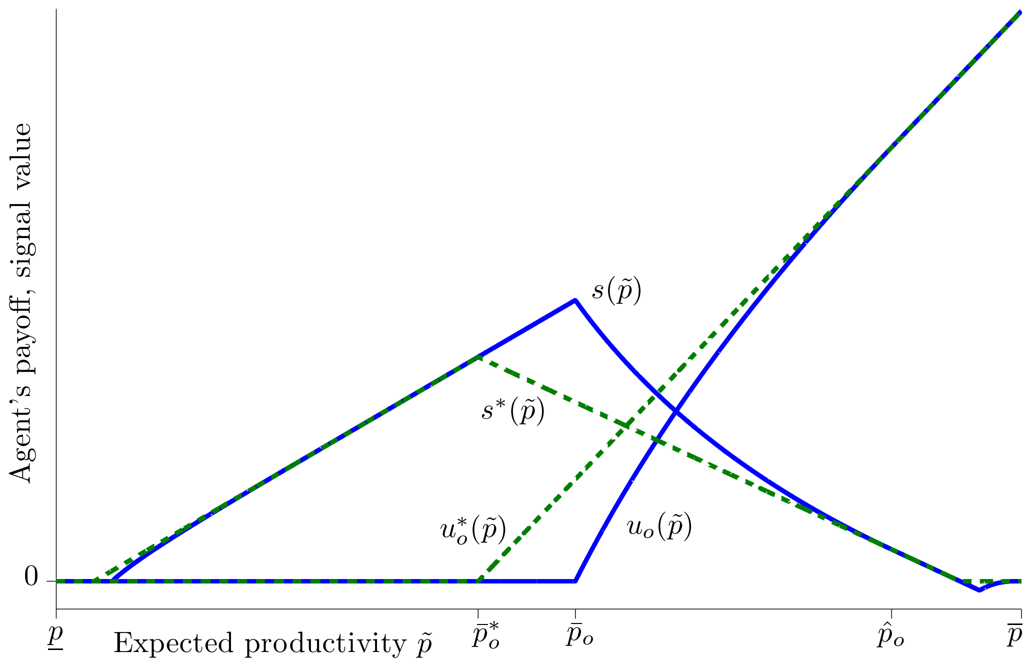

Fig. 1: Old agents' payoffs and young agents' signal value in equilibrium (solid lines) and benchmark (dashed lines).

The principal's payoff is

$$\pi = q(R(A, \tilde{p}) - w_a) - (1 - q)w_b - (k_a^2 + k_b^2)/2 - F. \tag{9}$$

In contrast to the case of old agents, the participation constraint (8) does not bind if $s(\tilde{p}) > c + \underline{u}$. In this case $w_a = k_a = 0$, and, to ensure incentive compatibility, $w_b + k_b = s(\tilde{p}) - c$. Because limited liability implies $w_b \geq 0$,

$$w_b = 0 \text{ and } k_b = s(\tilde{p}) - c \text{ if } s(\tilde{p}) - c \leq 1 - q, \text{ and}$$
$$w_b = s(\tilde{p}) - c - (1 - q) \text{ and } k_b = 1 - q \text{ otherwise.}$$

Instead, if $s(\tilde{p}) \leq c + \underline{u}$ condition (8) binds and $w_b + k_b = \underline{u} = w_a + s(\tilde{p}) - c + k_a$.

Again, it is cheaper to transfer utility in kind if $k_a < q$ and $k_b < 1-q$, such that

$$\begin{aligned} &w_a = 0 \text{ and } k_a = \underline{u} + c - s(\tilde{p}) \text{ if } \underline{u} + c - s(\tilde{p}) < q \text{ and} \\ &w_a = \underline{u} + c - s(\tilde{p}) - q \text{ and } k_a = q \text{ otherwise, and} \\ &w_b = 0 \text{ and } k_b = \underline{u} \text{ if } \underline{u} < 1-q \text{ and} \\ &w_b = \underline{u} - (1-q) \text{ and } k_b = 1-q \text{ otherwise.} \end{aligned} \tag{10}$$

Career concerns bias the agent toward the visible task a. A flexible contract balances against this bias by providing adequate incentives for task b. Specifically, the contract makes task a relatively more costly than b by using an appropriate mix of investments and monetary incentives. For young agents with low outside options, the provision of employee perks satisfies the participation constraint. To ensure incentive compatibility the principal then optimally biases investments toward those that complement task b.

If a rigid contract is used to implement a for a young agent, incentive compatibility and individual rationality require

$$w_a + s(\tilde{p}) - c + k_a \geq w_b + k_b \text{ and } w_a + s(\tilde{p}) - c + k_a \geq \underline{u}.$$

The principal's payoff is

$$\pi = qR(A,\tilde{p}) + (1-q)R(B,\tilde{p}) - w_a - (k_a^2 + k_b^2)/2 - F.$$

Therefore the principal optimally sets $k_b = 0$ and $w_b = 0$. Analogous to the case of a flexible contract, the participation constraint does not bind if $s(\tilde{p}) > c + \underline{u}$. As a consequence $k_a = w_a = 0$. Otherwise, in-kind transfers in the form of the investment k_a are more profitable than cash payments as long as $k_a < 1$, as in the case of old agents. Therefore,

$$\begin{aligned} &w_a = 0 \text{ and } k_a = c - s(\tilde{p}) + \underline{u} \text{ if } c - s(\tilde{p}) + \underline{u} \leq 1, \text{ and} \\ &w_a = c - s(\tilde{p}) + \underline{u} - 1 \text{ and } k_a = 1 \text{ otherwise.} \end{aligned} \tag{11}$$

Rigid contracts emphasize productive perks and do not provide employee perks. They rely primarily on implicit incentives to encourage employees to choose task a. Monetary payments are used only for agents with sufficiently high outside options.

Note that if the outside option $\underline{u}$ is given by labor market equilibrium payoffs, the participation constraint necessarily holds in equilibrium (i.e., $\underline{u} \geq s(\tilde{p}) - c$), because the agent's payoff in any match with some principal is at least $s(\tilde{p}) - c$. Comparing payoffs under rigid and flexible contracts yields the following statement.

Lemma 7. *For a young agent with expected productivity $\tilde{p}$ with outside option $\underline{u} \geq s(\tilde{p}) - c$, a rigid contract Pareto dominates a flexible contract if, and only if, both outside option $\underline{u}$ and the signal value $s(\tilde{p})$ are sufficiently large, that is, if*

(i) $\underline{u} \geq \hat{u}(\tilde{p})$, *for a cutoff value* $\hat{u}(\tilde{p})$, *with* $\hat{u}(\tilde{p}) > 0$ *if* $R(B, \tilde{p}) < 0$, *and*

(ii) $s(\tilde{p}) \leq \hat{s}(\underline{u})$, *where* $\hat{s}(u)$ *is a decreasing function on* $[\hat{u}(\tilde{p}), +\infty)$ *approaching* $c - q - R(B, \tilde{p})$ *in the limit.*

Corporate investments in productive perks k_a and employee perks k_b maximize the joint surplus given contractual choice if $\underline{u} \geq q$, and $\underline{u} \geq 1 - q$, respectively.

That is, rigid contracts are used for young agents with strong career concerns and good outside options. High outside options are necessary to make rigid contracts preferable under limited liability, because the agent needs to compensate the principal for the decrease in expected revenue ($R(B, \tilde{p})$ instead of 0) through a lower wage.

Interpreting the outside option $\underline{u}$ as the agent's market value, Lemma 7 allows us to tie contractual and organizational choice to the characteristics of employees. *High potentials* (who have both high market and signal value) will receive rigid contracts that discourage idleness and emphasize task a. Corporate investment is focused on productive perks. *Hidden gems* (who have low market and high signal value) receive flexible contracts and corporate investments are distorted to discourage signal generation on the job. Organizations may efficiently invest in employee perks while under-investing in productive perks. Such organizations emphasize the possibility of staying idle and actively discourage employees from activities that generate public signals. Finally, *proven talents* (who have low signaling value) receive flexible contracts. Idleness is tolerated but not explicitly rewarded. Investment in productive perks is efficient, and employee perks are used to reward the agent but not to affect task choice.

4.4 Equilibrium Organizational Choice

Given the principals' and old agents' labor market equilibrium payoffs (as stated in Proposition 5) and using (10), we can compute the difference in the composition of corporate investments in flexible contracts between old and young agents. This comparison yields the following proposition. Its proof is in the appendix.

Proposition 8. *Consider a young agent and an old agent of equal expected productivity $\tilde{p}$, both obtaining a flexible contract. Investment in employee perks k_b is higher for the young agent than for the old agent, and strictly so if $k_b < 1 - q$ for the old agent. Investment in productive perks k_a is higher for the old agent than for the young agent, and strictly so if $k_a < q$ for the young agent.*

That is, the positive signal values of young agents bias corporate investment toward employee perks whenever flexible contracts are used. In such contracts, the monetary and non-monetary incentives for task a need to be balanced by an appropriate reward for idleness, which take the form of employee perks k_b.

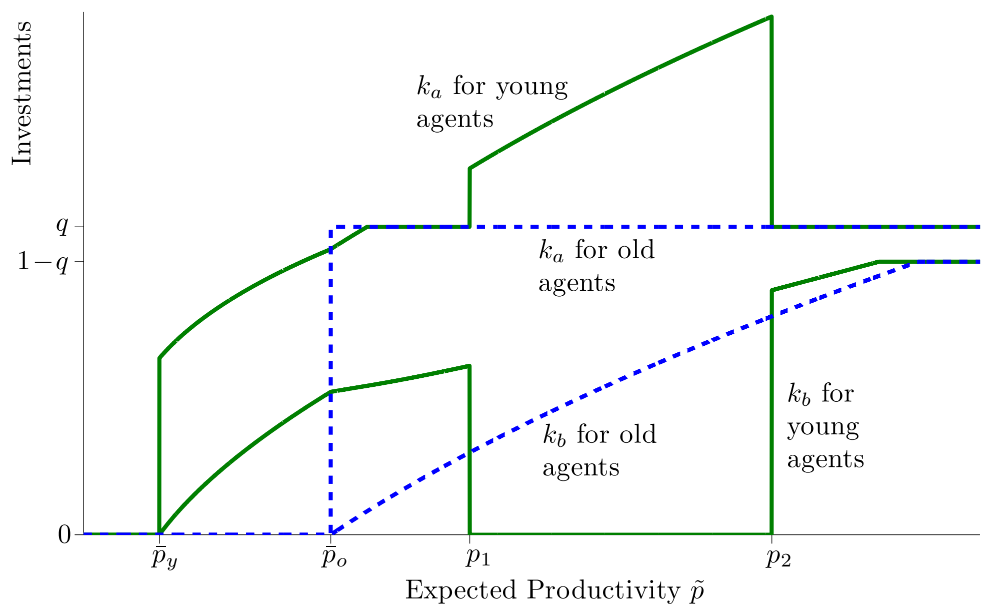

Fig. 2: Investment in k_a and k_b, for given agent's productivity and age.

Figure 2 depicts the equilibrium corporate infrastructure investment for old and young agents at different productivity levels. As in the benchmark model, for young agents the investment is discontinuous whenever the contractual regime changes. A young agent receiving a flexible contract enjoys higher k_b (e.g., sports facilities or game rooms) and lower k_a (e.g., office equipment or corporate jets) relative to an old agent with the same productivity. Young agents who receive rigid contracts enjoy lower k_b than old agents with the same productivity.

To determine the structure of organizational and contractual choice in a labor market equilibrium, we start by examining which young agents will actually be employed. A young agent's equilibrium payoff $u_y(\tilde{p})$ can be derived using the fact that $\pi = 0$. In addition $u_y(\tilde{p})$ strictly increases in $\tilde{p}$ (see the proof of Lemma 9 below in the appendix). Hence, there is a unique productivity level $\bar{p}_y$ such that under a flexible contract $u_y(\tilde{p}) \geq 0$ for $\tilde{p} \geq \bar{p}_y$ and $u_y(\tilde{p}) < 0$ otherwise. Because the participation constraint is binding, $u_y(\tilde{p}) = 0$ implies $s(\tilde{p}) \leq c$. Hence $\bar{p}_y$ is pinned down by

$$q(R(A, \bar{p}) - w_a) - k_a^2/2 - F = 0, \tag{12}$$

with $w_a = 0$ and $k_a = c - s(\bar{p}_y)$ if $s(\bar{p}_y) < c - q$, and $w_a = c - q - s(\bar{p}_y)$ and $k_a = q$ otherwise. According to Lemma 7 a flexible contract Pareto dominates a rigid one for small payoffs $u_y(\tilde{p}) \leq \hat{u}(\tilde{p})$ with $\hat{u}(\tilde{p}) \geq 0$. This finding implies the next statement. Missing details are in the appendix.

Lemma 9. *There is $\bar{p}_y$ such that all young agents with $\tilde{p} \geq \bar{p}_y$ are hired by a principal. For $\tilde{p}$ close to $\bar{p}_y$ this contract is flexible. Moreover, $\bar{p}_y < \bar{p}_o$: young agents are hired by principals at lower productivity levels than old agents.*

As in the benchmark model, young agents are employed at lower productivity levels than old agents. However, in this case marginal young agents (with $\tilde{p}$ close to $\bar{p}_y$) always receive flexible rather than a rigid contracts. The reason is that under limited liability a young agent has no means to compensate the principal for the decrease in expected revenue ($E[R(B, \tilde{p})]$ instead of 0). This outcome may be inefficient, because in the benchmark rigid choice of a may be optimal for the marginal young agent (e.g., for $q > 1/2$).

We now turn to the organizational choice of the remaining firms. By Lemma 7 young agents obtain rigid contracts if they have both sufficient equilibrium payoff

$u_y(\tilde{p})$ and signal value $s(\tilde{p})$. Both are endogenous and, in equilibrium, depend on each other because the signal value is part of a young agent's payoff. Specifically, by Lemma 7 for a high enough payoff $u_y(\tilde{p})$, a rigid contract is chosen if the signal value exceeds a threshold $\hat{s}(u_y(\tilde{p}))$ depending on the payoff. Because $\pi = 0$ in equilibrium, this threshold value becomes a function of $\tilde{p}$, which first decreases before increasing. Because $s(\tilde{p})$ first increases before decreasing, there may be several intersection points, such that the optimal contractual and organizational choices may switch several times between flexible and rigid contracts as $\tilde{p}$ increases from $\bar{p}_y$ to $\overline{p}$. This point is stated in the following proposition. Its proof is in the appendix.

Proposition 10 (Labor Market Outcome)**.** *In a labor market equilibrium, old agents obtain flexible contracts if $\tilde{p} \geq \bar{p}_o$ and stay idle otherwise, and young agents obtain flexible or a rigid contracts if $\tilde{p} \geq \bar{p}_y$ and stay idle otherwise.*
If $R(B, \tilde{p})$ is sufficiently close to 0 and c is sufficiently close to q there are thresholds $p_y < p_1 < p_2 \leq p_3 < p_4 < \overline{p}$ such that the optimal contract for a young agent is:
(i) flexible for $\bar{p}_y < \tilde{p} < p_1$ with $w_a = 0$, $0 < k_a \leq q$, and $0 < k_b \leq 1 - q$,
(ii) rigid for $p_1 < \tilde{p} < p_2$ and $p_3 < \tilde{p} < p_4$ with $w_a \geq 0$, $q < k_a \leq 1$, and $k_b = 0$,
(iii) flexible for $p_3 < \tilde{p} < \overline{p}$ with $w_a > 0$, and $k_a = q$, and $0 < k_b \leq 1 - q$.

That is, career concerns generate organizational and contractual heterogeneity for young agents, as in the benchmark. Here, firms react to the agent's desire to signal in one of three ways. For agents with low productivity, $\bar{p}_y < \tilde{p} < p_1$, career concerns are strong, but the associated market payoff is low. These agents receive flexible contracts with under-investment in k_a used to discourage task a. This case describes the hidden gems mentioned above. Agents with $p_1 < \tilde{p} < p_2$ are high potentials, with strong career concerns and intermediate market values, which enables them to compensate the principal for the expected revenue loss if a rigid contract is used. This contract may take the form of $k_a < 1$ and $w_a = w_b = 0$, which is reminiscent of unpaid internships that are common, for example, in journalism. Finally, agents with high productivity have weak career concerns and high market value. Thus, proven talents obtain flexible contracts with efficient investment in k_a and possibly in k_b. Figure 3 summarizes these points and also shows the signal value threshold $\hat{s}(.)$, which determines the different regimes.

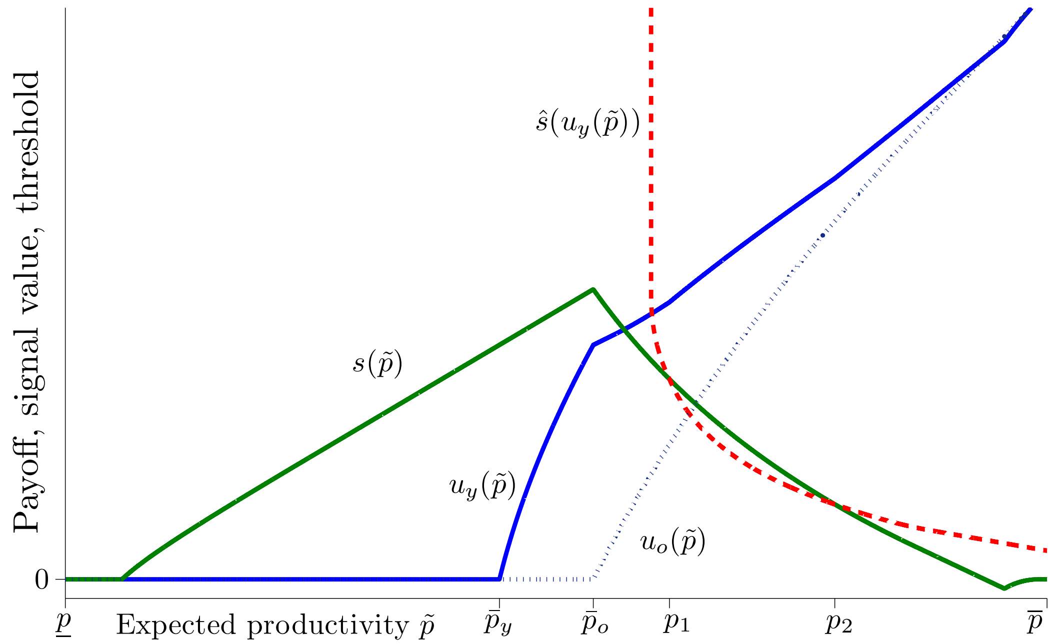

Fig. 3: Contractual and organizational choice depending on expected productivity $\tilde{p}$.

Contracts for agents with $\bar{p}_y < \tilde{p} < \bar{p}_o$ are an extreme form of discouraging work and rewarding idleness, especially when $u_y(\bar{p}_o) > 1-q$, since then $w_b > 0$, but $w_a = 0$. Such a contract pays a wage only if the agent remains idle, but then terminates the relationship because $\tilde{p} < \bar{p}_o$. If the agent chooses task a and generates a signal, no wage is paid and the agent will either move up to a better contract with a potentially different employer, or move out and fail to obtain a contract.

5 Discussion

5.1 If the Agent Is Not an Expert

Assume that both the agent and the principal observe the state of the world after writing a contract. In this case, flexible contracts will not have to satisfy the agent's incentive compatibility condition. That is, investments in employee perks and monetary rewards for task b will not need to equalize the payoffs across states.

Hence, under symmetric information investments k_a and k_b will always be chosen at the efficient ratio $k_a/k_b = q/(1-q)$. This fact also implies that the joint surplus for a given productivity is greater under symmetric information, which matters for agents with high signal value and expected productivity close to $\bar{p}_y$ (the hidden gems in our terminology), who, in the model with asymmetric information, receive flexible contracts with an inefficiently high ratio of employee to productive perks. This investment distortion causes the break-even productivity $\bar{p}_y$ to be higher under asymmetric information than under symmetric information.

5.2 If the Routine Task b is Productive

If task b is productive, yielding a positive return $r > 0$ with $R(A, \tilde{p}) > r > R(B, \tilde{p})$, the analysis derived above carries over qualitatively. A rigid contract will now be more costly but will still be chosen if the signal value is high enough relative to $r - R(b, \tilde{p})$. The main difference from the results above is that young agents with low expected productivity (the ones that are left unmatched when $r = 0$) are assigned to rigid contracts implementing the non-visible task b, which allow us to interpret our setup as a labor market with routine and complex occupations.

One industry that this type of equilibrium describes well could be academia. Teaching could be interpreted as the non-visible task, while research corresponds to the visible task. The organizational and contractual choices for entry positions differ markedly across departments. Some departments favor organizational and contractual designs that primarily encourage task b (teaching) while relying on market incentives for task a (i.e. research output). Other departments appear to favor the exact opposite by encouraging research over teaching, using bonus payments for publications (but not for teaching), and providing large research budgets. The organizational structure in a third group seems to explicitly encourage both tasks.

5.3 Firm Sizes

The assumption that firms consist of pairs of principals and agents can easily be extended if states are drawn independently across agents. If corporate investments can be tailored to each agent the analysis proceeds unchanged. If corporate investments have to be chosen for the whole firm and agents are substitutes, optimal investments would take into account all employees' productivities and signal values. Each principal would hire similar agents and match investments to an average of the agents' attributes. The organizational structure within an industry would change discontinuously with the employees' average productivity (see Gall, 2010, for a labor market model with heterogeneous agents and principals and endogenous firm sizes). If agents are not substitutes (for instance because young and old agents could have complementary human capital) the optimal contractual and investment choice would take into account both agents' attributes, to blunt the effect of a young agent's high signal value. However, rigid contracts will remain possible if their cost $(c - R(B, \tilde{p}))$ is sufficiently small.

5.4 Technological Change

Technological change may have an interesting effect on the dynamics of the labor market if different productivity types are affected differentially: if technological change is skill biased. A simple way to model this effect is to allow the top productivity $\overline{p}$ to increase, which implies that highly productive agents are affected but not less productive agents. As a consequence, old agents' market values increase and the wage schedule for old agents becomes more convex.

This change increases the value of choosing the visible task for young agents, which, in turn, increases the desirability of rigid contracts and exacerbates underinvestment in productive perks. This effect is partially compensated for by an increase in young agents' market values as expected surplus increases due to technological change. Overall, the use of rigid contracts will increase. That is, a shock that affects only some type of agents may generate substantial reorganization of firms in this economy.

5.5 Dynamics

When moving from a two-period model to a multi-period model, the pattern described above largely carries over. As in Gibbons and Murphy (1992), the value of choosing action a decreases over the lifetime of an agent. This decrease reflects the diminishing net present value of future earnings and therefore the value of success as the agent grows older. In turn, this decline implies that the expected productivity of the marginal agent (who generates an expected joint surplus of 0) increases with an agent's age. Hence, the organizational choice described above functions as a screening mechanism that becomes increasingly demanding as agents grow older.

6 Conclusions

This paper has examined the organizational response to the career concerns of agents who have private information on the profitability of different tasks. Principals' choices of contracts and investment in corporate infrastructure are discontinuous in agents' attributes. Firms that employ similar types of agents may optimally choose very different organizational forms, such as one that rewards idleness or one that rewards conspicuous activities generating a public signal. The reason is that generating a public signal may impose a cost on the principal, and rewarding idleness reduces an agent's incentive to generate a public signal. However, if the agent values generating a public signal enough, the principal may find that discouraging the agent is too costly. These results match empirical facts such as the huge variety in the use of employee perks and firms' expectations of employees' willingness to perform overtime work.

In the labor market equilibrium, three different regimes of organizational choice can emerge: hidden gems (agents close to break-even productivity) receive flexible contracts that balance career concerns by rewarding idleness, but corporate investments are under-provided as a result of limited liability. This situation may reflect a market failure because the surplus maximizing organization choice absent limited liability tends to encourage the visible task by mean of rigid contracts. High potentials (agents of intermediate productivities) receive rigid contracts encouraging visible activities and discouraging idleness, and are rewarded by productive perks that complement the visible task. Proven talents (agents of high productivity) have weak career concerns and receive flexible contracts, where career concerns are balanced using monetary payments, and corporate infrastructure investments are efficient.

Career concerns depend on the convexity of future payoffs. As convexity increases, the signal value associated with performing a visible task increases as well. Hence, for more convex wage schedules firms will increasingly choose an organizational form that discourages idleness, corresponding to the well-known negative empirical relationship between worse market conditions (higher unemployment rate) and sick-days leave.

To derive the results in a tractable manner, we chose the model setup for simplicity rather than generality. For instance, the effort choice by the agent is discrete. An extension could consider continuous effort, and explore the relationship between organizational choice and the power of monetary incentives. Another extension that appears promising could allow for heterogeneity among principals. This modification would introduce the possibility of externalities from task choice.

Finally, the model has implications for the analysis of job turnover and internal labor markets. Performing the visible task generates a public signal and thus an update of the agent's expected productivity. This signal also changes the organizational setup for the agent in the following period (i.e., when the agent changes jobs). Thus, a rigid contract can be interpreted as an 'up or out' work environment, where employees are either promoted or fired. A flexible contract allows for the possibility that an agent stays idle and remains in the organization in the following period. That is, turnover is lower in firms that use employee perks.

A Mathematical Appendix

Proof of Lemma 1

Denote by τ the prior belief over the distribution of $\underline{p}$ and $\overline{p}$, so that $\tilde{p} = \tau\overline{p} + (1-\tau)\underline{p}$. Then

$$p_S(\tilde{p}) = \frac{\tau\overline{p}}{\tau\overline{p} + (1-\tau)\underline{p}}\overline{p} + \left(1 - \frac{\tau\overline{p}}{\tau\overline{p} + (1-\tau)\underline{p}}\right)\underline{p}.$$

Using $\tilde{p} = \tau\overline{p} + (1-\tau)\underline{p}$ yields the expression in the lemma. An analogous argument yields $p_F(\tilde{p})$. If an agent chose task b or remained unmatched in the first period no new information is generated, therefore $p_I(\tilde{p}) = \tilde{p}$.

Proof of Proposition 2

Without limited liability the principal's choice of investments and contract type also maximizes expected joint surplus in a match. The expected joint surplus with a young agent given optimal investments is

$$E[\pi_j+u_i] = q[R(A,\tilde{p}) - c + s^*(\tilde{p})] + (q^2 + (1-q)^2)/2 - F \text{ with a flexible contract,}$$
$$E[\pi_j+u_i] = qR(A,\tilde{p}) + (1-q)R(B,\tilde{p}) - c + s^*(\tilde{p}) + 1/2 - F \text{ with rigid choice of } a,$$
$$E[\pi_j+u_i] = 1/2 - F \text{ with rigid choice of } b.$$

Bilateral comparison then yields the statements in the proposition, because $F \geq 1/2$ implies that rigid choice of b is dominated. For a match to be profitable $E[\pi_j + u_i] \geq F$, that is

$$qR(A,\tilde{p}) \geq F - (q^2 + (1-q)^2)/2 + q(c - s^*(\tilde{p})) \text{ with a flexible contract,}$$
$$qR(A,\tilde{p}) + (1-q)R(B,\tilde{p}) \geq c - s^*(\tilde{p}) + F - 1/2 \text{ with a rigid contract.}$$

Since both expressions increase in $\tilde{p}$ for $\tilde{p} \leq \bar{p}_o^*$ and a young agent with $\bar{p}_o^*$ must be employed, there is $\bar{p}_y^* < \bar{p}_o^*$ such that all young agents with $\tilde{p} \geq \bar{p}_y^*$ are employed.

$\bar{p}_y^*$ is given by $R(A,\bar{p}_y^*) = c - s^*(\bar{p}_y^*) + F/q + 1 - q - 1/(2q)$ if $R(B,\bar{p}_y^*) \geq c - s^*(\bar{p}_y^*) - q$ and by $qR(A,\bar{p}_y^*) + (1-q)R(B,\bar{p}_y^*) = c - s^*(\bar{p}_y^*) + F - 1/2$ otherwise.

Proof of Proposition 3

Because $s^*(\tilde{p})$ attains a maximum at $\bar{p}_o^*$, rigid contracts will be used if $c - q < s^*(\bar{p}_o^*) + R(B,\bar{p}_o^*)$. Suppose this is the case. As both $s^*(\tilde{p})$ and $R(B,\tilde{p})$ increase in $\tilde{p}$ for $\tilde{p} < \bar{p}_o^*$, there is at most one $p_1 \in [\bar{p}_y^*, \bar{p}_o^*)$, such that $c - q - s^*(p_1) = R(B,p_1)$. Because $s^*(\tilde{p})$ approaches 0 as $\tilde{p}$ approaches $\overline{p}$, a flexible contract is used for $\tilde{p}$ in the neighborhood of $\overline{p}$. Hence, there is at least one $p_2 \in (\bar{p}_o^*, \overline{p})$, such that $c - q - s^*(p_2) = R(B,p_2)$. Because both $s^*(\tilde{p})$ and $R(B,\tilde{p})$ are linear functions of $\tilde{p}$, there is at most one such p_2. This implies that $c - q < s^*(\bar{p}_o^*) + R(B,\bar{p}_o^*)$ is also necessary for the use of rigid contracts. Since $u_o^*(p_S(\bar{p}_o^*)) = q(R(A,p_S(\bar{p}_o^*)) - c) + (q^2 + (1-q)^2) - F > 0$, $\bar{p}_o^* u_o^*(p_S(\bar{p}_o^*)) > 0$ and there are c, $q < c$ close enough to c, and $R(B,\tilde{p}) < 0$ close enough to 0 for $\tilde{p} \in [\underline{p}, \overline{p}]$, such that $c - q - R(B,\bar{p}_o^*) < q(R(A,p_S(\bar{p}_o^*)) - c) + (q^2 + (1-q)^2) - F$. For the last statement in the proposition note that $c - s^*(\tilde{p}) \leq (1-q)R(B,\tilde{p}) + 1/2$ (the condition that a rigid contract generates positive surplus) implies $c - s^*(\tilde{p}) \leq q + R(B,\tilde{p})$ (the condition that a rigid Pareto dominates a flexible contract) if $1/2 < q(1 - R(B,\tilde{p}))$.

Proof of Proposition 4

It suffices to compare the rigid choice of a to a flexible contract (the rigid choice of b yields a payoff of 0). Suppose $\underline{u} < 1 - c$ first, which implies $\underline{u} < 1 - q$. A flexible contract is more profitable if

$$(1-q)c + q^2/2 + (1-q)\underline{u} - \underline{u}^2/2 > (1-q)R(B,\tilde{p}) + c + \underline{u} - (c + \underline{u})^2/2.$$

After some rearranging this becomes

$$(c-q)^2/2 + (c-q)\underline{u} > (1-q)R(B,\tilde{p}),$$

where the LHS is strictly positive. Let now $1 - c < \underline{u} < 1 - q$. Then a flexible contract is more profitable if

$$(1-q)c + q^2/2 + (1-q)\underline{u} - \underline{u}^2/2 > (1-q)R(B,\tilde{p}) + 1/2.$$

This becomes

$$c - (1+q)/2 + \underline{u}(1-\underline{u})/(2(1-q))) > R(B,\tilde{p}).$$

Since $1 - c < \underline{u} < 1 - q$ by assumption, the LHS is bounded below by $(c-q)/2 > 0$. Finally, in case $\underline{u} > 1 - q$ the condition is the same as in the benchmark case. This establishes the statement. The second statement follows from computing expected payoffs and the statements on investments have been derived in the text.

Proof of Proposition 5

Compute first the minimum productivity of an old agent required to generate positive surplus in firm. Note that positive surplus is only generated if task a is chosen with positive probability and by Proposition 4 a flexible contract Pareto dominates a rigid one. Using a flexible contract a principal j and an old agent i with expected productivity $\tilde{p}$ have positive expected surplus $\pi_j + u_i$ if

$$\pi_j = q(R(A,\tilde{p}) - c) + q^2/2 - u_i^2/2 \geq F \text{ for } 0 \leq u_i \leq 1 - q.$$

That is, with an old agent joint surplus can be positive only if

$$\tilde{p} \geq \frac{c - \frac{q}{2} + F/q - \underline{R}(A)}{\overline{R}(A) - \underline{R}(A)}.$$

Note that $\bar{p}_o > \bar{p}_o^*$, so that by Assumption (A2) also $\bar{p}_o > \underline{p}$ for all $\pi \geq 0$. Hence, agents with high enough expected productivity to break even are scarce, since the measure of principals equals the one of all agents. Therefore in any labor market equilibrium each principal obtains payoff $\pi_j = 0$. Since $\pi_j = 0$ investments in a flexible contract are efficient if $u_i \geq 1 - q$, that is,

$$q(R(A, \tilde{p}) - c) + (q^2 + (1-q)^2)/2 - F \geq 1 - q.$$

Solving for $\tilde{p}$ yields

$$\hat{p}_o = \frac{c - q + F/q - \underline{R}(A) + \frac{1}{2q}}{\overline{R}(A) - \underline{R}(A)} > \bar{p}_o. \tag{13}$$

This allows computation of old agents' equilibrium payoffs $u_o(\tilde{p})$ as a function of their expected productivity $\tilde{p}$ as given by expression (7) in the proposition.

Proof of Lemma 6

Parts (i) and (ii) of the lemma have been discussed in the benchmark case. Regarding part (iii), differentiating $s(\tilde{p})$ yields

$$\begin{aligned}\frac{\partial s(\tilde{p})}{\partial \tilde{p}} =& u_o(p_S(\tilde{p})) - u_o(p_F(\tilde{p})) + \tilde{p}\frac{\partial u_o(p_S(\tilde{p}))}{\partial p_S}\frac{\partial p_S(\tilde{p})}{\partial \tilde{p}} \\ &+ (1-\tilde{p})\frac{\partial u_o(p_F(\tilde{p}))}{\partial p_F}\frac{\partial p_F(\tilde{p})}{\partial \tilde{p}} - \frac{\partial u_o(\tilde{p})}{\partial \tilde{p}}.\end{aligned} \tag{14}$$

Since part (iii) requires $\tilde{p}$ to satisfy $\bar{p}_o < p_F(\tilde{p}) < \hat{p}_o$, necessarily $u_o(p^F(\tilde{p})) > 0$. Recalling that $p_F(\tilde{p}) = \frac{\tilde{p}(1-\underline{p}-\overline{p})+\underline{p}\overline{p}}{1-\tilde{p}}$ and using the definition of $\hat{p}_o$ in (13) it is easily verified that $p_F(\tilde{p}) > \bar{p}_o$ implies that $\tilde{p} > \hat{p}_o$. Therefore $u_o(\tilde{p}) > 1-q$ by the definition of $\hat{p}_o$, and $u_o(p^F(\tilde{p})) > 0$ as argued above, so that $\frac{\partial u_o(p_S(\tilde{p}))}{\partial p_S} = \frac{\partial u_o(\tilde{p})}{\partial p} > \frac{\partial u_o(p_F(\tilde{p}))}{\partial p_F}$ and the derivative (14) is positive.

Proof of Lemma 7

By assumption $\underline{u} \geq s(\tilde{p}) - c$, and the participation constraint binds for both types of contracts. We need to distinguish several cases.

Suppose $\underline{u} < s(\tilde{p}) - c + q$ first. Then $w_a = 0$ in both contracts and a rigid contract is preferred to a flexible contract if

$$-\frac{\underline{u}^2}{2} < (1-q)R(B,\tilde{p}) \text{ if } \underline{u} \leq 1-q$$
$$\frac{1-q}{2} - \underline{u} < R(B,\tilde{p}) \text{ if } \underline{u} > 1-q.$$

That is, a flexible contract is preferable if $\underline{u} < s(\tilde{p}) - c + q$ and

$$\underline{u} < \hat{u}(\tilde{p}) =: \begin{cases} (1-q)/2 - R(B,\tilde{p}) & \text{if } -2R(B,\tilde{p}) \geq 1-q \\ \sqrt{2(1-q)(-R(B,\tilde{p})} & \text{otherwise.} \end{cases} \tag{15}$$

Turn now to the case $s(\tilde{p}) - c + q \leq \underline{u} \leq s(\tilde{p}) + 1 - c$. Surplus is higher under a flexible than under a rigid contract if

$$q(s(\tilde{p}) - c) + \frac{q^2}{2} - \underline{u} + (1-q)k_b - \frac{k_b^2}{2} > (1-q)R(B,\tilde{p}) - \frac{(\underline{u} - s(\tilde{p}) + c)^2}{2}.$$

Solving for $s(\tilde{p})$ this yields a quadratic equation. Its determinant is positive if, and only if, $\underline{u} \geq \hat{u}(\tilde{p})$; otherwise the condition that a flexible contract is preferable always holds. Supposing $\underline{u} \geq \hat{u}(\tilde{p})$ the condition becomes

$$s(\tilde{p}) < \hat{s}(\underline{u}) := \underline{u} + c - q - \begin{cases} \sqrt{2(1-q)(\underline{u} + R(B,\tilde{p}) - (1-q)/2)} & \text{if } \underline{u} \geq 1-q \\ \sqrt{(\underline{u}^2 + 2(1-q)R(B,\tilde{p}))} & \text{otherwise.} \end{cases} \tag{16}$$

This defines a function $\hat{s}(\underline{u})$ for $\underline{u} \geq \hat{u}(\tilde{p})$ and $\hat{s}(\underline{u}) + q - c \leq \underline{u} \leq \hat{s}(\underline{u}) + 1 - c$. Since $\hat{s}(\underline{u}) \leq \underline{u} + c - q$ holds for the expression above, only the upper bound has a bite and becomes

$$(1-q)^2 - 2(1-q)R(B,\tilde{p}) \geq \begin{cases} 2(1-q)(\underline{u} - (1-q)/2) & \text{if } \underline{u} \geq 1-q \\ \underline{u}^2 & \text{otherwise.} \end{cases}$$

Because $(1-q)^2 - 2(1-q)R(B,\tilde{p}) > (1-q)^2$, the condition $\hat{s}(\underline{u}) + q - c \leq \underline{u} \leq \hat{s}(\underline{u}) + 1 - c$ holds if and only if $\hat{u} \leq \underline{u} \leq 1 - q - R(B,\tilde{p})$. Differentiating yields that $\hat{s}(\underline{u})$ is strictly decreasing on this interval.

Finally, let $\underline{u} > s(\tilde{p}) + 1 - c$. A flexible contract is now profitable if

$$q(s(\tilde{p}) - c) + \frac{q^2}{2} + (1-q)k_b - \frac{k_b^2}{2} > (1-q)R(B,\tilde{p}) - c + s(\tilde{p}) + 1/2.$$

That is,

$$s(\tilde{p}) < c - R(B,\tilde{p}) - \begin{cases} q & \text{if } \underline{u} \geq 1-q \\ ((1+q)/2 - \underline{u} + \underline{u}^2/(2(1-q))) & \text{otherwise.} \end{cases}$$

This defines $\hat{s}(\underline{u})$ for $\underline{u} > 1-q-R(B,\tilde{p})$, because by assumption $\hat{s}(\underline{u}) - \underline{u} - c + 1 < 0$, which in turn becomes $1-\underline{u}-R(B,\tilde{p}) < q$, as $(1-q)^2 - 2(1-q)R(B,\tilde{p}) < \underline{u}^2 < (1-q)^2$ yields a contradiction. That is,

$$\hat{s}(\underline{u}) = c - q - R(B,\tilde{p}) > 0 \tag{17}$$

for $\underline{u} > 2(1-q-R(B,\tilde{p}))$.

Surplus efficiency follows directly from the characteristics of the optimal contracts (10) and (11). This establishes the proposition.

Proof of Proposition 8

The statement is obvious for k_a since $k_a = q$ for old agents by Proposition 4, while $k_a < q$ for a young agent with outside option $\underline{u} < s(\tilde{p}) + q - c$, see (10).

For k_b note that if $k_b < 1-q$ in a flexible contract, necessarily $k_b = \underline{u}$ for young and $k_b = u_o(\tilde{p})$ for old agents. Because $\pi = 0$ in equilibrium, in a flexible contract a young agent obtains payoff $u_y(\tilde{p})$, which equals the outside option $\underline{u}$, determined by

$$0 = q(R(A,\tilde{p}) - c + k_a + s(\tilde{p})) - qu_y(\tilde{p}) - \frac{k_a^2 + u_y(\tilde{p})^2}{2} - F \text{ if } u_y(\tilde{p}) \leq 1-q,$$

with $k_a = \min\{q; u_y(\tilde{p}) + c - s(\tilde{p})\}$. By Proposition 5 an old agent obtains

$$u_o(\tilde{p}) = \sqrt{2q(q + R(A,\tilde{p}) - c) - 2F} - q \text{ for } u_o(\tilde{p}) \leq 1-q.$$

Clearly, $u_o(\tilde{p}) < u_y(\tilde{p})$ whenever $k_a = q$. Suppose therefore $k_a = u_y(\tilde{p}) + c - s(\tilde{p})$. Then

$$u_y(\tilde{p}) = -\frac{c - s(\tilde{p})}{2} + \sqrt{qR(A,\tilde{p}) - F - (c - s(\tilde{p}))^2/4}.$$

Then $u_o(\tilde{p}) < u_y(\tilde{p})$ if

$$0 < \frac{q}{2}\left(R(A,\tilde{p}) + q - c + s(\tilde{p})\right) + s(\tilde{p}) + (2q - c + s(\tilde{p}))\sqrt{4qR(A,\tilde{p}) - (c - s(\tilde{p}))^2}.$$

This must be true for $\tilde{p}$ if an old agent with $\tilde{p}$ obtains a flexible contract, since to generate positive joint surplus $q(\tilde{p}R(A) + q/2 - c) > 0$.

Proof of Lemma 9

Using $\pi = 0$, (10), and (9), the equilibrium payoff $u_y(\tilde{p})$ of a young agent with expected productivity $\tilde{p}$ under a flexible contract is given by

$$u_y(\tilde{p}) = \begin{cases} \sqrt{qR(A,\tilde{p}) - F - (c - s(\tilde{p}))^2/4} - (c - s(\tilde{p}))/2 & \text{if } u_y(\tilde{p}) < 1 - q, q + s(\tilde{p}) - c \\ \sqrt{2q(R(A,\tilde{p}) + s(\tilde{p}) - c + q) - 2F} - q & \text{if } q + s(\tilde{p}) - c < u_y(\tilde{p}) < 1 - q \\ \sqrt{2[(1-q)(1-q+c-s(\tilde{p})) + qR(A,\tilde{p}) - F]} - 1 + s(\tilde{p}) - c + q & \text{if } 1 - q < u_y(\tilde{p}) < q + s(\tilde{p}) - c \\ q(R(A,\tilde{p}) - c + s(\tilde{p}) + q/2) + (1-q)^2/2 - F & \text{if } u_y(\tilde{p}) > 1 - q, q + s(\tilde{p}) - c. \end{cases}$$

Under a rigid contract,

$$u_y(\tilde{p}) = \begin{cases} \sqrt{2(qR(A,\tilde{p}) + (1-q)R(B,\tilde{p}) - F)} - c + s(\tilde{p})) & \text{if } E[R(s,\tilde{p})] < 1/2 \\ qR(A,\tilde{p}) + (1-q)R(B,\tilde{p}) - c + s(\tilde{p}) + 1/2 - F & \text{if } E[R(s,\tilde{p})] \geq 1/2. \end{cases}$$

Note that lifetime utility for an agent is thus given by $u_y(\tilde{p}) + u_o(\tilde{p})$. Establish first that $u_y(\tilde{p})$ strictly increases in $\tilde{p}$ when implementing task a at least some of the time. For this we need that $\frac{\partial s(\tilde{p})}{\partial \tilde{p}} > -[\overline{R}(A) - \underline{R}(A)]$, which is easily verified using the definitions of $s(\tilde{p})$ and $u_o(\tilde{p})$, which increases in $\tilde{p}$ as does $p_S(\tilde{p})$. In all cases the first derivative of $u_y(\tilde{p})$ with respect to $\tilde{p}$ is positive.

To check which of the above cases holds for $u_y(\bar{p}_y) = 0$, note first that $u_y(\bar{p}_y) < 1 - q$ so that $k_b = u_y(\bar{p}_y)$. Moreover, $s(\bar{p}_y) \leq c$. Suppose otherwise, then the agent's payoff in the firm is at least $s(\bar{p}_y) - c > 0$. But then there is $\tilde{p} < \bar{p}_y$ such that $s(\tilde{p}) - c > 0$. Hence, $u_y(\bar{p}_y) = 0$ and $s(\bar{p}_y) > c$ cannot both hold. Hence, either $u_y(\bar{p}_y) < 1 - q, q + s(\bar{p}_y) - c$ or $q + s(\bar{p}_y) - c < u_y(\bar{p}_y) < 1 - q$ must be the case. Setting $u_y(\bar{p}_y) = 0$ then yields

$$R(A,\bar{p}_y) = F/q + (c - s(\bar{p}_y))^2/(2q) \text{ if } s(\bar{p}_y) > c - q \text{ and}$$
$$R(A,\bar{p}_y) = c - s(\bar{p}_y) + F/q - q/2 \text{ otherwise.}$$

This immediately implies $\bar{p}_y > \bar{p}_o$ given by (6), since $R(A, \bar{p}_o) = c - q/2 + F/q$, with a strict inequality since $s(\bar{p}_o) > 0$. This also implies that $s(\bar{p}_y) = \bar{p}_y u_o(p_S(\bar{p}_y))$, which ensures that $s(\tilde{p})$ is increasing at $\bar{p}_y$. Using the definition of $s(\tilde{p})$ yields the cutoff productivity in terms of the primitives.

Lemma 11. *$\hat{s}(u_y(\tilde{p}))$ defined in (16) and (17) is a function of $\tilde{p}$ that strictly decreases for $\tilde{p} \in [\bar{p}_y, p_1]$ for some $\overline{p} > p_1 > \bar{p}_y$ and strictly decreases for $u_y(\tilde{p}) \geq 1 - q$.*

Proof: Note that $u_y(\tilde{p}) \geq \hat{u}(\tilde{p})$, which was defined in (15), implies that there is $p_1 > 0$ such that $\tilde{p} \geq p_1$, because $\frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} > \frac{\partial \hat{u}(\tilde{p})}{\partial \tilde{p}}$.

Suppose that $\hat{u}(\tilde{p}) \leq u_y(\tilde{p}) < 1 - q$ first. Then

$$\frac{\partial \hat{s}(u_y(\tilde{p}))}{\partial \tilde{p}} = \frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} - \frac{u_y(\tilde{p})\frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} + (1-q)(\overline{R}(B) - \underline{R}(B))}{\sqrt{(u_y(\tilde{p}))^2 + 2(1-q)R(B,\tilde{p})}}. \tag{18}$$

Note that $\frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} > 0$ (see proof of Lemma 9). $\frac{\partial \hat{s}(u_y(\tilde{p}))}{\partial \tilde{p}} < 0$ as $u_y(\tilde{p})$ approaches $\hat{u}(\tilde{p})$ if

$$\hat{u}(\tilde{p})\frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} + (1-q)(\overline{R}(B) - \underline{R}(B)) > 0,$$

as the nominator of the second term in (18) tends to zero. This condition necessarily holds if $\overline{R}(B) > \underline{R}(B)$. This establishes the first claim in the lemma.

Turn now to the case $1 - q \leq u_y(\tilde{p}) < 1 - q - R(B, \tilde{p})$. Differentiating $u_y(\tilde{p})$ in this case yields

$$\frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} = q\left(\overline{R}(A) - \underline{R}(A) + \frac{\partial s(\tilde{p})}{\partial \tilde{p}}\right).$$

Differentiating $\hat{s}(u_y(\tilde{p}))$ with respect to $\tilde{p}$ yields

$$\frac{\partial \hat{s}(u_y(\tilde{p}))}{\partial \tilde{p}} = \frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} - \sqrt{1-q}\frac{\frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} + \overline{R}(B) - \underline{R}(B)}{\sqrt{2(u_y(\tilde{p}) + R(B,\tilde{p}) - (1-q)/2)}}. \tag{19}$$

The second derivative is positive if $s(\tilde{p})$ is convex:

$$\begin{aligned}\frac{\partial^2 \hat{s}(u_y(\tilde{p}))}{\partial \tilde{p}^2} =& q\frac{\partial^2 s(\tilde{p})}{\partial \tilde{p}^2}\left(1 - \frac{\sqrt{1-q}}{\sqrt{2(u_y(\tilde{p}) + R(B,\tilde{p}) - (1-q)/2)}}\right) \\ &+ \sqrt{1-q}\frac{\left(q\left(\overline{R}(A) - \underline{R}(A) + \frac{\partial s(\tilde{p})}{\partial \tilde{p}}\right) + \overline{R}(B) - \underline{R}(B)\right)^2}{2(u_y(\tilde{p}) + R(B,\tilde{p}) - (1-q)/2)} > 0. \end{aligned} \tag{20}$$

Note that as $u_y(\tilde{p})$ approaches $1-q$ both $\hat{s}(u_y(\tilde{p}))$ and its first derivative converge both from below and from above.

For $\hat{u}(\tilde{p}) \leq u_y(\tilde{p}) \leq 1-q-R(B,\tilde{p})$ the function $\hat{s}(u_y(\tilde{p}))$ strictly decreases, as can be quickly verified using (19), $\frac{\partial \hat{s}(1-q-R(B,\tilde{p}))}{\partial \tilde{p}} = -(\overline{R}(B) - \underline{R}(B)) < 0$.

In case $u_y(\tilde{p}) > 1-q-R(B,\tilde{p})$ $\hat{s}(u_y(\tilde{p}))$ is a linear, decreasing function of $\tilde{p}$ with slope $-(\overline{R}(B) - \underline{R}(B))$, which does not require convexity of $s(\tilde{p})$. This establishes the lemma.

Proof of Proposition 10

The cutoff values $\bar{p}_o$ and $\bar{p}_y$ have been established before. A rigid contract is preferable for productivity $\tilde{p}$ if, and only if, $s(\tilde{p}) \geq \hat{s}(u_y(\tilde{p}))$. By lemma 9 the optimal contract for young agents with $\tilde{p} \geq \bar{p}_y$ in the neighborhood of $\bar{p}_y$ is flexible. Hence, there is $p_1 \in (\bar{p}_y, \overline{p}]$, such that flexible contracts are optimal for $p_y \leq \tilde{p} \leq p_1$. Clearly, $\lim_{\tilde{p}\to\overline{p}} s(\tilde{p}) = 0$, while $\hat{s}(u_y(\tilde{p})) > 0$ as defined in the proof of Lemma 7. Therefore there is $p_4 \in [\bar{p}_y, \overline{p})$, such that flexible contracts are optimal for $p_4 \leq \tilde{p} \leq \overline{p}$.

Next we derive a sufficient condition for existence of rigid contracts (i.e. $\bar{p}_y < p_1 < p_4 < \overline{p}$). To do so we focus on $\bar{p}_o$ where $s(\tilde{p})$ attains a maximum. A rigid contract is desirable for $\bar{p}_o$ if $u_y(\bar{p}_o) > \hat{u}(\bar{p}_o)$ and $s(\bar{p}_o) > \hat{s}(u_y(\bar{p}_o))$. Using the definition of $\hat{s}(u_y(\tilde{p}))$ in the proof of Lemma 7, a sufficient condition for the second is $s(\bar{p}_o) \geq u_y(\bar{p}_o)+c-q$. Because $u_o(\bar{p}_o) = 0$ and $k_a = q$ for the old agent, it follows that $u_y(\bar{p}_o) \geq s(\bar{p}_o)+q-c$ iff $s(\bar{p}_o)+q-c \leq \sqrt{2q(c-q)}$, and $s(\bar{p}_o)+q-c > \sqrt{2q(c-q)}$ implies $u_y(\bar{p}_o) > \sqrt{2q(c-q)}$. Hence, for $c-q$ sufficiently small $s(\bar{p}_o) > \hat{s}(u_y(\bar{p}_o))$.

$u_y(\bar{p}_o) > \hat{u}(\bar{p}_o)$ holds if

$$u_y(\bar{p}_o) > \begin{cases} (1-q)/2 - R(B,\bar{p}_o)/q & \text{if } -2R(B,\bar{p}_o) \geq 1-q \\ \sqrt{2(1-q)(-R(B,\bar{p}_o))} & \text{otherwise.} \end{cases} \tag{21}$$

Because $u_y(\bar{p}_o) > \sqrt{2q(c-q)}$, for any $c > q$ there is a function $R(B,\tilde{p})$ with $|R(B,\tilde{p})| < (1-q)/2$ small enough for all $\tilde{p}$ such that the above condition is satisfied.

That is, if effort cost c and expected revenue of task b, $R(B,\tilde{p})$ for all $\tilde{p}$ are sufficiently close to q and to 0, respectively, there is a productivity $\bar{p}_y < \bar{p}_o < \overline{p}$ such that a young agent with that productivity receives a rigid contract.

$\hat{s}(u_y(\tilde{p}))$ strictly decreases in the neighborhood of $\bar{p}_o$ and eventually strictly decreases for $u_y(\tilde{p}) > 1-q$ by Lemma 11. Since $s(\tilde{p})$ on the other hand first strictly increases, then strictly decreases, and has a unique maximum, optimality of rigid contracts for $\bar{p}_o$ implies there are $\underline{p} < p_a < p_b < \overline{p}$ such that rigid contracts are optimal for $p_a < \tilde{p} < p_b$.

If $\hat{s}(u_y(\tilde{p}))$ is convex this implies that $\hat{s}(\tilde{p})$ and $s(\tilde{p})$ intersect twice at most and therefore $p_a = p_1$ and $p_b = p_4$. Otherwise, there may be more intersection points. Optimality of flexible contracts for $\bar{p}_y \leq \tilde{p} \leq p_1$ and $p_4 \leq \tilde{p} \leq \overline{p}$ implies then existence of $p_2 \leq p_3$ such that rigid contracts are preferred for $p_1 \leq \tilde{p} \leq p_2$ and $p_3 \leq \tilde{p} \leq p_4$.

For flexible contracts $k_b = \min\{1-q; u_y(\tilde{p})\}$. Therefore $0 < k_b \leq 1-q$ for $\tilde{p} > \bar{p}_y$. For rigid contracts $k_b = 0$. Rigid contracts are optimal only if $s(\tilde{p}) > \hat{s}(\tilde{p})$. This implies $u_y(\tilde{p}) + c - s(\tilde{p}) > q$ (see proof of Lemma 7). This means that $q < k_a \leq 1$ in rigid contracts. For $s(\tilde{p}) < \hat{s}(\tilde{p})$ a flexible contract is optimal, with $k_a = \min\{u_y(\tilde{p}) + c - s(\tilde{p}); q\}$. Since $u_y(\tilde{p}) + c - s(\tilde{p}) > q$ for $p_1 < \tilde{p} < p_2$ and $\frac{\partial u_y(\tilde{p})}{\partial \tilde{p}} > \frac{\partial s(\tilde{p})}{\partial \tilde{p}}$ for $q > 1/2$, $u_y(\tilde{p}) + c - s(\tilde{p}) > q$ and $k_a = q$ for $\tilde{p} > p_2$.

Finally, a sufficient condition for rigid contracts not to occur is $s(\tilde{p}) < c - q - R(B, \tilde{p})$ for all $[\bar{p}_o, \overline{p}]$. This is implied by $s(\bar{p}_o) < c - q - R(B, \bar{p}_o)$.

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