Rewarding Idleness

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Abstract

Market wages reflect expected productivity, making use of signals of past performance and experience. These signals are generated at least partially on the job, creating incentives for agents to choose high profile and highly visible tasks. This paper points out that this can be mitigated by the use of employee perks, modeled as corporate public goods, by making visible and productive activities more costly relatively to idleness. Introducing heterogeneity in employee types induces diversity in organizational and contractual choices, in particular regarding the extent to which signaling activities are tolerated or encouraged, and regarding the use of employee perks and success wages. Organizational choices in turn affect the shape of the payoff function, and thus incentives to signal in earlier periods.

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1 Introduction

Some companies provide their employees with sizable non-monetary benefits, especially when the tasks involved require creativity and originality. Software developers are a case in point: for example, employees at Google have at their disposal a wide variety of on site services and sports facilities, such as tennis courts and a swimming pool, free catering in a high profile restaurant and cafeterias, various entertainment facilities, such as table football, and are allowed to use one workday per week for personal projects.[1] Similarly, computer

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[1] One should mention that Microsoft and Yahoo! also give access to substantial perks, including free cafeterias, a game room, massage service, or lake access.

game developers are known not only to provide their employees with free catering, but also with their own products at work, and in some instance arcade games on site.[2]

The usage of employee perks has been attributed to productive characteristics of the perks, such as nice office furniture or access to corporate jets (see Marino and Zábojník (2008), Rajan and Wulf (2006)). While the provision of free catering may be attributable to such concerns, other perks like video gaming or tennis courts seem rather to complement leisure activities. Perks have also been interpreted as non-monetary remuneration substituting for cash payments (see e.g. Rosen, 1986).[3] The claim is that perks can be a more efficient means to transfer utility than is cash, for instance in case of awarding status, or when in-kind-payments are treated favorable by the tax regime, or when perks come in the form of public goods (although employees' valuations for such goods, such as an on-site rock climbing wall, may vary quite substantially across employees). While there may be situations where perks are a more efficient way to reward employees, it is clear that some of these perks have also an impact on the employees choice of task. Finally, perks have been attributed to managerial discretionary power over free cash flow (see e.g. Jensen, 1986, Bebchuk and Fried, 2004). Yet most of the perks mentioned above are employee perks, in the sense that those who benefit do not have the authority to introduce them.

In this paper we argue that employee perks that seem to encourage idleness do precisely this. Idleness can be desirable when, because of career concerns, employees have an incentive to over-invest in tasks that appear productive, in order to generate a payoff-relevant signal. This is likely when agents' productivity types are not observed before the work begins, but a signal about previous work experience is available. In such a framework a good signal will command a market premium in later stages, and therefore create incentives for the agent to excel in a task that permits signaling beyond the monetary incentives specified in a wage contract. Contracts and, in particular, organizational form will respond to this, biasing firms' investment toward employee benefits that are complementary to leisure rather than to productive activities. When agents of different productivity levels differ in their propensity to signal, organizational heterogeneity will arise in order to cater to agents' types taking into account signaling incentives. As a result organizations will differ in the extent to which they tolerate and reward idleness, for instance by means of corporate culture

[2] The company Blizzard is widely supposed to outfit its employees with digital equipment for its online game World of Warcraft.

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

or offering employee perks. Diversity of organizational form will then be linked to the wage distribution as differentials in compensation based on observable signals affect agents' incentives to signal.

We address these issues formally in a model of multi-task agency, where the agent has private information about the profitability of each task and there are career concerns. Agents live for two periods and produce output in firms. When employed by a firm an agent chooses to perform one of two tasks, a or b. Task a is a complex, non-standard task that induces a utility cost to the agent, and which may succeed or fail. The probability of success depends on the agent's type, and the outcome of task a are publicly observable. Revenue generated by task a is uncertain, and may result in a loss, and the agent has private information about its expected value. Therefore, task a corresponds to a high-profile, visible activity that commits a sizable portion of the principal's assets to a project, for instance preparing a merger, developing a new product, or launching a research project. Task b is costless for the agent and pays off 0 with certainty; it is best interpreted as staying idle or day-to-day-work.

Hence, performing task a when young creates an opportunity for agents to signal their ability to the market. This induces a bias toward task a despite the fact that an agent incurs lower effort cost for task b.[4] The value of the signal is determined by the period 2 wage distribution. Firms respond by adequately choosing contractual and organizational form. Choice of organization is modeled as an investment decision on providing corporate public goods to agents, which reduces the cost of performing task a, so that lower investment effectively subsidizes performing task b. Contracts can condition on the task performed, and, in case of a, on success or failure.

In a market equilibrium contracts for old agents implement the efficient outcome, as signaling is no longer a concern. Old agents who succeeded in task a obtain a premium, which determines incentives to signal when young. Young agents obtain either a separating, using the agent's private information to induce the agent to choose the task with higher expected profit, or a pooling contract, ignoring the agent's private information and always implementing the same task. The optimal type of contract depends on the value of signaling

[4] This mirrors findings of 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). This paper is concerned with the firm's organizational response.

for young agents: for agent who have low return from signaling a separating contract is implemented that pays a bonus for task a. For intermediate value signaling a separating contract discourages the agent from task a by rewarding task b with a monetary payment, or adjusting investment to increase the opportunity cost of a. For sufficiently high values of signaling discouraging the agent from signaling may become to costly so that the optimal is pooling, paying a flat wage inducing the agent to choose task a.

The value of signaling is endogenous and is determined both by the informativeness of the signal and the convexity of the wage distribution of old agents. Bayesian updating implies that signal is most informative for neutral priors, hence agents of intermediate productivity have highest informational gains from signaling. The more convex the wage distribution for old agents the more desirable is it to gamble for a success when young as the wage increase in case of success overcompensates the wage loss in case of failure. As a consequence organizational and contractual choices cater to the agents' expected productivities: for low productivity agents task a is rewarded (corresponding to low-powered incentives for clerical work) and as productivity grows organizational form rewards idleness (specialists or staff in advisory capacity). For intermediate productivity types organizations punish idleness (middle management) using pooling contracts. As productivity increases further employee perks are used again (creative professionals), and for highest expected productivity employers rely on high-powered monetary incentives (executives, key professionals). Optimal organizational choice is governed by productivity threshold levels; hence, firms may choose substantially different organizational forms (tolerating excessive signaling or rewarding idleness) although they are observationally very similar. Finally, organizational response to employees' incentives for signaling may induce flatter payoffs for young agents relative to old agents' payoffs. This in turn suggests that incentives for signaling in earlier periods are muted, and the value of signaling in a labor market equilibrium is non-monotonic in time for a given productivity level.

Related literature is, of course, Gibbons and Murphy (1992), though we are concerned with organizational heterogeneity as a response to career concerns rather than dynamic properties of optimal incentive contracts. Raith (2008) examines an agency setting with private information of the agent on the productivity of tasks and determines the optimal use of input and output monitoring in absence of career concerns. Our paper suggests, as does the multi-task literature, that the optimal choice of monitoring will depend on the monitoring device's signaling value for the agent.

This paper is also related to the literature on delegation and experts. Closest is probably

Prat (2005) who examines a setting where an expert may have an incentive to report untruthfully, if this coincides with the prior and therefore signals that the expert is of high quality (see also Prendergast, 1993), and concludes that avoiding full transparency on the agent's action in agency settings may be desirable. This is paper is primarily concerned with using perks, or investment complementary to less productive tasks, to remedy distortions of incentives by signaling. While it is of little consequence whether actions are observable in our model, an extension considers the possibility that the principal affects signal precision through costly investment.

The remainder of the paper is organized as follows. Section 2 introduces the theoretical framework, and Section 3 derives the properties of the basic model. Section 4 considers the general model and derives properties of the stationary distribution of wages and organizational choices. Section 5 concludes.

2 A Simple Model

The economy is populated by a continuum of agents $i \in [0, 1]$ endowed with measure 1, and a continuum of principals $j \in [0, 1]$ endowed with measure $\mu < 1$. 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. Suppose that in the first period all individuals share a common prior, which is denoted by

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

The case that agents differ in expected productivity in the first period is treated below.

2.1 Production

Principals and agents have the opportunity to jointly generate output in firms of size 2. Solitary agents or principals obtain a payoff of 0. In a firm (i, j) an agent can choose a task $d \in \{a, b\}$. Task b is a routine task that yields revenue 0 to the principal and is costless for the agent. Task a on the other hand is complex, generating utility cost of c for the agent, and may succeed (S) or fail (F). The probability of success is the agent's productivity type p, the one of failure $1 - p$. In case of success revenue $R(s)$ accrues for the principal, with $s \in \{A, B\}$ denoting the state of the world and $R(A) > R(B)$. In case of failure the revenue is 0. Task a is thus best interpreted as starting a new project, for instance, developing a new product, which may succeed or fail. In case the product development succeeds, the product is launched. Its profitability, however, depends on the state of the world s. In particular the case $R(A) > 0 > R(B)$ may arise, for instance if the product flops and fails to break even, quality problems hurt the firm's reputation, or design flaws trigger legal action and fines. The state s is specific to a match (i, j) and drawn independently, assigning probability q to A and $1 - q$ to B.

Assume that production is profitable for the commonly expected productivity $\tilde{p}$ in the first period:

$$\tilde{p}R(A) - c > 0.$$

2.2 Contractual and Informational Environment and Payoffs

In a firm (i, j) contracts can condition on the task chosen by the agent, and on whether task a resulted in success or failure. That is, contracts can specify payments w_I, w_F and w_S contingent on task choice b, failure in task a, and success in task a, respectively. Of course, payments w_S and w_F can be interpreted as a wage w_F for task a and a success bonus $w_S - w_F$.[5] Since agents are born without wealth contracts in the first period must respect a limited liability condition and not induce negative payments for agents. Task choice and the outcome of task a, that is success or failure, are publicly observable by all firms, but revenue is not.[6] Individuals can only sign two one-period contracts (equivalently, the parties can renegotiate any long-term contract signed in period 1).

In each period payoffs of an agent are thus given by $u = w_I$ if task b was chosen, and by $u = w - c$ if task a was chosen with $w = w_F$ in case of failure and $w = w_S$ in case of success. Correspondingly the principal obtains payoffs $\pi = -w_I$, $\pi = -w_F$, and $\pi = R(s) - w_S$, respectively. There is no discounting.

2.3 Timing of Events

In each period events in this economy unfold as follows.

1. At the beginning of a period a labor market matches principals and agents, who sign a binding contract.

2. Within each match (i, j) a state of nature $s \in \{A, B\}$ realizes.

[5] The cases of provision of corporate public goods and observable revenue are examined below.

[6] That revenue is unobservable is not crucial for our results, observability of the signal of success or failure is, however. Whether the contract signed in a match is publicly observable is not important when the task choice is observable.

3. The agent chooses a task $d \in \{a, b\}$.

4. If the task is a success or failure realizes, revenue accrues and payments are made.

An equilibrium in the labor market for agents is an individually rational stable allocation of pairs of principals and agents, such that there is no pair of principal and agent, not matched in equilibrium, who could obtain strictly higher joint payoff $u + \pi$ if they match and use a contract of the form (w_0, w_F, w_S).

3 Contractual Choice and Labor Market Equilibrium

This section derives optimal contractual choices and the labor market equilibrium in periods 1 and 2, proceeding backwards in time.

3.1 Period 2

At the beginning of period 2 agents have one of three types of histories: agents that succeeded in period 1, agents that failed, and those that stayed idle, either choosing task b or remaining unmatched. Failing or succeeding in task a provides an informative signal about the agent's productivity p. Denote an agent's expected productivity by $\tilde{p}_I$ if the agent chose task b in period 1, by $\tilde{p}_F$ if the agents failed at task a, and by $\tilde{p}_S$ is the agent succeeded. Applying Bayes' formula (see appendix for details) yields the following statement.

Lemma 1. *Expected productivity in period 2 is* $\tilde{p}_S = \overline{p} + \underline{p} - \frac{\overline{p}\underline{p}}{\tilde{p}}$ *after observing a success in task* a, $\tilde{p}_F = \frac{\tilde{p}(1-\underline{p}-\overline{p})+\overline{p}\underline{p}}{1-\tilde{p}}$ *after observing a failure in task* a*, and* $\tilde{p}_I = \tilde{p}$ *otherwise.*

Clearly, $\tilde{p}_F < \tilde{p}_I = \tilde{p} < \tilde{p}_S$. Agents' expected productivity will determine their market value in period 2, that is, the utility they obtain in a labor market equilibrium. Denote this market value by $v(\tilde{p}_k)$ with $k = I, F, S$.

3.1.1 Optimal Contracts

In a match (i, j) with expected productivity $\tilde{p}_i$, the principal can implement a pooling or a separating contract. The separating contract implements task a in state A and task b in state B. The incentive compatibility constraint leaves the agent indifferent between tasks a and b,

$$\tilde{p}_i w_S + (1 - \tilde{p}_i) w_F - c = w_0,$$

and the agent's participation constraint is

$$q(\tilde{p}_i w_S + (1-\tilde{p}_i)w_F - c) + (1-q)w_I \geq v(\tilde{p}_i).$$

Therefore $w_0 \geq v(\tilde{p}_i)$. Since the principal's payoff

$$\pi = q(\tilde{p}_i(R(A) - w_S + w_F) - w_F) - (1-q)w_I$$

decreases in w_I, it must hold that $w_I = v(\tilde{p}_i)$ and $\tilde{p}_i w_S + (1-\tilde{p}_i)w_F = c + v(\tilde{p}_i)$. Since principal and agent are risk neutral any combination $w_S = (c + v(\tilde{p}_i))/\tilde{p}_i - w_F(1-\tilde{p}_i)/\tilde{p}_i$ with $w_S, w_F > 0$ is feasible and maximizes joint surplus.

A pooling contract implements task a independently on the state (pooling on b requires $v(\tilde{p}) = 0$ and is equivalent to no production). The incentive compatibility constraint is

$$\tilde{p}_i w_S + (1-\tilde{p}_i)w_F - c \geq w_I.$$

The agent's participation constraint is

$$\tilde{p}_i w_S + (1-\tilde{p}_i)w_F - c \geq v(\tilde{p}_i).$$

Since the principal's payoff

$$\pi = \tilde{p}_i(qR(A) + (1-q)R(B) - w_S + w_F) - w_F,$$

decreases in payments, we have that $\tilde{p}_i w_S + (1-\tilde{p}_i)w_F = c + v(\tilde{p}_i)$, and $w_I \leq v(\tilde{p}_i)$. Finally, note that $v(\tilde{p}_i) \leq \tilde{p}_i[qR(A) + (1-q)R(B)] - c$ for $c \leq \tilde{p}_i R(B)$, since in any labor market equilibrium an agent cannot obtain higher utility than all of the maximal joint surplus in a match with any principal.

The following lemma summarizes the results so far.

Lemma 2 (Contracts in Period 2)**.** *A* separating *contract in period* 2 *specifies* $w_I = v(\tilde{p}_i)$, $w_S = \frac{c+v(\tilde{p}_i)}{\tilde{p}_i} - \frac{1-\tilde{p}_i}{\tilde{p}_i} w_F$, *and* $w_F \in [0, (c + v(\tilde{p}_i))/(1-\tilde{p}_i)]$. *The principal has payoff*

$$\pi_2^S = q(\tilde{p}_i R(A) - c) - v(\tilde{p}_i).$$

A pooling *contract in period* 2 *specifies* $w_I \in [0, v(\tilde{p}_i)]$, $w_S = \frac{c+v(\tilde{p}_i)}{\tilde{p}_i} - \frac{1-\tilde{p}_i}{\tilde{p}_i} w_F$, *and* $w_F \in [0, (c + v(\tilde{p}_i))/(1-\tilde{p}_i)]$. *The principal has payoff*

$$\pi_2^P = \tilde{p}_i(qR(A) + (1-q)R(B)) - c - v(\tilde{p}_i).$$

The optimal contract is separating whenever $\tilde{p}_i R(A) - v(\tilde{p}_i)/q \geq c \geq \tilde{p}_i R(B)$, *the optimal contract is pooling whenever* $\tilde{p}_i R(B) \geq c$. *Otherwise it is optimal not to produce.*

A pooling contract is chosen when the expected revenue in state B exceeds the cost of effort investment. That is, the choice of contractual form in period 2 maximizes the joint surplus of the match.

3.1.2 Labor Market Equilibrium

Recall that in period 2 agents are characterized by their expected productivity conditional on their history in period 1: S agents with expected productivity $\tilde{p}_S$, F agents with expected productivity $\tilde{p}_F$, and I agents who stayed idle in period 1, either by choosing task b or because they were unemployed, with expected productivity $\tilde{p}_I = \tilde{p}$.

Since principals are identical, it must be the case that agent i's market value $v(\tilde{p}_i)$ is equal to the difference in the expected profits generated by $\tilde{p}_i$ and the expected profits generated by the least productive agent matched in the economy. This gives rise to a series of cases, depending on who is marginal agent. However, with an appropriate assumption on the measure of principals in the economy we can significantly simplify the analysis.

Assumption 3. *The unemployed are abundant in period* 2, $\mu < \frac{1}{2}$.

The above assumption guarantees that, in both period 1 and period 2, the most common type of agent has productivity $\tilde{p}_I = \tilde{p}$. This implies that the marginal agent in period 2 has stayed idle in period 1. Since by Lemma 2 principals prefer agents of higher expected productivity $\tilde{p}_i$ at the same price $v(.)$, F agents and I agents must be indifferent between being matched and their outside option 0. That is,

$$v(\tilde{p}_F) = v(\tilde{p}_I) = 0.$$

To determine the market value of an S agent $v(\tilde{p}_S)$ note that $\tilde{p}R(A) - c > 0$ (production in period 1 was profitable). Therefore principals obtain

$$\pi_2 = \max \{q(\tilde{p}R(A) - c); \tilde{p}(qR(A) + (1-q)R(B)) - c\}.$$

This implies that[7]

$$v(\tilde{p}_S) = \max \{q(\tilde{p}_S R(A) - c); \tilde{p}_S(qR(A) + (1-q)R(B)) - c\} - \pi_2.$$

Now the labor market equilibrium in period 2 can be determined.

[7] Assumption 3 implies that the wage function is convex, so that it is always beneficial to signal. For a more in-depth discussion on the relationship between the shape of the wage function and value of signaling, see the last section

Proposition 4 (Market Outcome in Period 2)**.** *In a labor market equilibrium in period* 2 *all S agents are matched to a firm and obtain*

$$v(\tilde{p}_S) = \begin{cases} qR(A)(\tilde{p}_S - \tilde{p}) & \text{if } \tilde{p}_S R(B) < c \\ qR(A)(\tilde{p}_S - \tilde{p}) + (1-p)(\tilde{p}_S R(B) - c) & \text{if } \tilde{p}_S R(B) > c > \tilde{p}R(B) \\ ((1-q)R(B) + qR(A))\,(\tilde{p}_S - \tilde{p}) & \text{if } \tilde{p}R(B) > c \end{cases}$$

The remaining firms are matched to I agents who obtain $v(\tilde{p}_I) = 0$. All F agents remain unmatched and obtain $v(\tilde{p}_F) = 0$. The value of signaling is $\tilde{p}v(\tilde{p}_S) + (1-\tilde{p})v(\tilde{p}_F) - v(\tilde{p}_I)$.

For future reference, note that $v(\tilde{p}_S)$ is strictly increasing in $\tilde{p}_S$, weakly decreasing in $\tilde{p}$, constant in $R(B)$ for $R(B) < \frac{c}{\tilde{p}_S}$ and increasing in $R(B)$ for $R(B) > \frac{c}{\tilde{p}_S}$.

3.2 Period 1

In period 1 the agent has the chance to signal his ability by choosing to work on task a ignoring the state. In case of success the market belief over the agent's productivity will increase, as will future payoff. Conditional on a failure the expected productivity decreases, but since $v(\tilde{p}) = v(\tilde{p}_F) = 0$ the agent is effectively insured against reputational risk.

Note that in the first period, since the agents are abundant and their outside option equal to zero, the principals extract all surplus. Also, because of liquidity constraints, all transfers must be non negative. Taking into account the period 2 market value $v(\tilde{p}_S)$ and using that $q(\tilde{p}R(A) - c) > 0$ optimal contracts in period 1 can be determined. An argument analogous to the derivation of optimal contract choice above yields the following lemma; its proof is omitted.

Lemma 5 (Contracts in Period 1)**.** *A separating contract in period* 1 *specifies*
$w_I = 0$, $w_S \in \left[0, \frac{c}{\tilde{p}} - v(\tilde{p}_S)\right]$, $w_F = \frac{\tilde{p}}{1-\tilde{p}}\left(\frac{c}{\tilde{p}} - w_s - v(\tilde{p}_S)\right)$,
and $\pi_1^S = q(\tilde{p}(R(A) + v(\tilde{p}_S)) - c)$ *if* $c > \tilde{p}v(\tilde{p}_S)$,
$w_I = \tilde{p}v(\tilde{p}_S) - c$, $w_S = w_F = 0$, *and* $\pi_1^S = q\tilde{p}R(A) - (1-q)(\tilde{p}v(\tilde{p}_S) - c)$ *if* $c < \tilde{p}v(\tilde{p}_S)$.
A pooling contract in period 1 *specifies*
$w_I = 0$, $w_S \in \left[0, \frac{c}{\tilde{p}} - v(\tilde{p}_S)\right]$, $w_F = \frac{\tilde{p}}{1-\tilde{p}}\left(\frac{c}{\tilde{p}} - w_s - v(\tilde{p}_S)\right)$,
and $\pi_1^P = \tilde{p}(qR(A) + (1-q)R(B)) - c + \tilde{p}v(\tilde{p}_S)$ *if* $c > \tilde{p}v(\tilde{p}_S)$,
$w_I = w_S = w_F = 0$, *and* $\pi_1^P = \tilde{p}(qR(A) + (1-q)R(B))$ *if* $c < \tilde{p}v(\tilde{p}_S)$.
The optimal contract is separating whenever $c/\tilde{p} - R(B) > v(\tilde{p}_S)$, and pooling otherwise. If $q\tilde{p}R(A) < (1-q)(\tilde{p}v(\tilde{p}_S) - c)$ and $qR(A) + (1-q)R(B) < 0$ there is no production.

This means that there is a possibility that the payoff neutral task is explicitly incentivized, that is idleness is rewarded. This occurs when future benefits of signaling a success are great relative to the cost of effort, and for technologies such that revenues from the complex task carry a substantial downside risk, i.e. $R(B) < 0$. In this case, the agent prefers to exert costly effort in task a regardless of the the state to achieve a success. Because of limited liability transfers have to be positive, so that the only way the principal can discourage the agent from choosing action a is by rewarding action b.

Figure 1 represents the different types of equilibria as a function of the value of signaling $v(\tilde{p}_S)$ and $R(B)$. Once again, the greater the distance between $R(A)$ and $R(B)$ (on the graph, the lower $R(B)$), the more likely the principal is to use the separating contract. Also, the separating contract should reward the unproductive action whenever the private benefit is large enough and the return on the project in state B is negative. Finally, for given $R(A)$ and $R(B)$, a high $v(\tilde{p}_S)$ is associated with a pooling equilibrium, and a low $v(\tilde{p}_S)$ with separation. Intuitively, when the private benefit of signaling is high, it is very costly for the principal to force separation. Note also that, if $R(B)$ is very low, a high enough value of signaling may discourage production altogether. If instead $R(B) >$ the higher the value of signaling the greater the profits since the agent needs no reward from the principal to perform task a in a pooling contract as career concerns are sufficient motivation[8].

The value of signaling is, of course, endogenous and determined by the market wage in period 2 given by Proposition 4. To make things interesting, let us focus on a technology where possible returns of task a may be negative and optimal contracts therefore may reward idleness. That is, suppose

$$R(B) < 0.$$

Then by Proposition 4 and Lemma 1 an S agent has market value

$$v(\tilde{p}_S) = qR(A)\left(\underline{p} + \overline{p} - \frac{\underline{p}\overline{p}}{\tilde{p}} - \tilde{p}\right).$$

Note that for both $\tilde{p} = \underline{p}$ and $\tilde{p} = \overline{p}$ we have $v(\tilde{p}_S) = 0$ and a separating contract with $w_I = 0$ is used, since in these case the agent is believed to be of type $\underline{p}$ (or $\overline{p}$) with probability one.

[8] Note that assuming that the principal cannot make payments contingent on the value of a success is without loss of generality. The outcome in period 2 is efficient, in that surplus is maximized. It follows that profits in period 2 cannot be increased by allowing for $w_S(A) \neq w_S(B)$. This is true also in period 1 for pooling contracts and for separating contracts with $c > \tilde{p}v(\tilde{p}_S)$. Output is lower than efficient only if a separating contract is used in period 1 and $c < \tilde{p}v(\tilde{p}_S)$. In this case the principal, needs to reward action b to induce separation. Note that if $w_s(A)$ or $w_s(B)$ are greater than zero, profits can be increased by decreasing these payments. It follows that the principal will set $w_s(A) = w_s(B) = 0$.

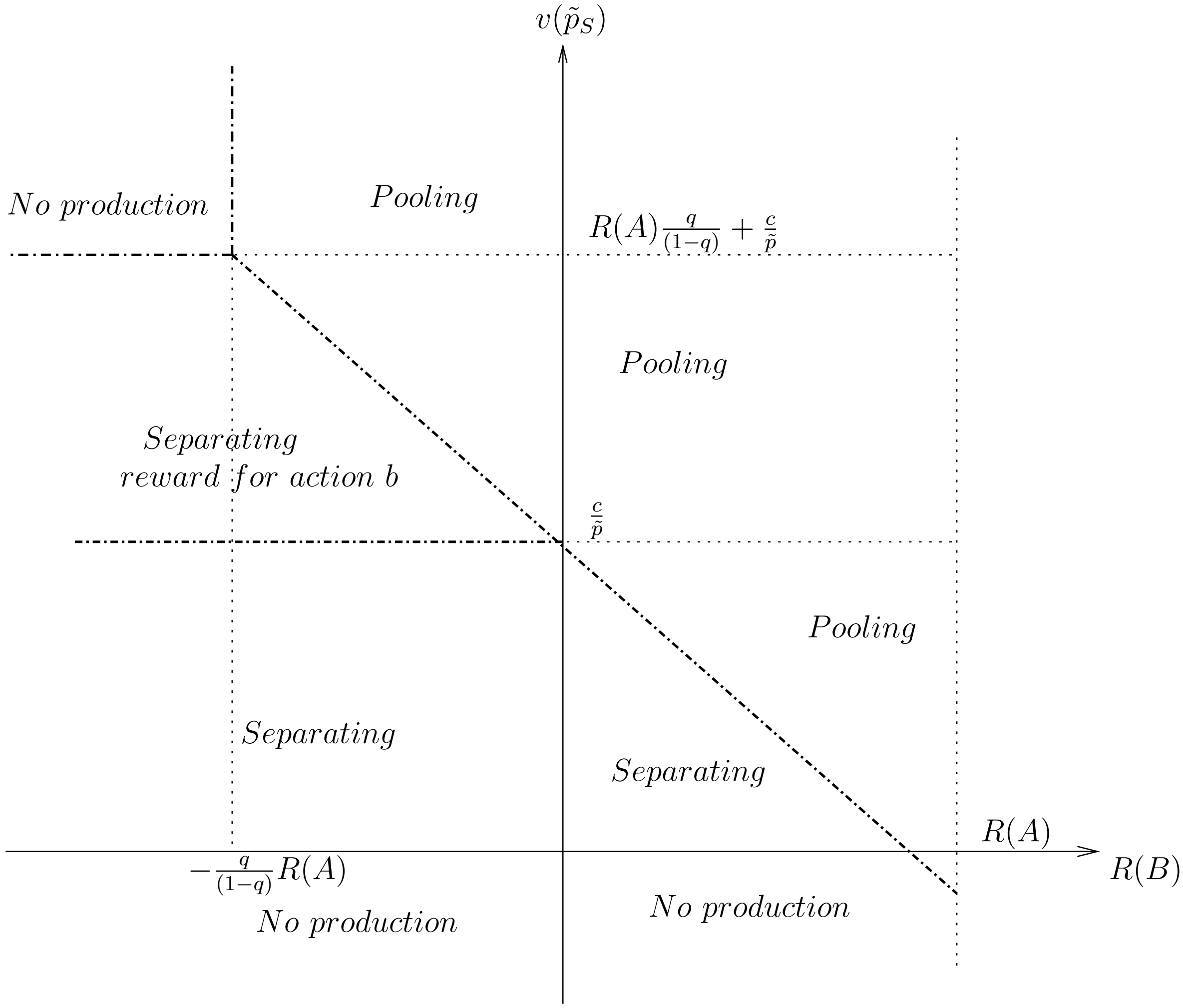

Fig. 1: Different types of equilibria

Therefore further signals are not informative and the value of signaling is zero. As usual the agent that stands to gain the most from signaling is the one with the least informative prior, so that $v(\tilde{p}_S)$ attains its unique maximum at a neutral prior $\tilde{p} = (\underline{p} + \overline{p})/2 := \hat{p}$. The market value $v(\tilde{p}_S)$ will determine the labor market outcome in period 1. Note that $v(\tilde{p}_S) < qR(A)$, so that production will always occur in a match in period 1. A pair (i, j) chooses a separating contract if

$$qR(A)\left(\tilde{p}(\underline{p} + \overline{p}) - \underline{p}\overline{p} - \tilde{p}^2\right) + \tilde{p}R(B) < c. \tag{1}$$

A separating contract rewards idleness if

$$qR(A)\left(\tilde{p}(\underline{p} + \overline{p}) - \underline{p}\overline{p} - \tilde{p}^2\right) > c. \tag{2}$$

Conditions (1) and (2) completely determine contractual and organizational choice depending on the agent's expected productivity $\tilde{p}$. Hence, if

$$qR(A)(\hat{p} - \underline{p}\overline{p}) + \hat{p}R(B) > c,$$

there are thresholds $\underline{p} < p_1 < p_2 < p_3 < p_4 < \overline{p}$ such that for $\underline{p} < \tilde{p} < p_1$ and $p_4 < \tilde{p} < \overline{p}$ a separating contract with $w_I = 0$ is optimal, for $p_1 < \tilde{p} < p_2$ and $p_3 < \tilde{p} < p_4$ a separating contract with $w_I > 0$ is optimal, and for $p_2 < \tilde{p} < p_3$ a pooling contract is chosen. Recalling that agents are identical ex ante and abundant and therefore receive payoff 0 this is summarized in the following proposition.

Proposition 6 (Market Outcome in Period 1)**.** *In a labor market equilibrium in period* 1 *all firms are matched to agents who obtain payoff* 0*. Contractual choice depends on expected productivity* $\tilde{p}$ *as follows. Let* $(\underline{p} + \overline{p})/2 := \hat{p}$*. If* $qR(A)(\hat{p} - \underline{p}\overline{p}) + \hat{p}R(B) > c$ *there are thresholds* $\underline{p} < p_1 < p_2 < p_3 < p_4 < \overline{p}$ *such that the optimal contract is*
(i) separating with $w_I = 0$ *for* $\underline{p} < \tilde{p} < p_1$ *or* $p_4 < \tilde{p} < \overline{p}$*,*
(ii) separating with $w_I > 0$ *for* $p_1 < \tilde{p} < p_2$ *or* $p_3 < \tilde{p} < p_4$*, and*
(iii) pooling for $p_2 < \tilde{p} < p_3$*.*
If $qR(A)(\hat{p} - \underline{p}\overline{p}) + \hat{p}R(B) < c$*, then* $p_2 = p_3$*.*

That is, the optimal contractual form of a firm is separating when the agent's expected productivity is either very small or very high, that is close to its bounds. A pooling contract is optimal for agents of intermediate productivity, and employee perks rewarding idleness are used in separating contracts for agents whose expected productivity is moderately high or low. This is because the contract form has to reflect the propensity to signal, and the value of signaling is non-monotonic in expected productivity. Hence, the organizational form chosen by a firm discourages idleness for employees with highest value of signaling, rewards idleness for those with intermediate value of signaling, and uses incentive pay contingent on the task for those with low value of signaling.

3.3 Investment in Corporate Public Goods

We established above that rewarding idleness may be an appropriate response to agents' incentives to signal their productivity. Such reward may take the form of biasing the principal's investment in corporate infrastructure at the disposal of all employees, such as the quality of office and IT equipment or certain employee perks, for instance in form of a sports center. Suppose therefore that at the matching stage a principal has the opportunity to invest in such a corporate public good g at a convex monetary cost g. Suppose further that this investment reduces the agent's cost of exerting effort, which are given now by

$$c(g) = c/g.$$

This is the simplest way of introducing investment in corporate public goods into the setting. Since the investment is complementary to task a under-investing can be used to discourage signaling. This can be interpreted as the provision of in-kind employee perks by biasing the investment choice away from corporate goods that are complementary to productive activities toward those complementary to leisure thus raising opportunity cost of effort.

The only only meaningful difference to the analysis above is that rewarding may be done by monetary payments, by changing the investment in the public good, or by a combination of the two. Notice that under-investment is a relative efficient means of discouragement, since it reduces investment cost for the principal. Therefore the principal's first choice is to reduce investment compared to the efficient level absent signaling, and only when the distortions caused by this outweigh the cost-savings will monetary transfers be used (this mirrors the mechanism at work in Legros and Newman, 2008).

Following this reasoning the principal will choose an efficient investment in period 2, since old agents do not have an incentive to signal. This investment is given by $g_S^* = \sqrt{qc}$ in case a separating contract is used and by $g_P^* = \sqrt{c}$ for a pooling contract. Hence, a separating contract in period 2 specifies

$$g = g_S^*, w_I = v(\tilde{p}_i), w_S = \frac{\sqrt{c/q} + v(\tilde{p}_i)}{\tilde{p}_i} - \frac{1-\tilde{p}_i}{\tilde{p}_i} w_F, \text{ and } w_F \in \left[0, \frac{\sqrt{c/q} + v(\tilde{p}_i)}{1-\tilde{p}_i}\right].$$

A pooling contract has

$$g = g_P^*, w_I \in [0, v(\tilde{p}_i)], w_S = \frac{\sqrt{c} + v(\tilde{p}_i)}{\tilde{p}_i} - \frac{1-\tilde{p}_i}{\tilde{p}_i} w_F, \text{ and } w_F \in \left[0, \frac{\sqrt{c} + v(\tilde{p}_i)}{1-\tilde{p}_i}\right].$$

A separating contract is more profitable than a pooling contract if and only if

$$2\sqrt{c} > (1+\sqrt{q})\tilde{p}R(B).$$

Wages in period 2 can be determined similarly to the case above. Suppose again that $\tilde{p}$ types are abundant, for which $\mu < 1/2$ is sufficient. Then $v(\tilde{p}_I) = 0$ and all firms obtain the same payoff

$$\pi = \max\{q\tilde{p}R(A) - 2\sqrt{qc}; \tilde{p}(qR(A) + (1-q)R(B)) - 2\sqrt{c}\}.$$

Assume as before that production is profitable in the first period, that is $\sqrt{q}\tilde{p}R(A) > 2\sqrt{c}$. Then agents' market values are given by

$$v(\tilde{p}_S) = \max\{q\tilde{p}_S R(A) - \sqrt{qc}; \tilde{p}_S(qR(A) + (1-q)R(B)) - 2\sqrt{c}\} - \pi.$$

To solve for the labor market equilibrium in period 1 focus again on the case that task a is complex, potentially resulting in a loss, that is

$$R(B) < 0.$$

This implies $v(\tilde{p}_S) = qR(A)(\tilde{p}_S - \tilde{p})$ as above.

The contract used in period 1 can be computed following the same steps described in the previous section, taking into account that decreasing investment by setting g to satisfy incentive compatibility is always more profitable to the principal than paying a positive wage for task b. This also implies that a pooling contract that implements $R(B) < 0$ with positive probability can never be profitable, as signaling can be more effectively discouraged by increasing the cost c/g.

Lemma 7. *If $R(B) < 0$, the optimal contract in period 1 is separating and specifies $g = g_S^*$, $w_I = 0$, $w_S = \frac{\sqrt{c/q}}{\tilde{p}_i} - \frac{1-\tilde{p}_i}{\tilde{p}_i} w_F$, and $w_F \in \left[0, \frac{\sqrt{c/q}}{1-\tilde{p}_i}\right]$ if $\sqrt{c/q} \geq \tilde{p}qR(A)(\tilde{p}_S - \tilde{p})$, $g = \frac{c}{\tilde{p}v(\tilde{p})} < g_S^*$ and $w_I = w_S = w_F = 0$, if $\sqrt{c/q} \leq \tilde{p}qR(A)(\tilde{p}_S - \tilde{p})$.*

Compared to the previous section, here the principal can discourage signaling by decreasing the investment in g. As a consequence, the greater the incentive to signal, the less the principal's investment cost. This has the effect of completely removing pooling contracts and separating contracts that reward action b. That is, with investments higher values of signaling allow separating to be induced at lower cost.

It is noteworthy though that the functional forms of the effort and investment cost, c/g and g, are necessary for a complete crowding out of pooling contracts and separating contracts where action b is rewarded. With effort cost functions that do not allow the principal to make effort investment arbitrarily costly (for instance $c/(1+g)$) there emerges a role for pooling contracts and separating contracts where action b is rewarded when the value of signaling is sufficiently high to make signaling preferable at $g = 0$. The general thrust of our argument carries over though.

As in the previous section, the optimal organizational structure can be derived as a function of the agent's initial expected productivity. The value of signaling is greater for agents with an uninformative prior $\tilde{p} = (\underline{p} + \overline{p})/2 := \hat{p}$. For this agent, the value of signaling is $v(\hat{p}_S) = qR(A)(\hat{p} - \underline{p}\overline{p})$. Also, the value of signaling is zero if $\tilde{p} = \underline{p}$ or $\tilde{p} = \overline{p}$. The proposition follows:

Proposition 8 (Market Outcome in Period 1)**.** *Assume that $R(B) < 0$. In a labor market equilibrium in period 1 all firms are matched to agents who obtain payoff 0 and implement a separating contract. The optimal investment in corporate public goods g depends on expected productivity $\tilde{p}$ as follows. Let $(\underline{p} + \overline{p})/2 := \hat{p}$. If $\sqrt{c/q} \leq \hat{p}qR(A)(\hat{p}_S - \underline{p}\overline{p})$ the investment g is always efficient:*

$$g = g^\star = \sqrt{qc}$$

Otherwise, there are thresholds $\underline{p} < p_1 < p_2 < \overline{p}$ such that
(i) for $\underline{p} < \tilde{p} < p_1$ or $p_2 < \tilde{p} < \overline{p}$, the investment in corporate public goods in efficient
(ii) for $p_1 < \tilde{p} < p_1$ the investment in public goods is lower than the efficient one

$$g = \frac{c}{\tilde{p}qR(A)\left(\underline{p} + \overline{p} - \frac{\underline{p}\overline{p}}{\tilde{p}} - \tilde{p}\right)}$$

Also here, the organizational structure responds to variations in the agents' initial productivity and in the agents' incentive to signal. In this case, firms can choose to leave the investment in corporate public good undistorted, or to distort the investment increasing the cost of performing action a relative to action b. Note that, once again, this is sensitive to the functional form chosen. If, for example, $c = \frac{1}{1+g}$, the principal may not be able to force separation by decreasing g. There may be situations where the principal invests in making task b more amenable, or situation where the principal rewards action b using cash transfers, therefore leading to an even richer contractual and organizational structure. Since this will largely be a repetition of the steps just derived, we will not push this direction further.

4 Stationary Equilibrium with a Continuum of Types

This section embeds the mechanism described in section 3 in a setting with a continuum of agents who differ in their ex-ante expected productivity $\tilde{p}$. Our goal is to show that heterogeneity in the ex-ante expected productivity translates into heterogeneity in the incentives to signal and into heterogeneity in the contractual and organizational choices observed in the economy.

As above, the economy is populated by agents and principals. Agents live for two periods and have unobserved productivity $p \in \{\underline{p}; \overline{p}\}$. When young, agents are characterized by their publicly observable expected productivity $\tilde{p} \in [\underline{p}, \overline{p}]$, which can be thought of as final educational achievement. In each period the economy is populated by measure 1/2 of young agents, by measure 1/2 of old agents, and by measure 1 of principals. Denote the time-invariant distribution of the young agents' expected productivities by $F(\tilde{p})$ with density $f(\tilde{p})$. Using Lemma 1 expected productivity when old is

$$\tilde{p}^o = \begin{cases} \tilde{p}_S(\tilde{p}) = \underline{p} + \overline{p} - \frac{\underline{p}\overline{p}}{\tilde{p}} & \text{after a success} \\ \tilde{p}_F(\tilde{p}) = \frac{\tilde{p}(1-\underline{p}-\overline{p})+\overline{p}\underline{p}}{1-\tilde{p}} & \text{after a failure} \\ \tilde{p}_I(\tilde{p}) = \tilde{p} & \text{otherwise} \end{cases}$$

Key to contractual and organizational choice in firms are the payoffs that different types of agents obtain in the market. Denote the market value, i.e. the rent an agent obtains in a labor market equilibrium, by $v(\tilde{p})$ when young and by $v(\tilde{p}_o)$ when old. All firms are homogeneous and are not liquidity constrained, so that they all obtain the same rent in a labor market equilibrium.

Contrary to the previous section assume now that the agent's productivity affects not only the probability of success, but also the value of a success:

Assumption 9. *In case of success, the expected output depends on the agent's type*

$$R(s,p) = R(s)p$$

We focus on situations where there is a sizable downside risk to task a and therefore idleness may optimally be rewarded

$$R(B) < 0.$$

Following the same steps described in Lemma 2, it is possible to show that, in this case, the optimal contract for an old agent is separating. As a consequence, a firm employing an old agent has output

$$y(\tilde{p}_o) = q\tilde{p_o}^2 R(A),$$

which is convex in the agent's type. Furthermore, by assuming that low productivity types can profitably produce, that is,

$$y(\underline{p_o}) \geq qc.$$

an old agents' market value can be written as

$$v(\tilde{p}_o) = y(\tilde{p}_o) - qc - \pi,$$

where π are the principals' equilibrium profits.

Under these assumptions the payoff of an old agent is increasing, convex and has a constant second derivative. Convexity of the payoff function is necessary for agents to have incentives to signal. Since the expected future productivity of agents that choose task a must be equal to their prior productivity, signaling is profitable only if the expected wage when choosing task a is greater than the wage earned at the expected productivity. For the same reason, everything else equal the more convex is the wage function, the higher the value of signaling. In the previous section a scarcity premium for $\tilde{p}_S$ agents provided the necessary convexity, generating a wage function that is flat for a given range and linearly increasing afterwards. Here we rely on assumption 9 instead. This enables a constant second derivative of the wage function, ensuring that any variation in the value of signaling stems from young agents' productivity, and not on local variations in convexity.

More formally, consider a lottery giving productivity $p_1 = \tilde{p} + \Delta_1$ with probability $\tilde{p}$ and $p_2 = \tilde{p} - \Delta_2$ with $1 - \tilde{p}$, where $\Delta_2 = \frac{\tilde{p}}{1-\tilde{p}}\Delta_1$ so that, in expected value, $\tilde{p} = \tilde{p}p_1 + (1 - \tilde{p})p_2$. Define the value of signaling as the expected increase in profit by choosing the lottery over the certain outcome $\tilde{p}$:

$$s(\tilde{p}) \equiv \tilde{p}q(p_1^2 R(A) - c) + (1 - \tilde{p})q(p_2^2 R(A) - c) - q(\tilde{p}^2 R(A) - c) = qR(A)\frac{\tilde{p}}{1 - \tilde{p}}\Delta_1^2.$$

Here Δ_1 is given by $\tilde{p}_S - \tilde{p}$, so that the value of signaling depends exclusively on the prior $\tilde{p}$

$$s(\tilde{p}) = qR(A)\frac{\tilde{p}}{1 - \tilde{p}}\left(\underline{p} + \overline{p} - \frac{\underline{p}\overline{p}}{\tilde{p}} - \tilde{p}\right)^2.$$

Period-1 expected productivity affects the value of signaling in two ways. The first one is Δ_1, representing the size of the update in productivity in case of success. This component depends on the information content of the signal, which is decreasing in the information content of the prior probability. Therefore Δ_1 is higher for intermediate values of $\tilde{p}$. The second component affecting the value of signaling is $\frac{\tilde{p}}{1-\tilde{p}}$, representing the probability of a success. This component is strictly increasing in $\tilde{p}$.

Overall, signaling has no value for extreme productivity types, since when $\tilde{p} = \underline{p}$, $\tilde{p} = \tilde{p}_S$, and similarly for $\overline{p}$ (which pins down the lowest market value for any young agent). Also, the value of signaling $s(\tilde{p})$ is strictly positive everywhere else, attaining a maximum for some $\tilde{p} = \hat{p} \in (\underline{p}, \overline{p})$, where

$$\hat{p}: \; 2\hat{p}^2 + \overline{p} + \underline{p} = 3\hat{p} - \underline{p}\overline{p}\left(\frac{1}{\hat{p}} - 2\right)$$

It is possible to show that $\hat{p}$ is unique.[9]

Turn now to the young agents. Denote the rent a young agent with expected productivity $\tilde{p}$ obtains in the labor market equilibrium by $v(\tilde{p})$. Applying Lemma 5 a separating contract specifies

$$w_I = v(\tilde{p}), w_S \in [v(\tilde{p}), v(\tilde{p}) + (c - s(\tilde{p}))/\tilde{p}] \text{ and } w_F = \tilde{p}/(1-\tilde{p})((c - s(\tilde{p}))/\tilde{p} - w_S),$$

if $c > s(\tilde{p})$, and

$$w_I = v(\tilde{p}) + s(\tilde{p}) - c, w_S = w_F = v(\tilde{p})$$

otherwise. A pooling contract specifies

$$w_I \leq v(\tilde{p}), w_S \in [v(\tilde{p}), v(\tilde{p}) + (c - s(\tilde{p}))/\tilde{p}] \text{ and } w_F = \tilde{p}/(1-\tilde{p})((c - s(\tilde{p}))/\tilde{p} - w_S),$$

if $c > s(\tilde{p})$ and $w_I = w_F = w_S = v(\tilde{p})$ otherwise. A separating contract induces higher joint surplus of principal and agent than a pooling contract if and only if

$$s(\tilde{p}) < c - \tilde{p}^2 R(B).$$

The following proposition summarizes these results and describes the labor market equilibrium for both young and old agents.

Proposition 10 (Market Outcome)**.** *In a labor market equilibrium all firms are matched to agents and obtain payoff $\pi \in [0, y(\underline{p}) - qc]$. Old agents get separating contracts specifying w_I and $\tilde{p}w_S + (1-\tilde{p})w_F = w_I + c$. Contractual choice for young agents depends on expected*

[9] show that LHS>RHS at $\tilde{p} = \underline{p}$; show that LHS<RHS at $\tilde{p} = \overline{p}$; the derivative or RHS-LHS is $4\hat{p} - \frac{\overline{p}\underline{p}}{\hat{p}^2} - 3$ and it is always negative for $\hat{p} \in (\underline{p}, \overline{p})$.

productivity $\tilde{p}$*: if* $s(\hat{p}) + \hat{p}R(B) > c$ *there are thresholds* $\underline{p} < p_1 < p_2 < p_3 < p_4 < \overline{p}$ *such that the optimal contract is*

(i) separating with $w_I = 0$ *for* $\underline{p} < \tilde{p} < p_1$ *or* $p_4 < \tilde{p} < \overline{p}$*,*

(ii) separating with $w_I > 0$ *for* $p_1 < \tilde{p} < p_2$ *or* $p_3 < \tilde{p} < p_4$*, and*

(iii) pooling for $p_2 < \tilde{p} < p_3$*.*

If $s(\hat{p}) + \hat{p}R(B) < c$*, then* $p_2 = p_3$*.*

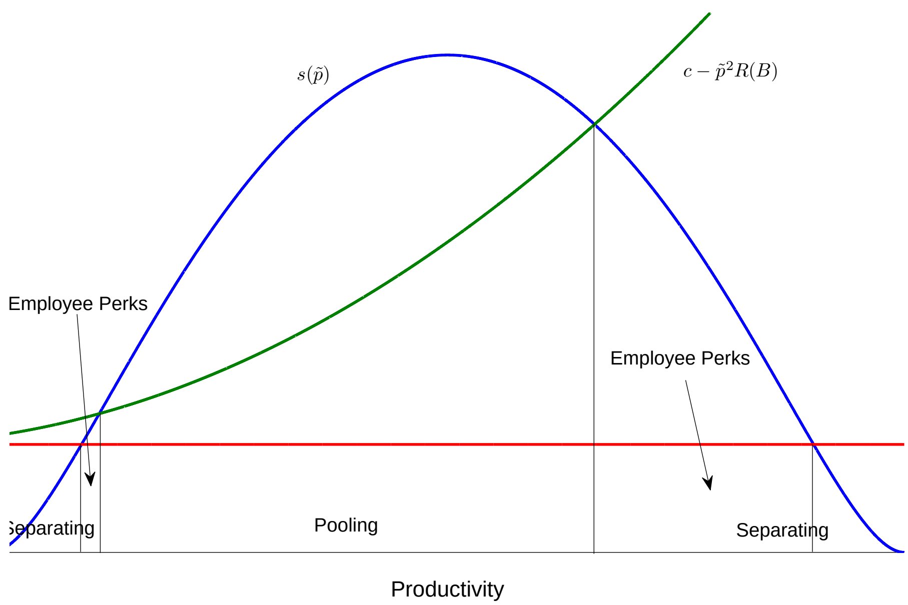

Fig. 2: Contractual Regimes.

That is, Proposition 10 implies that similar firms that hire similar employees (in the neighborhoods of p_2 and p_3) may nevertheless choose substantially different organizational styles: in one style /separating contracts that reward idleness) activities that generate signals such as lines in an employee's CV are discouraged (by raising the opportunity cost of signaling through rewarding activities that do not generate such signals) and only implemented as long as they have positive return. In another style (pooling contracts) employees are free or even encouraged to pursue activities that generate signals, compensation takes the form of a relatively flat salary. This is illustrated in Figure 2.

Recall that for $R(B) < 0$ the expected output-maximizing contract is separating. This will be the contract offered to old agents. However, because of signaling, some young agents

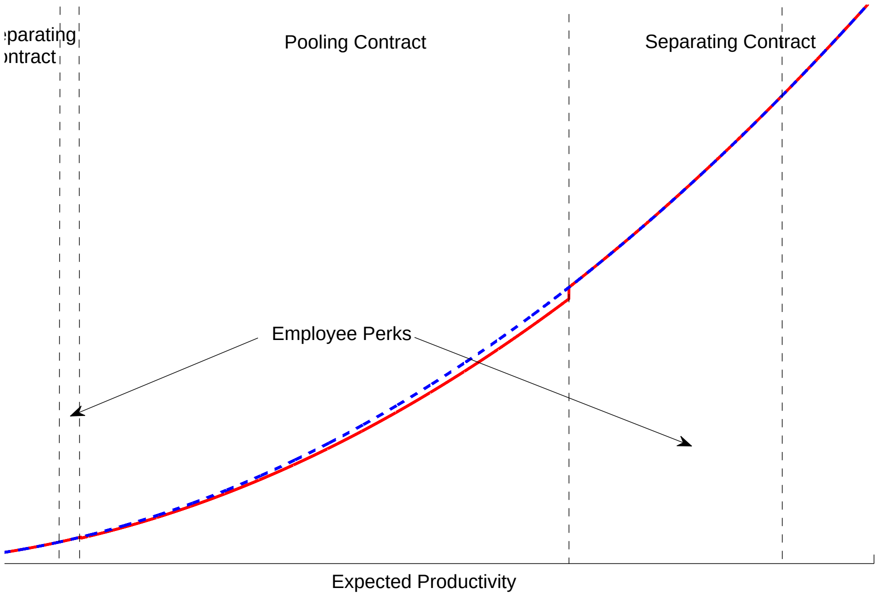

Fig. 3: Distribution of expected monetary compensation for young (solid line) and old (dashed line) agents.

may be offered a pooling contract. In this case, since the wage is equal to total output minus a constant, for the same expected productivity a young agent receives a lower wage than an old agent. This will be the case when the value of signaling is high, i.e. for intermediate productivity levels. In case the contract offered to young agent is a separating, the total monetary compensation offered to young and old agent is always $y(p) - \pi$. What is different, however, is how the expected monetary compensation is composed: old agent get a bonus for success, young agents get a reward for B. But both payment schemes have to yield the same expected monetary compensation. The monetary compensations of old agents and young agents are depicted in figure 3.

Turn now to expected payoffs of young agents. When getting a separating contract a young agent has payoff:

$$u_i = q(\tilde{p}^2 R(A) + s(\tilde{p}) - c) - \pi.$$

In case of a polling contract a young agent obtains

$$u_i = \tilde{p}^2 (qR(A) + (1-q)R(B)) + s(\tilde{p}) - c - \pi.$$

The total payoff is made of two components: the monetary wage and the benefit of signaling. Figure 3 shows that the monetary payment is, barred the discontinuity, convex. However, figure 2 shows that the incentive to signal is locally concave for most of the intermediate productivity levels. It follows that young agents' expected payoffs at the beginning of period 1 can be expected to be flatter than the payoff of an old agent. This is shown in Figure 4.

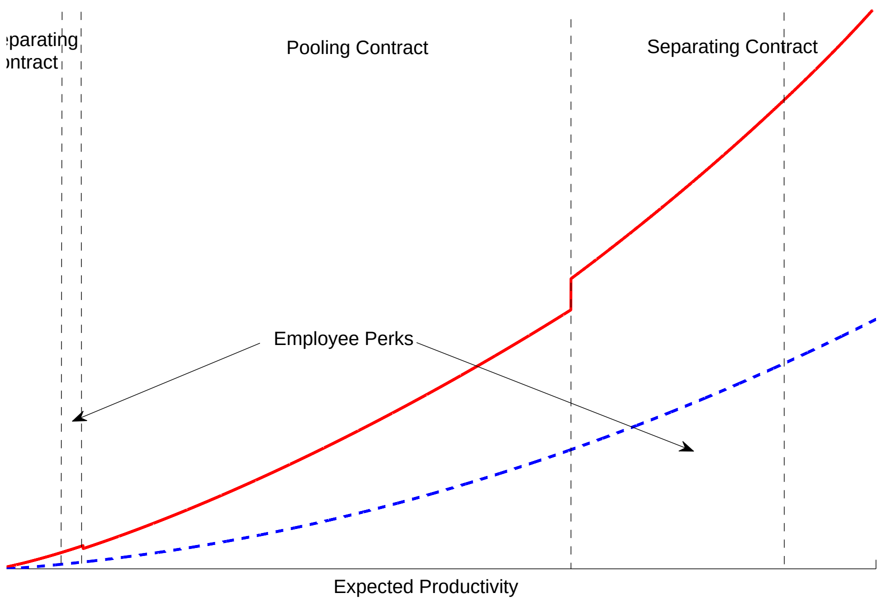

Fig. 4: Expected future payoffs of young (solid line) and old (dashed line) agents at the beginning of a period.

A Mathematical Appendix

A.1 Proof of Lemma 1

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

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

Using that $\tilde{p} = \pi\overline{p} + (1-\pi)\underline{p}$ yields the expression in the lemma. An analogous argument yields $\tilde{p}_F$. Since all agents are ex ante identical both if an agent chose b in the first period or remained unmatched generates no new information, hence $\tilde{p}_I = \tilde{p}$.

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