DELEGATING RECRUITMENT UNDER ASYMMETRIC INFORMATION

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Abstract

This paper studies the incentive to delegate recruitment. The owner decides whether or not to delegate recruitment to senior employees who are better able to evaluate candidates but may avoid recruiting the best candidates as they threaten their seniority. We find that senior employees will not deliberately choose bad candidates if the only information asymmetry between the owner and the recruiter relates to candidates’ ‘type’. Delegation is then superior to direct (owner) recruitment although ‘tenure’ may still be offered to elicit the ‘type’ of the recruit. If additional information asymmetry is present, however, moral hazard may exist and tenure is offered to ensure that the best candidate is selected.

Keywords: delegation, direct recruitment, moral hazard, tenure

JEL Classification: D23, D82, J41, L22

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1. Introduction

Recruiting competent employees is a vital and difficult task. Applicants have private information, so adverse selection is usually a concern. One way to mitigate the adverse selection problem is to delegate recruitment to well informed internal recruiters or senior employees (Williamson, Wachter and Harris, 1975, Greenwald, 1986). However, unless the recruiter’s interests are well aligned with the organization’s interests, delegation just converts the adverse selection problem between the owner and applicant to one between the owner and the recruiter. It also compounds it with a moral hazard problem: If the new employee will be competing with the recruiter in future, the recruiter may be tempted to hire applicants with low ability (Carmichael, 1988, Friebel and Raith, 2000). The purpose of this paper is to explore when and how recruitment decisions should be delegated, with a secondary focus on the role of job security (tenure) for recruiters.

We formulate the owner's choice between direct recruitment and delegation in a framework of complete contracts without commitment (Laffont and Tirole, 1987, 1988). The owner decides whether to delegate the task of hiring to senior personnel or do it herself. Thus, she has to trade off the gains from superior information of the supervisor against losses from opportunism. This is similar to the idea that transfer of real authority to the agent promotes the agent's initiative to acquire information but results in a loss of control for the principal (Aghion and Tirole, 1997). Dessein (2002) finds that delegating decisions to a better informed agent is preferable to communicating with the agent provided the principal’s uncertainty about the environment is large relative to the divergence in their preferences. Initially we assume that the owner cannot credibly commit to preserving the seniority of the supervisory employee in order to ensure that he doesn't deliberately choose an incapable candidate.
In this paper a manager who is privately informed of candidate type can obtain the same output (and hence rewards) with a lower own effort by hiring a good candidate. Since he should optimally produce a higher output with a better candidate, the owner prefers to pay him some (information) rents to partly mitigate this "moral hazard in production". However, if the manager produces a higher output, the owner infers that he has recruited a good candidate. She may then promote the junior worker over the manager (senior employee) – who then loses the opportunity of obtaining any information rents in the second period. This leads to "moral hazard in recruitment" of the manager i.e., the incentive to deliberately select an inferior candidate to ensure that his seniority in the organizational hierarchy is retained.

The complete contracting framework permits us to explicitly model second period information rents. Earlier papers discuss moral hazard in recruitment in an incomplete contract framework (Carmichael, 1988, Friebel and Raith, 2000). Carmichael (1988) examines why academic institutions offer tenure. In his model (a) the current faculty in a university can better evaluate new candidates than the university administration and (b) there are budgetary constraints on the number of faculty positions. The university learns the type of the new recruits through 'experience' rather than inferring it from output and the information rents of the faculty are assumed rather than being explicitly modeled. He finds that current faculty must be assured of their jobs - through tenure - to honestly evaluate the candidates who may threaten their position in the future.

In Friebel and Raith (2000), firms limit communication between senior management and junior workers to avoid moral hazard in recruitment of middle managers entrusted with recruiting. Owners can learn the types of managers and workers from observing an unverifiable output $y$ and receiving a credible but imperfect and unverifiable 'communication' $z$ from the worker. The fact that $y$ and $z$

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1 Studies on the incentive to delegate also take the incomplete contract approach (Aghion and Bolton, 1997, Dessein 2002).
cannot be verified rules out explicit incentive contracts. By contrast, the complete contracting framework in our paper - with its explicit modeling of second period information rents - leads to the conclusion that there can be no moral hazard in recruitment with a single source of information asymmetry.

In many firms the senior employee or line manager in charge of recruitment has other tasks like input purchase, product pricing, marketing or even investment and financial decisions that involve access to private information on various aspects of firm activities. We show that such additional asymmetry of information may lead to moral hazard in recruitment and the owner may then prefer to recruit directly (i.e., by herself). The main contributions of the paper are (a) to emphasize the role played by this additional asymmetry in information on moral hazard in recruitment, and (b) to explicitly analyze the owner's choice between direct recruitment and delegation when such moral hazard is present.

We also briefly examine whether it is worthwhile to provide the senior employee with a tenured contracts that assures his seniority. In contrast to the existing literature (eg. Carmichael 1988), we find that (a) tenure may be preferred even when there is no moral hazard in recruitment to induce the senior employee to reveal the type of the candidate (i.e., to mitigate moral hazard in production) (b) tenure is more likely to be desirable when the information asymmetry is multidimensional and moral hazard in recruitment exists.

Recruitment takes different forms in 'large' and 'small' firms. In large corporations, personnel departments are in overall charge of recruitment. Personnel managers have their own career concerns that are best achieved if they hire good recruits and therefore face no moral hazard in recruitment. For such large corporations, ''direct recruitment'' has to be interpreted as ''centralized recruitment'', where the line manager - who typically holds private information in
other aspects of business in addition to his special knowledge regarding candidates - has no significant role. By contrast, in small firms the owner is often directly involved in recruitment or leaves it to her senior employees (Caroll, Marchington, Earnshaw and Taylor, 1999, Stewart and Knowles, 2000). It is unlikely that owners of small firms would be able to credibly commit to long-term contracts for senior employees.\footnote{Small firms often have low survival rates so that a commitment to retain the manager’s position may not mean much. More important, for an organization with a few employees it may be much more difficult to credibly commit to retain relatively incompetent persons in the few available managerial positions that are crucial to the survival of the firm.} Although the 'tenure' issue is not the principal focus of our paper, this limits the applicability of some of our results to small firms.

The paper is organized as follows. Section 2 describes the case of asymmetric information in a single dimension, i.e., the ability of the candidate. Sections 3 considers additional asymmetry in information. Section 4 briefly considers tenure. Section 5 concludes.

2. Information Asymmetry in candidates' ability

2.1 Model

We consider one principal -- the proprietor, partner or the personnel department of a large corporation -- and one agent -- the senior employee or a line manager. There is one vacancy and two applicants for the post -- although this may be easily generalized. We start with the setting where the senior employee's private information regarding the candidate's ability is the only source of information asymmetry between him and the owner. The model makes the following assumptions:

\textbf{Assumption 1}: The worker has a routine job where only her ability, \( l_t \), contributes to output, \( Y_t \). For the manager, both ability \( m_t \) and effort \( e_t (>1) \) contribute. The production function has the form

\[ Y_t = m_t (e_t + l_t) , \]  

(1)
where a more able manager obtains more output from his own effort and a given 'type' of worker.

The crucial assumption here is that the manager - who makes critical decisions - has a greater impact on productivity than the worker so that an owner prefers a more capable person in a senior position [see Milgrom and Roberts (1994)]. The specific form of the production function, which implies a strong complementarity between the ability of the manager and his effort, can be relaxed (at the cost of simplicity of some of the results) provided this basic assumption is retained.

**Assumption 2**: Candidates are either 'bad types' of ability $n_B$ with probability $p$ or 'good types' $n_G > n_B$ with probability $(1-p)$. At the time of recruitment, the senior employee - who is more involved in operating the firm - observes the type of the candidates while the owner only knows the probability distribution. The ability of the senior employee, $s$, is common knowledge, where

$$n_G > s > n_B,$$

so that the ability of the senior employee is lower than the good type candidate but higher than the bad type. Along with Assumption 1, this implies that if the owner learns that the new employee is 'good' (or at least if the 'expected type' is $> s$) she would promote her to the managerial position.

**Assumption 3**: The utility function of the employees is

$$U_t = U(w_t, e_t) = w_t - V(e_t) = w_t - e_t^2.$$  

The utility function is separable in income (wages) and effort. We assume that opportunity costs of employees are independent of their abilities and are equal to zero. Then for junior workers, we

\begin{align*}
\text{All our results go through with opportunity costs (positively) correlated with type. If the opportunity cost of the senior employee, } r(s), \text{ increases with his type, } s, \text{ we have } U_t = w_t - e_t^2 > r(s) \text{ or } w_t > e_t^2 + r(s). \text{ Since this type is known, his gross payment increases by } r(s) \text{ and the profit of the owner falls. If the recruit's opportunity cost also increases with type, then, the owner maximizes } \Pi = Y_t - w_t - w_j \text{ subject to participation constraints } w_t \geq e_t^2 + r(s) \text{ and } w_j \geq r(n_j). \text{ } \end{align*}
have \( w_j^* = 0 \). Under perfect information, the wages of the managers exactly compensates for their effort, \( e^* \), which is optimally chosen by the owner, i.e., \( w_i^* = \left(e^*\right)^2 \). Thus, under perfect information there is no reason for the employee to strive for promotion. This changes once we introduce asymmetric information and the manager gets an information rent \( w_s^* > (e^*)^2 \) to prevent opportunistic behavior. This makes employees strive to attain managerial positions.

**Assumption 4**: If the junior employee is promoted at the end of period 1, the senior employee is not fired but relegated to the junior position. This contrasts with `up-or-out' contracts where an employee is either promoted or fired (O’Flaherty and Siow, 1990), which although sometimes observed, are not common in most firms worldwide. In our model, the senior employee is indifferent between being fired or relegated to a junior position as either way he gets just his reservation wages. The assumption makes the model simpler as otherwise a recruitment would have to be made every time a junior employee is promoted. One way to justify this assumption is that there is a (fixed) cost of recruitment and/or termination - not made explicit - that leads the owner to avoid this option.

The time structure of the game is shown in Figure 1:

**Fig 1: Time Structure - private information on `type' of recruit**

We implicitly assume that the senior employee can be superseded only at the end of period 1. This avoids the implausible situation where a new recruit may be promoted over her recruiter immediately after being hired. While direct hiring at senior levels is quite common, internal
candidates "currently" holding or competing for the same positions rarely have a decisive role in such decisions.\(^4\)

In this structure, the senior employee may retain his seniority either by deliberately choosing a 'bad' candidate or by concealing the true type of the new recruit. Note also that the desire to retain seniority provides an additional incentive for the senior employee to conceal the true type of the recruit (aside from obtaining immediate information rents). The additional compensation needed to persuade the manager to reveal the type of the recruit in this case may render separating contracts unviable. It is therefore important to look at the expected profits of the owner not only under the usual (second - best) separating contract but also the pooling contract. We begin by describing the optimization problems of the parties under the (a) first best (full information) contract (b) optimal separating contract under asymmetric information and (c) optimal pooling contract under asymmetric information.

**First Best Contract:** If the candidate's type is observable, the owner maximizes

\[
\Pi_t = Y_t - w_t \quad \text{subject to} \quad U_t = 0
\]

in each period. In period 1, the manager is the senior employee, or \(m_1 = s\) and the subordinate is the new recruit with perfectly observed type: \(l_1 = n_i, \; i = B, G\). The optimal effort, wages and benefits of the two parties are

\[
e_1^* = \frac{s}{2}, \quad w_1^* = e_2^* = \frac{s^2}{4}, \quad U_1^* = 0, \quad \Pi_{1}^* = s(e_1 + n_1) - w_1 = s\left(\frac{s}{4} + n_1\right), \; i = B, G.
\]

**The Separating Contract under asymmetric information:** Assume now that only the senior employee can observe the 'type' of the recruit(s) so his effort cannot be directly observed

\(^4\) Alternatively, if we assume that the owner promotes the junior with a better expected type than the senior employee - immediately following recruitment - we need only a single production period following the managerial choice decision. All of our major results still go through - including the crucial role of "additional asymmetry in information" for the existence of moral hazard in recruitment.
(inferred?) by the owner and hence contracted on. Suppose that the owner offers a pair of separating contracts (output-payment pairs) \([\hat{w}_i, \hat{Y}_i, i = B, G]\) in a one-period post-recruitment game.

Define \(\hat{e}(n_i)\) as the effort required by a senior employee who truthfully reports the `type' of his candidate to produce the output selected for him by the owner, i.e.,

\[
\hat{e}(n_i) : s(\hat{e}(n_i) + n_i) = \hat{Y}_i, i = B, G,
\]

and \(e'(n_B, n_G)\) as the effort required by the senior employee with a `good recruit' \(n_G\), to produce the output intended for the case where the recruit is bad, \(\hat{Y}_B\),

\[
e'(n_B, n_G) : s(e'(n_B, n_G) + n_G) = s(\hat{e}(n_B) + n_G) = \hat{Y}_B.
\]

This implies that

\[
e'(n_B, n_G) = \hat{e}(n_B) - n_G + n_B = \hat{e}(n_B) - \Delta n.
\]

The optimal separating wage-effort pair \([\hat{w}_i, \hat{e}(n_i), i = B, G]\) underlying such a separating contract \([\hat{w}_i, \hat{Y}_i, i = B, G]\) must satisfy the standard **incentive compatibility condition** (for the good type):

\[
\hat{w}_G - (\hat{e}(n_G))^2 \geq \hat{w}_B - (e'(n_B, n_G))^2 = \hat{w}_B - (\hat{e}(n_B))^2 + 2\hat{e}(n_B)\Delta n - (\Delta n)^2,
\]

along with the usual **individual rationality condition** (for the bad type)

\[
\hat{w}_B - (\hat{e}(n_B))^2 \geq 0.
\]

To optimally select a pair of separating contracts in this one period post recruitment game, the owner maximizes one period expected profits

\[
\hat{\Pi}(\beta) = \beta[s(\hat{e}(n_B) + n_B) - \hat{w}_B] + (1 - \beta)[s(\hat{e}(n_G) + n_G) - \hat{w}_G],
\]

subject to (7) and (8), where \(\beta\) is the probability - post recruitment - that the candidate is `bad'.

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5 Suppose opportunity costs are related to type and the recruit is paid through the senior employee, so that the payment to the senior employee is \(W_{jt} = w_t + w_j\). Then, with private information about `type', the problem for the owner
The Optimal Pooling Contract: Consider now the optimal static pooling contract \([\bar{w}, \bar{Y}]\) that satisfies the individual rationality constraint and hence is always accepted. If we define the effort of the senior employee who has a bad candidate under such a pooling contract as \(\bar{e}(n_B)\), where
\[
\bar{e}(n_B) : s(\bar{e}(n_B) + n_B) = \bar{Y} ,
\] (10)
then the individual rationality condition for the bad type,
\[
\bar{w} - (\bar{e}(n_B))^2 \geq 0 ,
\] (11)
must be satisfied. Further, to produce the same amount of output \(\bar{Y}\) the senior employee with the 'good' candidate obviously puts in lower effort,
\[
\bar{e}(n_G) = \bar{e}(n_B) - \Delta n ,
\] (12)
for the same payment \(\bar{w}\). To choose an optimal pooling contract, the owner therefore, maximizes one period expected profits:
\[
\bar{\Pi}(\beta) = \beta[s(\bar{e}(n_B) + n_B) - \bar{w}] + (1 - \beta)[s(\bar{e}(n_G) - \Delta n + n_G) - \bar{w}] ,
\] (13)
subject to the preceding conditions.

The period 1 post recruitment profits of the employer under the pooling and separating contracts depend on \(\beta\) – a function of the mode of recruitment. It can be shown (see appendix) that

\begin{enumerate}
\item \(\hat{\Pi}(\beta) > \bar{\Pi}(\beta)\) \quad (14)
\item \(\frac{d\hat{\Pi}}{d\beta} < 0, \frac{d\bar{\Pi}}{d\beta} = 0\). \quad (15)
\end{enumerate}

Lemma 1: (i) \(\hat{\Pi}(\beta) > \bar{\Pi}(\beta)\) (14)

(offering an optimal separating one period contract may be characterized as (suppressing t) one of maximizing \(\Pi_t = Y_t - W_t\) subject to the participation constraints, \(W_G - (e(n_G))^2 \geq r(s) + r(n_G)\) and \(W_B - (e(n_B))^2 \geq r(s) + r(n_B)\) and the incentive constraint \(W_G - (e(n_G))^2 - r(s) - r(n_G) > W_B - (e(n_B,n_G))^2 - r(s) - r(n_G)\), which reduces to \(W_G - (e(n_G))^2 \geq W_B - (e(n_B,n_G))^2\). This differs from our model only in the payment to the employees and the owner’s profit. All our results go through.

The ‘type’ of the candidate may be revealed in direct contracting between her and the owner if opportunity costs are related to type. But this may be taken care of in a simple one period model by the senior employee through appropriate side-payments (‘bribes’) to the ‘good type’ recruit to conceal her type.
Part (i) states that the owner's profit is higher in a separating contract than in a pooling contract. Part (ii) implies that while under a separating contract the expected one period profits of the owner are lower when the recruit is more likely to be 'bad', under a pooling contract expected profit is not sensitive to the distribution of types. The optimal pooling contract specifies the optimal effort and minimum reservation wages corresponding to the 'bad' type. Hence the output and expenses of the owner as well as her expected profits are always the same. In a separating contract the owner obtains higher profits despite paying information rents when the senior employee 'reveals' the candidate to be 'good', hence her expected profits are a decreasing function of $\beta$.

2.2 Dynamic Contracts without commitment

Suppose that the owner cannot credibly commit that the senior employee will not be superseded if he chooses the best available candidate and exerts the optimal effort in period 1. A senior employee with a 'good' recruit may then lower his own (unobservable) effort to conceal the candidate's type. Laffont and Tirole (1987,1988) consider situations where types are perfectly correlated across periods and the principal cannot commit not to take advantage of the information revealed in period 1. Then (provided the rate of discount $\varphi$ is high enough) a separating contract in the first period is not feasible since the good type would demand additional rents to compensate for lost information.

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6 The owner does better than a pooling contract by offering a pair of separating contracts where the manager always apply his first best effort. The manager with the bad type gets his reservation value $w'_b = (e'(n_s))^2 = s^2/4$, while the one with the good type gets at least the information rents as in the pooling contract $w'_g = s^2/4 + s\Delta n - (\Delta n)^2$. Total profits are $\Pi' = s^2/4 + sn_b + (1-\beta)(\Delta n)^2 \geq \Pi$, i.e. higher than in a pooling contract. Evidently, she does even better in the optimal separating contract by reducing the specified output and hence the gross payment of the manager with the bad type recruit. While the optimal output required of the manager with the good recruit remains the same, his gross payment is also reduced. In our specific model this lower required payment makes the optimal separating contract more attractive than the pooling contract, though the expected output under both contracts is the same, $\hat{Y} = s^2/4 + sn_b = \overline{Y}$. 

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rents in period 2. The optimal solution is a pooling contract in period 1 followed by a static separating contract in period 2. The senior employee gets information rents only if he has chosen a ‘good' candidate. With a ‘bad' candidate he earns no information rent in either period. Hence:

**Lemma 2:** If the only information asymmetry is about the type of the candidate there is no ‘"moral hazard in recruitment'', i.e., the senior employee never intentionally chooses a bad candidate.

In contrast to the Laffont-Tirole model, a pooling contract in period 1 in our case leads to the replacement of the senior employee if his type is lower than the expected type of the new recruit, i.e., $E(n) > s$. The senior employee then loses nothing by accepting a separating contract where his type is revealed in the first period, provided he is paid the usual first period information rents.\footnote{Opportunity costs positively correlated with type lead to virtually no significant changes in this result. This is obvious in case the recruit is paid through the senior employee (footnote 6). But even if the recruit is paid directly, no additional compensation (or side payments from the senior employee) is required to induce the 'good candidate' to conceal her type as there are no scope for second period information rents once this type is revealed and she is promoted.} A separating contract is also more likely under delegation as the senior employee's preference for a good type (if available) implies that the expected type of new recruit is higher in this case.

**Proposition 1:** If the only asymmetric information is about candidate type the optimal contract is:

1. **Pooling** in period 1 if the expected type of the new recruit is worse than the senior employee, $E(n) < s$, and the senior employee retains his position. The period 2 contract is separating.

2. If $E(n) > s$, the first period contract is **separating** and the senior employee loses his seniority if the new recruit turns out to be more efficient. The period 2 contract is first best.

3. Further, the owner always prefers to delegate recruitment.

**Proof:** Under direct recruitment, the probability that the recruit is bad $\beta = p$, as the owner cannot observe the candidates’ type and the expected type of the new recruit is $E(n) = \bar{n} = pn_b + (1 - p)n_g$.
Hence, if $s \geq \tilde{n}$, pooling in period 1 leads to the senior employee retaining his position. Without commitment, the owner offers the optimal static pooling contract in period 1 and the optimal separating contract in period 2. However, if $s \leq \tilde{n}$ a pooling contract in period 1 leads to the senior employee losing his job. He therefore accepts the optimal separating contract in period 1 (as he gets at least as much as he would get by concealing type).

Under delegation, without moral hazard (lemma 2), the senior employee chooses a bad type only if both are bad, $\beta = p^2 < p$. The expected type of the recruit is $\bar{n} = p^2 n_B + (1 - p^2) n_G > \tilde{n}$, which is even more likely to be greater than the senior employee’s type.

Comparing the direct and delegated contracts, when $s > \bar{n} > \tilde{n}$, the period 1 contract is pooling and delegation is superior as the expected type of the new recruit is higher under delegation both under the pooling and separating contracts, $\Pi(p^2) + \varphi \Pi'(p^2) > \bar{\Pi}(p) + \varphi \bar{\Pi}'(p)$. For a similar reason, when $\bar{n} > s > \tilde{n}$, and the period 1 and period 2 contracts are fully separating and first best respectively, $\hat{\Pi}(p^2) + \varphi \Pi^*(p^2) > \bar{\Pi}(p) + \varphi \bar{\Pi}'(p)$, and delegation dominates. When $\bar{n} > s > \tilde{n}$, the period 1 contract under delegation is separating and the period 2 contract first best, while under delegation the period 1 contract is pooling and the period 2 contract separating in type. Thus $\hat{\Pi}(p^2) + \varphi \Pi^*(p^2) > \bar{\Pi}(p) + \varphi \bar{\Pi}'(p)$ and again delegation is preferred.

Intuitively, when the only information asymmetry between the owner and manager regards the 'type' of the recruit, the manager obtains information rents in either period only if he actually selects a good candidate, as is usual in adverse selection models. If he selects a bad candidate his rents in both periods are zero. Thus, with a single source of information asymmetry there is no ‘moral hazard in recruitment’. However, if the expected type of the recruit is lower than that of the senior employee, there may be “moral hazard in production” – lower effort by the senior
employee to conceal the recruit's type and retain his seniority. *The owner always prefers to delegate recruitment*. The absence of moral hazard in the presence of a single source of information asymmetry contrasts with earlier studies and is the product of our complete contracting framework.

3. **Additional Asymmetry in Information**

3.1 Model

This section considers the situation where the senior employee in charge of recruitment is involved in other important activities like production, marketing or finance. This gives him access to an additional level of private information regarding the true realization of a periodwise uncorrelated random parameter $z_t$ (independent of the ability of the recruit $n$) in each period. The production function in period $t$ is:

$$ Y_t = m_t(e_t + l_t + z_t), $$

where $z_t$ is the realization of the random parameter in period $t$. We assume that in any period $t$, $z_t$ may take a value $L$ (low) with probability $q$ or $H$ (high) with the complementary probability $1-q$.

The modified time structure of the game is shown in Figure 2:

**Figure 2: Time Structure with additional asymmetry**

As before, the senior employee may retain his seniority either by deliberately choosing a 'bad' candidate or by concealing the candidate's type. However, the senior employee now has
private information regarding both \( n \) and \( z \).\(^8\) These two dimensions of information asymmetry are different. Whereas \( n \), the candidate type, once chosen, remains unaltered across periods, \( z_t \) is a periodwise independent random parameter known only at the beginning of period \( t \). Thus, while the senior employee has incentives to conceal \( z_t \) just to earn (period specific) information rents, he has an additional incentive to conceal \( n \) to retain his own seniority. This implies that it may be too costly for the owner to offer adequate information rents to persuade him to reveal \( n \), i.e., to offer a contract separating in \( n \). So we need to look at the expected profits of the owner not only under the second best fully separating (in \( n \) and \( z \)) contract but also the contract that is pooling in \( n \) but separating in \( z \).

Thus let \( \hat{\Pi}(\beta) \) and \( \overline{\Pi}(\beta) \) be the one period expected (post recruitment) profits of the owner under the fully separating and the pooling-cum-separating contracts respectively - which as before are dependent on \( \beta \), the probability that the candidate has a 'bad' type. Then, as shown in the appendix,

\[ \text{Lemma 3: (i) } \hat{\Pi}(\beta) > \overline{\Pi}(\beta) \]  
\[ \text{(ii) } \frac{d\hat{\Pi}}{d\beta} < 0, \frac{d\overline{\Pi}}{d\beta} = 0 \]  

This is similar to Lemma 1. The probability that the candidate is 'bad' does not affect the expected profit of the owner if the contract is pooling in type (pooling-separating contract) but affects it (adversely) if it is separating in type (fully separating contract). Part (ii) implies that the owner's profit is higher in the latter case.

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\(^8\) Generally, multidimensional contract menus are quite complex (Armstrong and Rochet, 1999). They are, however, relatively simple in our case because the relevant parameters, \( n \) and \( z \), are completely independent of each other.
3.2 Dynamic Contracts: Moral Hazard in Recruitment

In this setting, the senior employee can earn information rents from his private information regarding \( z \) in addition to the information rents on type. By deliberately choosing a bad candidate, he loses his current information rents on \( n \). However, he may retain his supervisory position that entitles him to positive information rents on \( z \) in period 2. This introduces the possibility of “moral hazard in recruitment”, i.e., of the senior employee deliberately choosing a ‘bad’ candidate. Specifically:

**Proposition 2**: With asymmetric information on both type \( n \) and the random parameter \( z \),

1. The owner offers a **pooling - separating contract in period 1** under direct recruitment if \( s > \bar{n} = pn_b + (1 - p)n_G \) and under delegation if \( s > \bar{n} = p^2n_b + (1 - p^2)n_G \). The senior employee chooses the best available candidate and retains his position. If \( s > \bar{n} > \tilde{n} \), then **delegation is preferred**, where \( \tilde{n} \) is

2. If \( s < \bar{n} \) under direct recruitment or if \( s < \bar{n} = p(2 - p)n_b + (1 - p)^2n_G \) under delegation she offers a **fully separating contract in period 1** and the more capable employee is put in charge in period 2. The senior employee chooses the best available candidate. If \( s < \underline{n} < \bar{n} \), then **delegation is preferred**.

3. Finally, if \( \bar{n} > s > \underline{n} \) there may exist **moral hazard** under delegation in the sense that the senior employee may deliberately choose a bad candidate. *Direct recruitment may then be preferred.*

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9 When opportunity costs are positively related to type, this goes through with minor differences if the recruit is paid through the senior employee. However, when payment is direct the bribe to the ‘good’ candidate to conceal her type may be steep as she must be compensated for the lost information rents from promotion. But this means that the senior employee’s first period information rents from type are lower and hence there is a stronger possibility of ‘moral hazard in recruitment’.
**Proof:** If the senior employee can retain his position by concealing the recruit’s type the optimal period 1 contract is 'pooling-separating'. Under direct recruitment this happens if the senior employee’s type is higher than the recruit’s expected type, \( s \geq \bar{n} \). Under delegation, since there is no moral hazard in recruitment in this case, the same happens if the type of the senior employee is higher than the expected type of the recruit *when the senior employee chooses the best available candidate*, \( s > \bar{n} \). The period 2 contract is fully separating. Thus, when \( s > \bar{n} \) there is a 'pooling-separating' contract in period 1 and a fully separating contract in period 2 under both direct and delegated recruitment.

The aggregate profit of the owner is \( \Omega = \hat{\Pi}(\beta) + \varphi \bar{\Pi}(\beta) \) for \( s > \bar{n} \), where \( \beta = p \) under direct recruitment and \( \beta = p^2 \) under delegation. Delegation is preferred because a 'good' recruit is selected with a higher probability and this positively affects the second period profit of the owner.

By Lemma 3, \( \frac{d\Omega}{d\beta} = \frac{d\hat{\Pi}}{d\beta} + \varphi \frac{d\bar{\Pi}}{d\beta} < 0 \).

If the senior employee is replaced following a pooling contract in period 1 he has no incentives to conceal the type other than obtaining period 1 information rents. The optimal period 1 contract is then fully separating. Under direct recruitment this happens if the senior employee’s type is less than the expected type of the recruit, \( s < \bar{n} \), or under delegation if the senior employee’s type is less than the expected type of the recruit *even if the senior employee chooses the worst available candidate*, \( s < \bar{n} \). There is no moral hazard in recruitment and the period 2 contract is first best. Thus when \( s < \bar{n} \) the period 1 contract is fully separating and the period 2 contract is first best under both direct recruitment and delegation. Then delegation continues to be preferred as the type of the candidate is more likely to be good compared to direct recruitment.
\[
\frac{d\tilde{\Omega}}{d\beta} = d\Pi + \phi \left[ \beta \frac{d\Pi(s,n_B)}{d\beta} + \frac{d\Pi(n_G,s)}{d\beta} + \Pi(s,n_B) - \Pi(n_G,s) \right] < 0 ,
\]

where \( \tilde{\Omega} \) as aggregate profits of the owner for \( s < \underline{n} \) and \( \Pi(s,n_B) \) and \( \Pi(n_G,s) \) are the period 2 profits of the owner with the senior employee and the new recruit in the supervisory position respectively.

If \( \bar{n} > s > \underline{n} \) the optimal contract under direct recruitment is pooling-separating in period 1 and fully separating in period 2 with the senior employee retaining his position if \( \bar{n} > s > \bar{n} \). If \( \bar{n} > s > \underline{n} \) the optimal contract in period 1 is fully separating and the superior employee obtains seniority in period 2. The period 2 contract is first best. The recruit is bad with probability \( p \) in either case.

Under delegation, there are two cases. In the first, the senior employee chooses the best candidate available (no moral hazard in recruitment) and is replaced in a pooling-separating equilibrium in period 1. Hence the optimal period 1 contract is fully separating while the period 2 contract is first best. Since the probability that the candidate is bad is \( p^2 < p \), delegation is preferred to direct recruitment whether \( s > \bar{n} \) or \( s < \bar{n} \).

However, if
\[
qR_{1GL} + (1-q)R_{1GH} < (1-q)R_{1BH} + \phi R_{2BH} ,
\]
(where \( R_{ij} = w_{ij} - (e_i(n_i,z_{zj}))^2 \) is the manager’s information rent in period \( t=1,2 \)), there appears moral hazard in recruitment. The senior employee’s (expected) two period rents on \( z \) by choosing the worst candidate available and retaining seniority in a period 1 pooling separating contract cannot be compensated by the owner through period 1 rents on " \( n \)" and " \( z \)" in a fully separating
contract. The optimal period 1 contract is then pooling separating and the period 2 contract fully separating with the probability of the bad type being \( p(2 - p) > p \). Check that under moral hazard, direct recruitment is preferred by the owner whether \( s > \tilde{n} \) (since the probability of the bad type is lower) or \( s < \tilde{n} \) (additionally period 1 and period 2 contracts are superior).

Thus, if in addition to his private information regarding candidate type, \( n \), the manager privately observes some periodwise independent random parameter, \( z \), at the time the period 2 contract is offered, then there may be period 2 ‘information rents' even if the new recruit is bad. The manager then trades off higher first period information rents on both \( n \) and \( z \) by choosing a good candidate against two period rents on account of the \( z \) by intentionally choosing a bad candidate to retain his seniority. *This leads to moral hazard in recruitment and the owner may prefer to recruit directly.* Moral hazard in recruitment exists if, relative to the expected type of the candidate, the type of the senior employee is neither too high (since he retains his seniority even if he chooses the best candidate) nor too low (as he loses his seniority even if he chooses the worst).

### 4. Tenure - Long Term Contracts

In this section we investigate the consequences of tenure. In our context, this means assuring the managerial position to the senior employee in period 2 even if the new recruit is more capable. We examine whether (1) the principal always prefers ‘tenured' contracts to untenured contracts, and (2) specifically, whether delegating recruitment accompanied by tenure can do better than direct recruitment under moral hazard. Our analysis has limited applicability for small firms

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10 This happens when \( \phi \) is high enough (see Laffont and Tirole, 1987)
unable to credibly commit to tenure because of (a) their low survival rates and (b) difficulty of retaining incompetent persons in the few available managerial positions (footnote 3).

In contrast to the existing literature, we analyze the problem in a complete contracting framework. This helps us to explicitly derive the second period information rents that make tenure desirable instead of assuming them as usually done in the incomplete contracts literature. Consequently, we obtain the precise role played by tenure as well as the conditions under which it is desirable. Specifically, (a) when the only asymmetric information is regarding the type of the recruit and there is no moral hazard in recruitment, offering tenure prevents the senior employee from concealing the type of the new recruit thereby avoiding a pooling equilibrium in period 1. Hence it is offered under delegation only if the senior employee has a higher type than the expected type of the newly recruited worker, since only under this condition is a pooling equilibrium possible. Second, (b) if there is additional asymmetry in information and there exists moral hazard in recruitment, tenure is also offered to mitigate such moral hazard.

**Proposition 3** When the only asymmetric information is regarding the type of the candidate and the owner can commit to tenure for the senior employee:

1. The tenured (long term) contract is a two period replica of the one period separating contract.
2. if $s > \bar{n}$ the owner prefers to delegates recruitment along with an offers of tenure.
3. if $\bar{n} > s$ the owner prefers delegation without the accompanying tenure offer.

**Proof:** In the static optimal separating contract the profit of the owner is decreasing in the probability of the bad type, i.e. $\frac{d\Pi}{d\beta} < 0$. Since the type of the recruit is perfectly correlated across

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11 `Tenure' as modeled here is not a fully long term contract because the period 2 payment is not conditional on the type of the recruit. A justification may be that the 'type' or 'ability' of the recruit - while observable to the senior employee and eventually to the owner from her observation of period 1 output - may not be verifiable by third parties.
periods, the optimal multi-period contract is simply a two period replica of the one period contract [Baron and Besanko(1984)], so that \( \frac{d((1+\psi)\hat{\Pi}(\beta))}{d\beta} < 0 \). Finally since the probability of the bad type is higher under direct than delegated recruitment \( 1 > p > p^2 \), delegation is preferable to direct recruitment even with tenure. Recall (Proposition 1) that delegation is preferable under the short-term contract. Thus without moral hazard the expected type of the recruit is \( \bar{n} \).

When \( s > \bar{n} \) the untenured contract yields the owner \( \bar{\Pi}(p^2) + \psi \hat{\Pi}(p^2) \) as the senior employee always chooses the good candidate and the first period equilibrium is pooling. This is lower than \( (1+\psi)\hat{\Pi}(p^2) \), which the owner gets under delegation with tenure. When \( \bar{n} > s \), the first period equilibrium for the untenured contract is separating and yields \( \hat{\Pi}(p^2) + \psi \Pi^*(p^2) \) which is always greater than \( (1+\psi)\hat{\Pi}(p^2) \) so that the owner never offers tenure.

With information asymmetry regarding only candidate type there is no moral hazard in recruitment so that tenure is not required to mitigate it. Delegation is also superior to direct recruitment. However, tenure may still be offered to induce the senior employee to reveal the type of the recruit in period 1, i.e., to mitigate “moral hazard in production”. Our complete contracting framework brings out this additional role of tenure. By contrast, with asymmetric information on both \( n \) and \( z \), tenure may be additionally required to mitigate “moral hazard in recruitment”.

**Proposition 4:** If there is asymmetric information regarding both candidate type and the periodwise independent random parameter and the owner can commit to tenure for the senior employee:

(i) Period 1 part of the tenured contract is the one period fully separating (in \( n \) and \( z \)) contract while the Period 2 component is conditional on the realized value of \( z \) and separating in type.
(ii) if \( s > \bar{n} \) the owner delegates recruitment with an offer of tenure to the senior employee.

(iii) if \( s < \underline{n} \) recruitment will generally be delegated without the tenure offer.

(iv) if \( \bar{n} > s > \underline{n} \) the owner prefers to delegate recruitment with or without tenure depending mainly on whether \( q R_{\text{val}} + (1 - q) R_{\text{val}} < \text{or} > (1 - q) R_{\text{val}} + \varphi R_{\text{zBH}} \), i.e., on whether there is moral hazard in recruitment.

**Proof:** The tenured contract is a two period offer where the senior employee retains his position in period 2. The period 1 component is fully separating in type and \( z \). The period 2 part is separating in 'type' which is perfectly correlated across periods but first best with respect to \( z \) as it is periodwise independent (Baron and Besanko, 1984). The senior employee gets no period 2 information rents on \( z \) as he doesn’t know it at the time of contracting.

If \( s > \bar{n} \), the best candidate is selected and even without tenure the senior employee retains his position under delegation. The period 1 contract is pooling-separating (Proposition 2), where the effort of the senior employee with the good candidate is suboptimal (in contrast to the fully separating contract with tenure). In period 2, the senior employee gets period 2 information rents on \( z \) (as he knows the realization of \( z \) at the time the period 2 contract is offered) in addition to 'type' (not revealed in the period 1 pooling-separating contract). Hence the owner prefers tenure.

When \( s < \underline{n} \) again the best available candidate is selected (as there is no moral hazard in recruitment) under delegation. The senior employee retains his position under tenure while without tenure the best available candidate obtains seniority in period 2. The period 1 contract is fully separating with tenure (as in \( s > \bar{n} \)) or without it (Proposition 2). As before, the period 2 contract with tenure concedes information rents on type (but not \( z \)). Without tenure there are information rents with respect to \( z \) – since it is periodwise independent - but not type – because this is revealed by the period 1 separating contract. The owner prefers an untenured contract because it yields a
higher expected output in period 2 with the more competent employee as manager\textsuperscript{12}. Under both $s > \bar{n}$ and $s < \underline{n}$ delegation is preferred to direct recruitment with or without tenure as there is no moral hazard and the probability that the recruit is bad is lower with delegation.

Finally, consider $\bar{n} > s > \underline{n}$. The contract with tenure is the same as before. Without tenure, we have two possible cases. First, if $qR_{1GL} + (1 - q)R_{1GH} > (1 - q)R_{1BH} + \varphi R_{2BH}$ there is no moral hazard in recruitment. Since even without tenure the best available candidate, $\bar{n}$ - is selected, the senior employee loses his position under a period 1 pooling separating contract and the case is similar to $s < \underline{n}$. The owner then generally avoids tenure.

Second, when, $qR_{1GL} + (1 - q)R_{1GH} < (1 - q)R_{1BH} + \varphi R_{2BH}$ without tenure there is moral hazard in recruitment. The worst available candidate is selected and equilibrium is pooling-separating in period 1 with the senior employee retaining his position. The period 2 contract is fully separating with information rents both on ‘type’ and $z$. With tenure, the best available candidate is selected so that the expected period 1 output is higher. Further, the senior employee retains his position under both arrangements so that expected period 2 output under tenure – where the expected type of the recruit is better - is higher. Finally, while the untenured contract concedes information rents for $z$, these are eliminated in the tenured contract. Thus, the owner favors the tenured contract, which as before, also dominates direct recruitment.

Thus when moral hazard in recruitment is present, and the owner with only the short term contract option would choose to recruit directly, the ability to offer tenure is able to mitigate this problem so that she can again delegate recruitment to the senior employee.

\textsuperscript{12} Unless, of course, the information rents from $z$ in the untenured contract are so high that they outweigh the advantage of higher output as well no rents on ‘type’ compared to tenure.
Conclusion

The study views an owner’s decision whether or not to delegate recruitment to an agent (a senior employee) as a tradeoff between the superior information of the agent and the moral hazard due to the future threat from a more capable recruit. This approach relates to but is distinct from previous work that conceives the choice as one between more freedom and superior control. We set up the problem as one of asymmetric information in a complete contracting framework unlike earlier studies on moral hazard in recruitment, which adopt the incomplete contract approach.

Our analysis leads to the significant conclusion that (a) when the only asymmetry in information between the principal and the agent regards the type of the candidates, the agent has no “moral hazard in recruitment”, i.e., incentive to intentionally select a bad candidate, and the owner always prefers to delegate. (b) However, if there is additional information asymmetry, moral hazard in recruitment appears and the owner may prefer not to delegate recruitment to the agent.

We also examine whether it is optimal to offer tenure to the senior employee to alleviate moral hazard. We find that tenure may sometimes be desirable even without moral hazard in recruitment, though with such moral hazard the preference for it becomes stronger.

Considering a larger number of recruits (per vacancy) tilts the results in favor of delegation since the probability that least one is good increases. Extending the work to include continuous ‘type’ or $z$ is also possible, though this takes us deeper into ‘multidimensional screening’.

An useful extension to this work would be to examine the role of outside hiring agencies that may assess candidates reasonably well, but are unlikely to understand the precise matching of the candidate and the job as well as the line manager. And while they would be likely to be free from the kind of moral hazard problem described above, their services can only be purchased at a price.
Appendix

**Proof of Lemma 1:** The solution to the problem of maximizing (9) subject to (7) and (8)\(^\dagger\) is:

\[
\hat{e}(n_G) = \frac{s}{2}, \quad \hat{e}(n_B) = \frac{s}{2} - \frac{1 - \beta}{\beta} \Delta n, \quad \hat{w}_G = \frac{s^2}{4} + 2 \left( \frac{s}{2} - \frac{1 - \beta}{\beta} \Delta n \right) \Delta n - (\Delta n)^2, \quad \hat{w}_B = \left( \frac{s}{2} - \frac{1 - \beta}{\beta} \Delta n \right)^2,
\]

\[
\hat{U}_G = 2 \left( \frac{s}{2} - \frac{1 - \beta}{\beta} \Delta n \right) \Delta n - (\Delta n)^2, \quad \hat{U}_B = 0, \quad \hat{\Pi}(\beta) = \frac{s^2}{4} + sn_s + \frac{1 - \beta}{\beta} (\Delta n)^2.
\]

Next, check that the solution to the problem of maximization of (12) subject to (7) and (8) is

\[
\bar{e}(n_B) = \frac{s}{2}, \quad \bar{e}(n_G) = \frac{s}{2} - \Delta n, \quad \overline{w} = \frac{s^2}{4}, \quad U_G = \Delta n(s - \Delta n), \quad U_B = 0, \quad \overline{\Pi}(\beta) = \frac{s^2}{4} + sn_B.
\]

Clearly, therefore, \(\frac{d\hat{\Pi}}{d\beta} < 0, \frac{d\overline{\Pi}}{d\beta} = 0,\) and \(\hat{\Pi}(\beta) > \overline{\Pi}(\beta).\)

**Proof of Lemma 3:**

Assume that only the senior employee can observe both the \(n\) and \(z\) in period 1. As already indicated, \(z\) is observed by the senior employee before recruitment is made.

**Optimal Static Fully Separating Contract**

Assume that the owner offers a fully separating contract\([\hat{w}_{BL}, \hat{Y}_{BL}, \hat{w}_{BH}, \hat{Y}_{BH}, \hat{w}_{GL}, \hat{Y}_{GL}, \hat{w}_{GH}, \hat{Y}_{GH}]\) in a static(one-period) post-recruitment game. If \(\hat{e}(n_i, z_j)\) is the effort required by a senior employee who truthfully reports the candidate `type', i.e.,

\[
\hat{e}(n_i, z_j) : s(\hat{e}(n_i, z_j) + n_i + z_j = \hat{Y}_{ij}, \quad i = G, B, \quad j = L, H
\]

\(^\dagger\) \(\hat{\Pi}\) is quasi-concave, so a solution to this problem exists. An interior solution exists if \(\beta\) is not very low since \(\Delta n\) is small relative to \(s\). Intuitively, if the probability of bad type, \(\beta\), is very low, it is profitable to offer a contract that gives the good type just the opportunity cost in exchange for efficient effort. The expected loss from rejection of this contract by the bad type is low compared to the gain from good types who are not given any information rent.
and \( \hat{e}(n_k, z_j, n_i, z_j) \) as the effort required by the senior employee with a recruit \( n_i \), who has observed a realization of the random parameter \( z_j \) to produce the output \( Y_{kl} \) intended for the case where the candidate is of type \( n_k \) and the realization of the random parameter \( z_i \), i.e.,

\[
\hat{e}(n_k, z_j, n_i, z_j) : s(\hat{e}(n_k, z_i, n_i, z_j) + n_i + z_j) = s(\hat{e}(n_k, z_i) + n_k) + z_{ij} = \hat{Y}_{kl},
\]

which implies that

\[
\hat{e}(n_k, z_i, n_i, z_j) = \hat{e}(n_k, z_i) - (n_i - n_k) - (z_j - z_i).
\]

The optimal menu \([\{\hat{w}_{ij}, \hat{e}(n_i, z_j)\}, i = B, G; j = L, H] \) underlying such a separating mechanism must satisfy the `downward incentive compatibility conditions:

\[
\hat{w}_{BL} - (\hat{e}(n_G, z_{L}))^2 \geq \hat{w}_{BL} - (\hat{e}(n_B, z_{L}, n_G, z_L))^2 = \hat{w}_{BL} - (\hat{e}(n_B, z_L))^2 + 2\hat{e}(n_B, z_L)(\Delta n - (\Delta n)^2),
\]

\[
\hat{w}_{BH} - (\hat{e}(n_B, z_{H}))^2 \geq \hat{w}_{BL} - (\hat{e}(n_B, z_{L}, n_B, z_H))^2 = \hat{w}_{BL} - (\hat{e}(n_B, z_L))^2 + 2\hat{e}(n_B, z_L)(\Delta z - (\Delta z)^2),
\]

\[
\hat{w}_{GH} - (\hat{e}(n_G, z_{H}))^2 \geq \max \left[ \hat{w}_{BL} - (\hat{e}(n_B, z_{L}, n_G, z_H))^2, \hat{w}_{GL} - (\hat{e}(n_G, z_{L}, n_G, z_H))^2, \hat{w}_{BH} - (\hat{e}(n_B, z_{H}, n_B, z_H))^2 \right]
\]

along with the usual individual rationality contract (for `bad-low' type)

\[
\hat{w}_{BL} - (\hat{e}(n_B, z_L))^2 \geq 0.
\]

The problem of the owner in devising an optimal (static) fully separating contract is to maximize

\[
\hat{\Pi}(\beta) = \beta[\hat{q}(s(\hat{e}(n_B, z_L) + n_B + z_L) - \hat{w}_{BL}) + (1 - \hat{q})(s(\hat{e}(n_G, z_H) + n_B + z_H) - \hat{w}_{BH})] \\
(1 - \beta)[\hat{q}(s(\hat{e}(n_G, z_L) + n_G + z_L) - \hat{w}_{GL}) + (1 - \hat{q})(s(\hat{e}(n_G, z_H) + n_G + z_H) - \hat{w}_{GH})]
\]

where \( \beta \) is the probability that the candidate is bad, subject to the preceding constraints. The incentive constraints above are the downward incentive constraints on the `good-low' and `bad-high' types as well as the downward incentive constraint on the `good-high' type which must ensure that it does not mimic either of `bad-low', `good-low' and `bad-high'. Regarding the last three it is easy to check that if either of the last two is satisfied then so is the first. Consequently,
the first expression in constraint [3] drops out (is not binding). Given the information rents obtainable by the 'good-low' and the 'bad-high' types, the rent obtained by the 'good-high' type is given by

$$\hat{w}_{GH} - (\hat{e}(n_g, z_H))^2 \geq \text{Max}\{\hat{w}_{GL} - (e'(n_g, z_L, n_g, z_H))^2, \hat{w}_{BH} - (e'(n_b, z_H, n_g, z_H))^2\}$$

$$= \text{Max}\{2\hat{e}(n_b, z_L)\Delta n + 2\hat{e}(n_g, z_L)\Delta z, 2\hat{e}(n_b, z_L)\Delta z + 2\hat{e}(n_b, z_{LH})\Delta n\} - (\Delta n)^2 - (\Delta z)^2.$$

If the first term under parentheses is larger (i.e. the information rents of the 'good-high' type required to meet its incentive constraints with the 'good-low' type are higher than the one required to meet its incentive constraints with respect to the 'bad-high' type), then the third incentive constraint takes the form

$$\hat{w}_{GH} - (\hat{e}(n_g, z_H))^2 \geq 2\hat{e}(n_b, z_L)\Delta n + 2\hat{e}(n_g, z_L)\Delta z - (\Delta n)^2 - (\Delta z)^2.$$

Solving for the optimal effort levels we obtain

$$\hat{e}(n_g, z_H) = \frac{s}{2}, \quad \hat{e}(n_b, z_H) = \frac{s}{2}, \quad \hat{e}(n_g, z_L) = s - \frac{1 - q}{q} \Delta z, \quad \hat{e}(n_b, z_L) = \frac{s}{2} - \frac{1 - q}{q} \Delta z - \frac{(1 - \beta)}{\beta q} \Delta n.$$

Similarly, if the information rents of the 'good-high' type required to meet its incentive constraints with the 'bad-high' type are higher we get

$$\hat{e}(n_g, z_H) = \frac{s}{2}, \quad \hat{e}(n_b, z_H) = \frac{s}{2} - \frac{1 - \beta}{\beta} \Delta n, \quad \hat{e}(n_g, z_L) = \frac{s}{2}, \quad \hat{e}(n_b, z_L) = \frac{s}{2} - \frac{1 - \beta}{\beta} \Delta n - \frac{(1 - q)}{\beta q} \Delta z.$$

Substituting these values into the objective function, the profit of the owner can be reduced to

$$\hat{\Pi} = \frac{s^2}{4} + sn_b + sz_L + \frac{1 - q}{q} (\Delta z) + K(\beta) > 0 \quad \text{and} \quad \frac{dK}{d\beta} < 0.$$
Consider now the optimal static contract \([\bar{w}_L, \bar{Y}_L, \bar{w}_H, \bar{Y}_H]\) that is pooling in types but separating in the periodwise uncorrelated random parameter \(z\). Define the effort of the senior employee with a candidate of type \(n_B\) and a low realization of \(z\) under such a contract as \(\bar{e}(n_B, z_L)\), where

\[
\bar{e}(n_B, z_L) : s(\bar{e}(n_B, z_L) + n_B + z_L) = \bar{Y}_L.
\]

Then it must be true that \(\bar{w} - (\bar{e}(n_B, z_L))^2 \geq 0\).

Further, to produce the same amount of output the senior employee with the same low realization but a better candidate \(n_G\) with obviously puts in lower effort, \(\bar{e}(n_G, z_L) = \bar{e}(n_B, z_L) - \Delta n\), and produces the same output \(\bar{Y}_L\) for the same payment \(\bar{w}_L\). The contract is however separating in the additional parameter \(z\) so that it involves higher output and payments for the senior employee with the bad candidate who has observed \(z_H\). As usual this is given by

\[
\bar{w}_H - (\bar{e}(n_B, z_H))^2 \geq \bar{w}_H - (\bar{e}(n_B, z_L))^2 + 2(\bar{e}(n_B, z_L))\Delta z - (\Delta z)^2 = 2(\bar{e}(n_B, z_L))\Delta z - (\Delta z)^2.
\]

The senior employee with a good recruit but the same \(z_H\) is paid the same \(\bar{w}_H\) but applies lower effort \(\bar{e}(n_G, z_H) = \bar{e}(n_B, z_H) - \Delta n\). The problem of the owner then is to maximize profits:

\[
\bar{\Pi}(\beta) = \beta[q\{s(\bar{e}(n_B, z_L) + n_B + z_L) - \bar{w}_L\} + (1 - q)\{s(\bar{e}(n_B, z_H) + n_B + z_H) - \bar{w}_H\}] - (1 - \beta)[q\{s(\bar{e}(n_B, z_L) - \Delta n + n_G + z_L) - \bar{w}_L\} + (1 - q)\{s(\bar{e}(n_B, z_H) - \Delta n + n_G + z_H) - \bar{w}_H\}]
\]

\[
= q\{s(\bar{e}(n_B, z_L) + n_B + z_L) - \bar{w}_L\} + (1 - q)\{s(\bar{e}(n_B, z_H) + n_B + z_H) - \bar{w}_H\},
\]

when the probability of the bad type is \(\beta\) subject to the three preceding conditions. It is easy to check that the solution to this problem is given by

\[
\bar{e}(n_B, z_L) = \frac{s}{2} - \frac{1 - q}{q} \Delta z, \quad \bar{e}(n_G, z_L) = \frac{s}{2} - \frac{1 - q}{q} \Delta z - \Delta n, \quad \bar{e}(n_B, z_H) = \frac{s}{2}, \quad \bar{e}(n_G, z_H) = \frac{s}{2} - \Delta n,
\]

\[
\bar{w}_L = \left(\frac{s}{2} - \frac{1 - q}{q} \Delta z\right)^2, \quad \bar{w}_H = \frac{s^2}{4} + 2\left(\frac{s}{2} - \frac{1 - q}{q} \Delta z\right)\Delta z - (\Delta z)^2, \quad \bar{\Pi}(\beta) = \frac{s^2}{4} + sn_B + sz_L + \frac{1 - q}{q} (\Delta z)^2.
\]

From these it may be checked that \(\frac{d\bar{\Pi}}{d\beta} < 0\), \(\frac{d^2\bar{\Pi}}{d\beta^2} = 0\) and \(\hat{\beta}(\beta) > \bar{\Pi}(\beta)\).
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