Abuse of Authority and Hierarchical Communication

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If managers and their subordinates have the same basic qualifications, organizations can benefit from replacing unproductive superiors with more productive subordinates. This threat may induce superiors to deliberately recruit unproductive subordinates, or abuse their personnel authority in other ways, to protect themselves. We show that requiring intrafirm communication to pass through a “chain of command” can be an effective way to provide superiors with an incentive to recruit the best possible subordinates. We discuss alternative ways to prevent the abuse of authority and general implications of our analysis for organizational design. We also present supporting evidence from the literature on human resource management and organizational behavior.

Doggert’s Top Secret Management Handbook (Adams, 1996, Ch. 1, p.15)

1. Introduction

In many organizations, not only monitoring and control but also the flow of information are hierarchically structured. Employees are often discouraged from communicating with any higher-level managers other than their immediate superiors; that is, they are required to follow a “chain of command.” Hierarchical communication is often interpreted as an optimal response to costly information processing.1

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1 The importance of a chain of command for the coordination of activities was first emphasized by Fayol (1949). Modern theories that derive communication structures from costs of communicating and processing information include Radner (1993) and Bolton and Dewatripont (1994). See also Melumad, Mookherjee, and Reichelstein (1995), who argue...
In this article we argue that hierarchical communication can also help to prevent conflicts between superiors and their subordinates over hiring and promotion decisions.

Positions at higher levels in organizations are typically accompanied by higher wages and additional benefits. Since organizations seek to fill positions with the most qualified employees, a subordinate may try to convince top management that she is better suited for her supervisor’s position than the incumbent. Accordingly, managers sometimes see their subordinates as threatening.

Managers can usually counter this threat in various ways. They can, for instance, deliberately recruit weaker subordinates (we refer to this as “strategic recruiting”) or refrain from developing employees under their purview. These responses directly decrease the productivity of the workforce and jeopardize the function of internal labor markets as a screening device for talent. The costs to the firm can be substantial. If it is infeasible to perfectly monitor supervisors, a firm must find other ways to prevent the abuse of authority.

The key idea of how prohibiting “skip-level” communication, i.e., communication between subordinates and top management, can mitigate this problem is simple. A manager can be replaced by his own subordinate only if top management believes that the subordinate is better qualified than he is. To reach this decision, top management must have sufficiently reliable information about the subordinate’s qualifications. If communication between the subordinate and top management is disrupted, this information is less likely to be available. Although valuable information may be lost, subordinates will also be less threatening to their manager, reducing the manager’s incentive to deliberately hire or develop unproductive employees.

The above argument is incomplete, however, because hiring unproductive subordinates reduces the performance of the manager’s unit, which in turn reflects badly on the manager’s ability. A manager who systematically hires unqualified people is unlikely to stay in his job for long. Since pressure to maximize the performance of his unit reduces a manager’s incentive to abuse his authority, one could expect that the organization has no or less reason to restrict communication between his subordinates and top management. Our analysis shows that restricting communication can be optimal even when unit performance can be observed.

In the model there is a three-tier hierarchy consisting of a principal, a manager, and a worker (Section 3). We assume that the principal appoints the manager and delegates to him the recruiting, training, and development of the worker. The manager thus has the power to influence the productivity of the worker.

In large firms, explicit pay for performance is common among top executives but rare among the middle or lower ranks. Talented employees are typically rewarded by promotion to a higher-level job (see Baker, Jensen, and Murphy, 1988). Accordingly, we assume that the principal maximizes the net profit of the firm, while the manager and worker receive fixed wages. The principal initially does not know the abilities of the manager or the worker but obtains information about them in the course of production, which may lead to job reassignments.

The principal obtains information in two ways. First, she can observe the outcome of a project jointly realized by the manager and the worker. This assumption captures the idea that the performance of the manager’s subunit reveals information about both the manager’s and the worker’s productivity. Second, we assume that a worker who is more productive than her manager may try to convince the principal of this fact, hoping to be promoted. The ability to convey this information to the principal depends on how open the communication channel between the worker and the principal is, or, in other words, to what extent a chain of command is followed.

In Section 4 we determine the equilibrium between the principal and the manager. The principal decides whether to retain or replace the manager for a second period of production, depending on the information she has available. If she learns that the worker is more productive than the manager, she will want to fire the manager and promote the worker. Otherwise, if observed
performance is good, the principal will want to retain the manager; if performance is poor, she will prefer to fire him.

An unproductive manager then faces a conflict when hiring a worker. A productive worker increases the manager’s odds of retaining his job because of good performance, but she may also be able to inform the principal that she is more productive and thus pose a threat to the manager. The more open the communication channel, the larger the threat, and the smaller the manager’s incentive to hire a productive worker. Eventually, the manager may even actively seek an unproductive worker.

We then examine the optimal degree of openness of communication. Allowing communication makes it easier to replace an unproductive manager with a more competent worker. But precisely this possibility may lead a manager to abuse his personnel authority by hiring and developing a less competent worker. We show that depending on the parameters of the model, it can be optimal to prohibit communication entirely. But it can also be optimal to have an intermediate degree of openness or to allow completely open communication.

If, contrary to our basic assumptions, payments that depend on output are feasible, bonus or severance payments can alleviate the abuse of authority. It may still be optimal, however, to restrict communication.

In Section 5 we present the predictions of our theory. Firms are more likely to restrict skip-level communication and thus give managers control over information flows (i) the more difficult it is to monitor managers’ personnel decisions, and hence the more a firm needs to rely on managers in making personnel decisions; (ii) the more wages in an internal labor market are backloaded and shielded from the external labor market; and (iii) the more costly it is for managers to hire good subordinates. These results show that there are important complementarities between a firm’s human resource policies, its production technology, and its rules of communicating.

Our formal analysis leaves two questions open, to which we turn in Section 6. First, how do alternative solutions to prevent the abuse of managerial authority compare to restricting skip-level communication? Allocating personnel decisions to a centralized personnel department, or monitoring managers’ decisions closely, mitigates the problem but in practice is possible to only a limited extent. Restricting communication may save on monitoring costs. Restricting communication may also be more efficient than other ways to eliminate the threat that subordinates pose to their superiors. These include promoting employees by seniority, giving superiors an employment guarantee (as in academia), or promoting employees into other units.

The second question relates to whether and how a firm can choose the degree of openness of communication. Drawing on the literature on organizational behavior, we argue that firms can influence the desired degree of openness of communication to a large extent.

We argue in Section 2 that our incentive-theoretic approach to hierarchical communication is supported by the management and industrial psychology literature. That is, while hierarchical communication may help to reduce the costs of communication and information processing, this literature suggests that in practice, restrictions on skip-level communication have more to do with the concerns of managers who are bypassed than with information overload at higher levels.

2. Hierarchical communication in organizations

The central claim of our article is that there is a link between the potential abuse of managerial authority and the prevalence of hierarchical communication in organizations. This section presents evidence in support of this claim.

While the popular business press tends to advocate unrestricted communication as a way to achieve a maximum flow of ideas and information, most firms in practice maintain hierarchical
communication patterns. That is, communication is typically confined to direct interaction between superiors and subordinates.3

This kind of hierarchical communication to some extent simply reflects the hierarchical structure of command and control, and even absent any organizational rules, one could expect most communication to follow the structure of the hierarchy. What is striking, however, is that many organizations have rules and norms that specifically discourage skip-level communication (see Wilson, 1992; Gildsford, 1994). It is the rationale for such rules that our theory seeks to explain.

A closer look at the management and organizational behavior literature suggests that middle managers are concerned about what their subordinates might say about them to top managers. This in turn causes a problem for the organization because middle managers have substantial power over their subordinates. Management scholars are aware of the strategic concerns of managers when communication between their subordinates and superiors is too open. Lillico (1972, p. 45), for example, writes:

Open-door policies, suggestion schemes, etc., can themselves be interpreted as bypassing methods commonly used by top management, . . . These policies often generate suspicion among the bypassed middle management. How far can a subordinate go in pointing out his boss’s mistakes—the man often in charge of his progress and salary in the organization?

Similarly, Baird (1977, p. 267) writes:

How can upward communication be improved? One common method is to short-circuit the normal chain of communication by skipping intermediate levels and communicating directly to someone several ranks removed. . . . While this method often serves to improve communication accuracy, several dangers are present. . . . The people who are bypassed by a subordinate may be resentful and judge the subordinate disrespectful or impertinent. . . . If this method is to be used, care must be taken to . . . reassure those employees who have been bypassed.4

The quotes indicate that fear of managers’ obstructive behavior rather than concerns for optimal information processing is what leads firms to restrict communication between employees and higher-level superiors.

The experience with “360-degree feedback” and “upward appraisals” provides further evidence in support of our theory. In the late 1980s, many management theorists recommended involving subordinates in the evaluation of managers’ performance. Firms have been reluctant, however, to implement upward appraisals. In a survey of 305 firms (Bettenhausen and Fedor, 1997), only 9% reported using upward appraisals. The dangers associated with them are evident:

A potentially negative aspect of an employee rating a supervisor is the possibility of retaliation. Supervisors who are aware that subordinates have given them negative ratings may punish them by assigning undesirable tasks, withholding salary increases, or generally making the employees’ jobs more difficult. (Brutus, Fleenor, and London, 1998, p. 17).5

Hence, it is today widely believed that upward appraisals should be used only for purposes of feedback and development of the superiors’ skills rather than as a basis for their pay, promotion, or termination (Dalton, 1998). There is a consensus that upward appraisals work best if an organization is characterized by a flat hierarchy, participatory management, and a good corporate climate. If the scope for conflict between managers and their subordinates is large, then upward appraisals, which represent a form of institutionalized violation of the chain-of-command principle, should be avoided—in line with our theory.

3 Perhaps as a consequence, almost all research on the determinants of upward communication focuses on direct supervisor-subordinate communication. Mention of skip-level communication is almost completely absent from this literature; see Wilson (1992). The only work we know of that looks at skip-level communication, that of Randolph and Finch (1977) and Wilson (1992), does not address to what extent the organizations studied encourage or discourage skip-level communication.

4 The same argument is made in the nonacademic management literature; Falconi (1997, p. 15) writes that open-door policies are problematic because “encouraging employees to avoid using the chain of command is demoralizing to supervisors.” Most comments in this vein, however, do not pin down exactly what the resulting problems for the organization (not just the managers) are.

5 A practitioner, Kiechel (1989, p. 202) writes: “Even fans of the practice admit that it’s tricky. Do not try it, for instance, in an authoritarian organization, one being downsized, or any place with minimal communication up and down: it will only feed the general paranoia. Administered incorrectly, the process may leave subordinates open to reprisals from you know whom.”
3. The model

We consider an organization that consists of three individuals in a hierarchical relationship: a principal ("P," female), a manager ("M," male), and a worker ("W," female).

Timing. There are two periods, 1 (stages 1 through 5 of the game) and 2 (stages 6 through 8). In each period, P and M make personnel decisions, which are followed by the production of output, and in period 1 by a stage in which W may communicate with P.

Stage 1: P hires M. With probability \( \alpha_0 \), M is productive ("good"), and with probability \( 1 - \alpha_0 \), he is unproductive ("bad"). The type "good" or "bad" refers to the quality of the match between person and job, and it is unknown to M before he is hired. As soon as M starts his job, he learns his type.

Stage 2: M chooses \( \alpha \in [0, 1] \) (while recruiting or training W), which affects W's productivity. With probability \( \alpha \), W is good, and with probability \( 1 - \alpha \), she is bad. See below for details.

Stage 3: M and W observe each other's type.

Stage 4: M and W jointly produce the first-period output \( y \). It can be observed by P but is not contractible. The production technology and our assumptions about feasible contracts are discussed in more detail below.

Stage 5: W signals productivities to P. (See a more detailed discussion below.) If the team is of the form \( (M = \text{bad}, W = \text{good}) \), W can send a noncontractible signal to P that perfectly reveals the types of M and W without cost and in a credible way. This information reaches P only with a probability \( \phi \in [0, 1] \), which captures the openness of skip-level communication between W and P: \( \phi = 1 \) represents completely open communication; \( \phi = 0 \) corresponds to the strict enforcement of a "chain of command."

Stage 6: P retains or replaces M. Based on her updated beliefs about M and W, P chooses to either retain the current M, fire M and hire a new one from outside, or fire M and promote W. The latter is an option because we assume that W is eligible for the job of M. In particular, W is good as an M if and only if she was good as a W.\(^6\)

Stage 7: M retains or replaces W. We assume that this not a strategic decision: a retained M, who knows W's type, acts in the firm's interest and retains W if she is good and hires a new W if she is bad. Any newly hired W is good with probability \( \alpha_0 \), regardless of whether the M hiring her was retained, recently promoted, or just hired.

Stage 8: The second-period output is realized.

Only P and M are players in a game-theoretic sense. Each chooses one action in the course of the game, M at stage 2, when he hires W, and P at stage 6, when she decides whether to retain M. All other moves in the game are dominant actions.

Recruitment and personnel development. When M chooses the probability \( \alpha \) of having a good W, he incurs the following cost:

\[
C(\alpha) = k_0 \alpha^2 + k_1 (1 - \alpha)^2. \tag{1}
\]

The first term represents the cost of M's productive effort to increase W's expected productivity. This cost is scaled by \( k_0 \) and is convex in M's desired probability of hiring a good W. The second term represents the costs of influence effort that M may want to exert. We assume that P monitors M's personnel decisions to an extent measured by \( k_1 \). The costs of influence effort are convex.

\(^6\) Alternatively, we could assume that a person who is good as a W is also good as an M with some probability \( \beta \leq 1 \). None of our results change under this weaker assumption, except that we need to specify a lower bound to \( \beta \).

in $1 - \alpha$ (the probability of having a bad $W$), because it is easy for $M$ to get $P$’s approval for a candidate with outstanding credentials but difficult to get $P$’s approval of an applicant who looks rather weak.\footnote{Similarly, if $M$ is expected to invest in the training and development of $W$, he may have to explain himself if he fails to meet this expectation.}

\section*{Joint production by $M$ and $W$.} The output $y$ produced by $M$ and $W$ is random and takes the value 0 or 1. We disregard any moral hazard problems related to production; the probability of $y = 1$ depends only on the productivities of $M$ and $W$. Let $q_{gg} = \text{prob}\{y = 1 | M = \text{good and } W = \text{good}\}$, and define $q_{gb}, q_{bg},$ and $q_{bb}$ analogously. Thus, the firm’s technology is completely characterized by the vector $q = (q_{gg}, q_{gb}, q_{bg}, q_{bb})$.

We assume that $q_{gg} \geq q_{gb} \geq q_{bg} \geq q_{bb}$. The first and last inequalities state that the expected output is an increasing function of the productivities of $M$ and $W$. The second inequality states that $M$ is at least as important for production as $W$. We also assume that $q_{gg} - q_{gb} \geq q_{bg} - q_{bb}$, which means that a good manager values having a good rather than a bad worker more highly than does a bad manager. In other words, $M$’s and $W$’s productivities are complementary.

\section*{Communication. Structure of the signal from $W$ to $P$.} In formal terms, $P$ receives a signal $z$ that takes the value “d” (types are disclosed) if $W$ successfully signals to her that $W$ is good and $M$ bad. If either the production team is of another form or $W$’s signal does not get through to $P$, the signal $z$ takes the value “c” (types are concealed). It is always optimal for $W$ to send a signal if she is better than $M$, because she can never lose and moreover may gain by being promoted. This signal structure can be seen as resulting from the following more primitive assumptions:

(i) The signal from $W$ to $P$ is not contractible. That is, the evidence $W$ produces cannot be used in court and therefore cannot be the basis of an explicit contract.

(ii) $W$ can hide her information but not forge it.

(iii) $W$ can signal only rank-order (relative) information about $M$’s and $W$’s productivities, not information about $M$’s or $W$’s absolute productivity. This assumption is familiar from the literature on tournaments (Lazear and Rosen, 1981).

(iv) $W$ sends a signal to $P$ if and only if her expected benefit from doing so is positive.

To keep the model tractable, we assume that only $W$, not $M$, can communicate productivities to $P$ (see our discussion in the next paragraph). To illustrate these assumptions, suppose $M$ and $W$’s joint project involves the purchase of securities. Suppose also that $M$ decides to purchase another type. If it turns out that $W$’s investment would have been more profitable, $W$ can ex post convince $P$ of this by producing memos or other internal documents as evidence. Such evidence conveys information only about the relative, not absolute, abilities of $M$ and $W$. Moreover, $W$’s evidence that her suggested investment was better than $M$’s may convince $P$ when she sees it. It would be too costly, however, for $P$ and $W$ to write an enforceable contract ex ante that describes events leading to $W$’s promotion or some other reward.

Communicating with both agents. Our assumptions raise the question of whether the principal could gain from asking both $W$ and $M$ to provide reports about (the rank order of) their types after stage 3. Since the two agents are symmetrically informed, $P$ could in principle costlessly elicit their types. As Tirole (1999) points out, however, such mechanisms may not be feasible for a variety of reasons. Among those reasons are wealth constraints, which are implicit in our assumption that firing the agent is the harshest punishment that $P$ can inflict on $M$ or $W$.

In addition, the best possible outcome of a mechanism that elicits joint reports, namely costless and truthful revelation of the agents’ information, is already a feasible outcome in our setup. To see this, recall that we have assumed $W$ always reports her private information truthfully, if at all. If $P$ chooses completely open communication, i.e., $\phi = 1$, this means that with certainty,
she receives truthful information from W about the agents’ rank order of productivities. No additional information can be gathered by asking M for a report as well. A key feature of our model, however, is that W’s type is endogenously determined by M’s action. As we show in Section 4, P will typically want to choose \( \phi < 1 \), that is, commit to remaining imperfectly informed, to provide good incentives to M to recruit a productive W. Put differently, in our model the endogeneity of one agent’s type is a reason not to use an elicitation mechanism that is distinct from those discussed by Tirole (1999).

\section*{Payoffs}

Our assumptions about the players’ payoffs are based on Baker, Jensen, and Murphy’s (1988, p. 595) empirical observations that “explicit financial rewards in the form of transitory performance-based bonuses seldom account for an important part of a worker’s compensation,” and that “most of the average increases in an employee’s compensation can be traced to promotions and not to continued service in a particular position . . . Promotions are used as the primary incentive tools in most organizations” (pp. 599–600). An implication of this observation is that reaching a higher level in a hierarchy is associated with a rent or quasi-rent.\(^8\)

Motivated by these stylized facts, we assume that the base wages M and W receive in each period are fixed and exogenous, and are given by \( r_M > r_W > 0 \). Since it is impossible to write contracts that specify payments to M or W contingent on realizations of \( y \) or \( z \), the wages \( r_M \) and \( r_W \) represent the two agents’ total compensation in each period. If M is fired after the first period, he receives a wage of less than \( r_M \) in a different job; that is, he loses a rent. For simplicity, let M’s wage in an alternative job be \( r_W \).\(^9\) Our assumptions imply that M strictly prefers keeping his job to losing it, and W strictly prefers promotion over staying in her job. The manager chooses \( \alpha \) to maximize his discounted second-period payoff, net of his recruiting costs

\[
U(\alpha) = r_M - C(\alpha) + \delta \{ P_{ret}(\alpha) [r_M + (1 - P_{ret}(\alpha)) r_W] \},
\]

(2)

where \( P_{ret}(\alpha) \) is the probability that M is retained, as a function of \( \alpha \) and his own type, and \( \delta \) is the discount factor.

The principal maximizes the firm’s profit, i.e., the expected present value of outputs produced in the two periods, net of the monetary compensation for M and W. In addition, we allow in our model that there are positive effects of open communication unrelated to the detection of bad Ms, captured by the assumption that the firm’s expected profit increases in \( \phi \) at rate \( \omega \geq 0 \).

Formally, P’s beliefs about the composition of the \((M,W)\)-team are characterized by a probability distribution over the four possible teams \((g,g), (g,b), (b,g), \text{ and } (b,b)\). Let the quadruple \( p_1 \) denote P’s beliefs about the team in the first period, and let \( E(p_2) \) be her expected beliefs in period 2. Since \( p_2 \) is the P’s belief at the beginning of period 2, we take the expected value in looking at the \textit{ex ante} expected profit. Normalizing the payoff associated with \( y = 1 \) to one, the firm’s expected profit can be written as

\[
\pi = p_1 \cdot q + \delta E(p_2) \cdot q + (1 + \delta) \omega \phi - (1 + \delta)(r_M + r_W),
\]

(3)

where “\( \cdot \)” denotes the inner product of two vectors. We allow \( \delta \) to exceed one, since the second period might represent a discounted future that may be more important than the first period.

\section*{Parameter constraints}

The derivation of the equilibrium below makes use of the following parameter constraints:

\(^8\) Theories that predict backloaded age-wage profiles include Salop and Salop (1976) and Lazear (1981). To the extent that pay increases are administered through promotions, backloaded wages imply that pay is correlated with rank in a hierarchy. Theories that directly predict wages that increase in rank include Lazear and Rosen (1981) and Qian (1994).

\(^9\) We also rule out that the \((M,W)\)-unit of the firm is sold to M, i.e., that M becomes the residual claimant of this unit.
Assumption 1. \( q_{gg} = 1 \).

Assumption 2. \( q_{gg} - q_{gb} > q_{bg} \).

Assumption 3. \( \alpha_0 \geq \alpha_0^b \) := \([2k_1 + \delta(q_{bg} - q_{bb})(r_M - r_W)]/2(k_0 + k_1)\).

Assumptions 1 and 2 are simple sufficient conditions for the equilibrium to have the properties described in Proposition 1 below. Assumption 3 serves to exclude a situation that does not make sense economically. Recall that \( \alpha_0 \) is the probability with which \( P \) hires a good \( M \). As we will show in Proposition 1, \( \alpha_0^b \) represents the highest possible probability with which a bad \( M \) will hire a good \( W \). Without Assumption 3, the worker hired by \( M \) might be good (and therefore also good as an \( M \)) with a higher probability (from \( P \)'s perspective) than \( M \) himself, in which case \( P \) might like to promote \( W \) and replace \( M \) even without any communication from \( W \) to \( P \). Assumption 3 is necessary though not sufficient to rule out this situation.

4. Equilibrium and optimal openness of communication

First, we derive the equilibrium for the game between \( P \) and \( M \). We then analyze how an organizational planner would optimally choose the level of openness \( \phi \), and finally discuss the robustness of our results when monetary incentives are feasible.

Equilibrium. In its reduced form, the model is a simple sequential game involving \( M \) and \( P \) with incomplete information on the part of \( P \). There are two types of \( M \)s, good ones and bad ones. \( P \) knows the distribution of types (given by \( \alpha_0 \)) but cannot observe the type of \( M \) she hires. \( M \) chooses an unobservable probability that \( W \) is good, depending on his own type. Upon observing the team's output and \( W \)'s message to \( P \), \( P \) chooses to retain \( M \), hire a new one, or promote \( W \).

Proposition 1. Under Assumptions 1–3, there exists a unique Bayesian Nash equilibrium. It has the following properties:

(i) a good \( M \) chooses

\[
\alpha_g = \min \left\{ \frac{2k_1 + \delta(q_{gg} - q_{gb})(r_M - r_W)}{2(k_0 + k_1)}, 1 \right\},
\]

(ii) a bad \( M \) chooses

\[
\alpha_b = \max \left\{ \alpha_0^b - \frac{\delta q_{bg}(r_M - r_W)}{2(k_0 + k_1)}, 0 \right\},
\]

(iii) upon observing \( z = d \), \( P \) promotes \( W \); upon observing \( z = c \) and \( y = 0 \), \( P \) hires a new \( M \); and upon observing \( z = c \) and \( y = 1 \), \( P \) retains \( M \).

Proof. See the Appendix.

Assumptions 1 and 2 are sufficient but not necessary for the equilibrium to have the properties described in Proposition 1. The precise necessary and sufficient conditions for these properties to hold are conditions (A7)–(A10) in the proof. If these conditions do not hold, a unique equilibrium still exists for any combination of parameters. Their properties are different, as we explain below and in the proof.

To understand \( P \)'s best response to \( M \)'s strategy, consider the effects of the signals \( y \) and \( z \) on \( P \)'s updated belief that \( M \) is good. First, upon observing \( y = 1 \), \( P \)'s posterior about \( M \) exceeds her prior, whereas if \( y = 0 \), the opposite is the case. Second, if \( z = d \), \( P \) knows for sure that \( M \) is bad, which implies that \( z = c \) is good news about \( M \). If \( z = d \), \( P \) promotes \( W \) because a good \( M \) is more valuable than a good \( W \). The principal’s inference is more complicated if \( z = c \). The parameter conditions of Proposition 1 ensure that in this case \( P \)'s decision about \( M \) depends on the observed output: if \( y = 1 \), she retains \( M \), whereas if \( y = 0 \), she hires a new one.

More precisely, a low output \((y = 0)\) is negative information about \( M \), but observing \( z = c \)
is favorable news. Assumption 1 ensures that the first effect dominates: if \( q_{gg} = 1 \), then upon observing \( y = 0 \), P knows that M and W cannot both be good, and in this case it is more likely that M is bad than that W is bad. Thus, low output is sufficiently bad news about M to outweigh the positive effect of \( z = c \) on P’s updated belief, inducing P to hire a new M. Assumptions 1–3 also ensure that P would never want to promote W if \( z = c \).

M’s best response is to choose the \( \alpha \) that maximizes his payoff (2), anticipating P’s response to \( y \) and \( z \). Since a good M (for whom always \( z = c \)) is retained if and only if \( y = 1 \), his probability of being retained is \( P_{ret}(\alpha) = \alpha q_{gg} + (1 - \alpha)q_{gb} \). Substituting this expression into (2) leads to the expression for \( \alpha_s \) stated in the proposition. A bad M, in contrast, is fired whenever \( y = 0 \), but also if \( z = d \), which happens with probability \( \phi \) if W is good. Hence, his probability of being retained is \( P_{ret}(\alpha) = \alpha(1 - \phi)q_{bg} + (1 - \alpha)q_{bb} \), which leads to the expression for \( \alpha_b \) in Proposition 1.

Comparing \( \alpha_s \) and \( \alpha_b \), we find that for any \( \phi \), a bad M chooses a lower probability than a good M, for two reasons. First, because of our complementarity assumption, a good W is less valuable to a bad M than to a good one. Second, a bad M faces a risk of being replaced by a good M, for two reasons. First, because of our complementarity assumption, a good W is less threatening to M, which further reduces M’s incentive to rule them out. We have argued that such equilibria are economically unrealistic, for they imply that P would in effect prefer to delegate hiring of the second-period M to the first-period M, instead of hiring M herself.

Other equilibria. If Assumptions 1 or 2 do not hold, the resulting equilibrium is still unique for any set of parameters. We can distinguish two types of equilibria. First, there is an equilibrium in which P always retains M, irrespective of output, as long as \( z = c \). A bad M would then have no incentive to hire a good W, since a good W only threatens M’s position. It follows that when the performance of M’s unit is not sufficiently informative about M’s productivity, the problem of strategic recruiting is most severe. Throughout the article we assume that output is sufficiently informative to influence P’s decision, not because the opposite case is unrealistic, but to make clear that restricting communication may be desirable even if performance is observable.

Second, there are equilibria in which P promotes W upon observing \( y = 0 \) or \( y = 1 \), although \( z = c \) (Assumption 3 is not sufficient to rule them out). We have argued that such equilibria are economically unrealistic, for they imply that P would in effect prefer to delegate hiring of the second-period M to the first-period M, instead of hiring M herself.

\[\square\] Optimal choice of \( \phi \). An increase in the openness of communication has three different effects on the net profit of the firm (or unit): First, there is a direct positive effect because a bad M is detected with higher probability. Second, a bad M faces a greater risk of being revealed by a good W and therefore reduces \( \alpha_b \), which decreases expected output. Third, captured by \( \omega \), there may be positive effects of open communication unrelated to the detection of bad Ms. Taken together, these three effects imply the following proposition.

**Proposition 2.** Under the assumptions of Proposition 1, the firm’s expected equilibrium profit is concave in \( \phi \).

**Proof.** See the Appendix.

To see this, notice that \( \phi \) affects the expected profit both directly (the first and third effects discussed above) and indirectly through \( \alpha_b \):

\[
\frac{d\pi}{d\phi} = \frac{\partial\pi}{\partial\phi} + \frac{\partial\pi}{\partial\alpha_b} \frac{\partial\alpha_b}{\partial\phi}.
\]

\[
10 \text{ Notice that Assumption 3 together with (5) implies that } a_0 \geq a_b, \text{ whereas Assumption 2 is somewhat stronger than the complementarity assumption } q_{gg} - q_{gb} > q_{bb} - q_{gb}, \text{ imposed earlier.}
\]

\( \odot \) RAND 2004.
Since expected profit is linear in $\phi$, and $\alpha_b$ is a linear function of $\phi$, the second-order derivative simplifies to $d^2\pi/d\phi^2 = (\partial^2 \pi/\partial \alpha_b \partial \phi)(\partial \alpha_b/\partial \phi)$. The cross-derivative of $\pi$ with respect to $\phi$ and $\alpha_b$ is positive: other things equal, a larger $\alpha_b$ increases the probability of having a team with a bad M and a good W in the first period, which in turn increases the firm’s marginal value of detecting a bad M, and hence the marginal value of more openness. With $\alpha_b$ decreasing in $\phi$, it then follows that expected profit is concave in $\phi$.

The firm’s profit $\pi(\phi)$ can be increasing, decreasing, or (since $\pi(\phi)$ is concave) hump-shaped in $\phi$. Depending on which case obtains, it can therefore be optimal to have completely open or completely closed communication between W and P, or to have an intermediate degree of openness ($0 < \phi < 1$). The corresponding parameter conditions are difficult to interpret. However, the following proposition identifies conditions for open communication to be optimal.

**Proposition 3.** Suppose the assumptions of Proposition 1 hold. If $k_1 = 0$ and $\omega = 0$ and $\delta < 1$, then $\pi(0) > \pi(1)$; i.e., complete enforcement of a chain of command is more profitable than completely open communication.

**Proof.** See the Appendix.

The implication of Proposition 3 is that full openness can be optimal for the firm only if

(i) P exerts some control over M’s personnel decisions ($k_1 > 0$), or
(ii) future production (and hence detecting a bad M in period 1) is particularly valuable ($\delta > 1$), or
(iii) there is some benefit of openness unrelated to detecting bad Ms ($\omega > 0$).

The intuition for this result is that unless P exerts some direct control over M’s hiring decisions, a bad M will definitely hire a bad W if communication is completely open. In this case, no signalling from W to P will occur, because a bad W cannot credibly tell on M. The same is true with completely closed communication, except that here, M has an incentive to hire a good W. Closed communication is therefore preferred unless there are other advantages of having open communication, or if future production is so important that P wants a bad M to hire a bad W, in order to maximize the chance of getting rid of him after one period of production because of bad performance.

**Monetary incentives.** We have seen above that if P can observe an output signal that is informative of M’s productivity, a bad M’s incentive to abuse his authority is alleviated, although generally not eliminated. It is natural to ask whether an output signal is even more useful if M’s compensation can be conditioned on it. We therefore now assume that the output $y$ is contractible, while continuing to take the base wages $r_M$ and $r_w$ as given. Two types of contingent payments are conceivable: a bonus that is paid whenever performance is good, and a severance payment that is made if performance is good but M is fired nevertheless.  

**Severance payments:** The principal can offer a contract stipulating a severance payment $s$ that is paid only if M is fired and $y = 1$. Such a contract insures a bad M against losing his job because of communication between W and P, and should reduce the risk of abuse of authority. How does the feasibility of severance payments affect the firm’s optimal communication structure compared to our preceding analysis?

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11 If instead of $y$ W’s signal $z$ is assumed to be contractible, P can offer M a severance payment if she receives $z = d$ from W, i.e., if she learns that W is good and M bad and therefore would like to fire M. The situation is therefore qualitatively the same as with contractible $y$, so we omit the details of this case.

12 Two remarks: First, an alternative setup would be to assume that severance payments are conditioned not on output but on the firing of M and the subsequent promotion of W. The results obtained under this rather unrealistic assumption differ only slightly from those presented here. Second, notice that P would never want to pay severance regardless of output, as this would only reward bad performance and reduce the incentives for both a good and a bad M to hire a good W.
Our theory leads to a number of predictions about the openness of communication in firms. The first prediction is implicit in the setup of our model: firms are more likely to restrict skip-level communication when subordinates are eligible for their superior’s position, because that is when subordinates have the greatest incentive (and the necessary credibility) to communicate better incentives for the manager can be superior to a raise because it implicitly includes a severance payment and hence provides some severance that increases M’s incentive without eliminating abusive behavior completely, and where communication is more open.

**Bonus payments.** Suppose P offers M a bonus b for high output in order to increase his incentive to choose a good W. In our two-period model, such a bonus is very similar to a raise of r_M in the second period, since M is also retained only if y = 1. (Such a raise could be seniority-based, i.e., be offered only to a retained M, even under the noncontractibility assumptions of Section 4.) The only difference between b and Δ_r is that if z = d and y = 1, a bad M would receive the bonus but not the raise. This means that a bonus is equivalent to a severance payment combined with a raise of the same discounted magnitude. Formally, we have the following proposition.

**Proposition 4.** Let π(s, b, Δ_r) denote the firm’s expected profit as a function of a severance payment s, a bonus b, and a raise Δ_r for a retained M. Then δ(dπ/db) = dπ/dΔ_r + δ(dπ/ds).

**Proof.** See the Appendix.

Proposition 4 implies that when a severance payment is feasible and raising the manager’s compensation is not desired, a severance payment is a better targeted instrument than a bonus payment. On the other hand, when raising the manager’s compensation is desired, a suitable bonus can be superior to a raise because it implicitly includes a severance payment and hence provides better incentives for the manager’s personnel decisions.

5. Comparative statics and predictions

- Our theory leads to a number of predictions about the openness of communication in firms.
negative information about their superiors to higher-level managers. For example, skip-level communication is more likely to be restricted for line managers, where this condition is often satisfied, than for staff employees who are supervised by line managers. The comparative statics of the model lead to additional empirical predictions:

Proposition 5. Under the assumptions of Proposition 1, the firm’s optimal level of \( \phi \) is:

(i) increasing in \( k_1 \);
(ii) decreasing in \( r_M - r_W \);
(iii) increasing in \( k_0 \) if \( \omega > 0 \), otherwise independent of \( k_0 \);
(iv) decreasing in \( \alpha_0 \) if \( \omega = 0 \), but increasing in \( \alpha_0 \) if \( \omega \) is sufficiently larger than 0; and
(v) increasing in \( \omega \).

Proof. See the Appendix.

(i) More control by P over M’s personnel decisions raises the costs of abusive behavior and leads to higher levels of \( \alpha_b \) for any \( \phi \). A higher \( \phi \) is then optimal. This prediction is supported, for example, by research on change management. Blackburn and Rosen (1993) report that firms that change their communication from traditional top-down patterns to multidirectional patterns also tend to change their recruitment patterns from selection by the respective manager toward peer-based selection. This reduces the scope for strategic recruiting. Similarly, casual observation of management consulting and other industries suggests that firms with open communication structures often also emphasize the involvement of peers in hiring decisions.

In principle, this prediction is testable, as managerial involvement in personnel decisions can often be measured rather precisely (see, for example, Pinfield (1995)). However, we are not aware of any quantitative evidence on the relationship between communication patterns and hiring practices.

(ii) The difference \( r_M - r_W \) affects the optimal \( \phi \) through \( \alpha_b \). If \( r_M - r_W \) increases, \( \alpha_b \) increases in \( \phi \) at a smaller rate. Trading off the benefits of openness and the loss due to abuse of authority, P therefore chooses a smaller \( \phi \). Employees (except for those at the lowest levels) earn rents if a firm’s wages are backloaded for either incentive (Lazear, 1981) or selection (Salop and Salop, 1976) reasons. Internal labor markets with this feature are characterized by wages that do not vary sensitively with wages on the external labor market. Moreover, employees must expect to spend some time in the firm and to have the opportunity to get promoted into better-paid positions. Consequently, restrictions on communication are more likely to be observed (1) the less closely wages are related to the external market (see Bertrand (1999), who measures this relationship directly), (2) the longer employees’ job tenures are, and (3) the more a firm fills vacancies by promoting employees from within.13 Consistent with these predictions, Pfeffer (1998) reports that a shift toward more performance-based compensation at firms such as Southwest Airlines and Hewlett-Packard has been accompanied by a reduction of status distinctions and barriers across hierarchical levels and by the introduction of more open communication practices.

(iii) An increase in the marginal cost of productive effort, i.e., the marginal cost of recruiting or developing a good \( W \), leads to a direct decrease in (a bad) \( M \)’s effort. The firm would want to compensate for this by decreasing \( \phi \) to provide better insurance to \( M \). On the other hand, an increase in the marginal cost of productive effort also makes \( M \) less sensitive to changes in \( \phi \), implying that the firm can afford to increase \( \phi \). When \( \omega = 0 \), these two effects cancel each other exactly. With \( \omega > 0 \), the more realistic case, the second effect dominates, so that an increase in recruiting costs is accompanied by more openness. Our prediction is that organizations in which recruiting costs are high also have more open communication. Hiring costs can be measured and expressed, for example, as a percentage of annual compensation.

13 A corollary of this prediction is that a firm’s transition from a shielded internal labor market with backloaded wages to more market-based wages (for evidence of this trend, see Bertrand (1998)) is likely to be accompanied by a shift toward more open communication.
A larger $\alpha_0$ is tantamount to a lower probability of recruiting a bad M. There are two effects: On the one hand, given $\alpha_b$, P is now less concerned about M’s potential abuse of authority, which would suggest to increase $\phi$. On the other hand, if the probability of having a bad M decreases, P’s benefit from detecting a bad M decreases too, which would suggest decreasing $\phi$. If $\omega = 0$, i.e., without any other benefit of openness for the firm, this second effect outweighs the first, implying that an increase in $\alpha_0$ leads to a decrease in the optimal $\phi$. If, however, $\omega$ exceeds some minimal level, then the effect is reversed: a higher probability of recruiting a good M implies that the firm can now afford more openness. In this case, firms that spend more effort on recruiting their middle management can also afford more open communication, because good managers have less to fear from good subordinates.

Similar effects apply to the effects of changes in $\delta$ on the optimal $\phi$. For example, an increase in the firm’s discount factor makes detecting a bad M more important for the firm, which suggests an increase in $\phi$. On the other hand, an increase in M’s discount factor raises the value to M of keeping his job. While $\alpha_g$ would increase, $\alpha_b$ might decrease, and it may be optimal to reduce $\phi$.

Similarly, the effects of changes in $q$ on the optimal $\phi$ are ambiguous. One conjecture, for instance, would be that the more informative observed output is (reflected in some measure of the spread of the $q_{ij}$), the more a bad M benefits from having a good W, hence the greater $\alpha_b$, and hence the greater the degree of openness $\phi$ that the firm can afford. More generally, there is an “output effect” of the model parameters on the optimal $\phi$: since restricting $\phi$ only serves to induce a bad M to hire a good W, changes that induce an increase in $\alpha_b$ lead the firm to increase $\phi$.

There is a second, “detection” effect, however, that goes in the opposite direction. If future profits are important, then conditional on having a bad M, the firm may not want a bad M to hire a good W, because he would then remain in the firm with greater probability, reducing expected future profits. The optimal value of $\phi$ depends on the relative importance of the output and detection effects, which in turn depends on $\delta$.

### 6. Alternative solutions and implementation

The abuse of personnel authority is recognized as a problem both among practitioners and in the more applied management literature. South and Matejka (1990), for example, observe that “Weak performing managers avoid selecting individuals who will threaten their status and contrast their own substandard performance. Surprisingly, they seem able to do this rather well.” The academic literature, in contrast, appears not to have addressed this problem in any systematic way.\(^\text{15}\)

South and Matejka suggest that in order to detect “multiple weak links,” that is, chains of weak managers that develop when one weak manager hires another, firms can check indicators of unit performance. They note, however, that reliable indicators are often unavailable. Moreover, as our analysis has shown, a firm may still want to restrict communication even if performance can be observed. In what follows we discuss other solutions.

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\(^\text{14}\) It would be easy to distinguish the discount factors formally, but it appears that no additional testable predictions would result from doing so.

\(^\text{15}\) We are not alone in this impression. Vredenburgh and Brender (1998, p. 1337), too, note that “Although much theoretical and empirical research has examined organizational power, virtually none has addressed the hierarchical abuse of power in organizations.” An exception is the occasional mention in the literature that managers often prefer subordinates who are similar to themselves or who are “yes men.”
Centralization of personnel decisions. In response to the tendency of managers to make personnel decisions that serve their own rather than the firm’s interests, firms may try to shift such decisions to a centralized personnel department.\(^{16}\) Indeed, the emergence of internal labor markets in American corporations in the mid-20th century, in part a result of pressure by unions that distrusted managers, was characterized by a shift toward more formalized and centralized personnel decisions (Jacoby, 1984). But hierarchies exist precisely because it is efficient to delegate tasks, including personnel decisions, to managers; and there are limits to monitoring managers in what they do. In practice, “most line managers make the final employment or promotion decision” (South and Matejka, 1990) because their assessment of future subordinates is essential.\(^{17}\)

Even if hiring decisions are made by a personnel department, managers still retain substantial influence over their subordinates’ careers and may use it to their advantage as long as subordinates pose a threat to them (see footnote 5).

Employment guarantee. Another way to prevent the abuse of authority is a guarantee not to fire a manager regardless of bad news about him. Carmichael (1988) argues that tenure in academia protects senior faculty against being replaced by more productive assistant professors. This assures the incentive to recruit the most productive juniors. While lifetime employment may or may not be optimal in academia, employment guarantees are rarely offered in firms that have to survive in a competitive environment.\(^{18}\)

In our simple model, which does not involve any moral hazard in production, an employment guarantee for M in the second period is inferior to a chain of command (unless open communication is strongly desired for other reasons, i.e., \(\omega >>> 0\)). While both policies prevent strategic recruiting, with an employment guarantee the organization cannot get rid of M if output is zero, which undermines M’s incentive to recruit a good subordinate. That said, restrictions on skip-level communication, which are common in private firms, may be too costly to implement in other organizations such as universities. If it is impossible to prevent university boards from comparing the performance of senior and junior faculty members (since the performance is largely public anyway), then the institution of tenure may be the only feasible, if costly, solution.

Nonreplacement rules. Many organizations follow a policy of never promoting an employee to the position of her immediate superior. If W cannot hope to get M’s position as a direct consequence of communicating with P, she will have much less incentive to do so, which reduces the threat of replacement for M. The protection for M might be only limited, though, for if W credibly informs P that M is unproductive, M will be fired even if W does not get promoted. Even if W has no specific interest in harming M, she may communicate with P to make a good impression, hoping to get promoted to a different department sometime later.

Promotion by seniority. More effective in preventing a subordinate from competing for her boss’s job is to promote employees by seniority rather than performance. Doeringer and Piore (1971) argue that the bureaucratic features of internal labor markets are necessary to provide experienced workers with an incentive to train younger workers: “the effectiveness of on-the-job training depends heavily upon the willingness of experienced workmen to teach new workers. Incumbent employees are thus in a position to frustrate this training process” (p. 84). Hence, “a certain degree of wage rigidity and job security is therefore necessary for on-the-job training to operate at all” (p. 33).

Our discussion suggests that as remedies for the abuse of authority, hierarchical communication and promotion by seniority are substitutes. This may seem counterintuitive, as casual

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\(^{16}\) Shifting authority away from managers is, for the purposes of this article, largely equivalent to monitoring managers’ decisions more closely. In our model, this would be reflected in an increase in \(k_1\); see Proposition 5.

\(^{17}\) See also Pinfield, 1995, p. 316: “In salaried employment systems [as opposed to blue-collar employment systems], managers typically have considerable discretion as to how jobs should be defined and which employee qualities would be most suited to performance of those jobs.”

\(^{18}\) Well-known examples are partnerships in law, auditing, and consulting firms. Similarly, lifetime employment has been a central element in the organization of large Japanese corporations. In both cases, however, there is trend away from employment guarantees.
observation suggests that rigid internal labor markets often exhibit both. It is important, however, to distinguish between seniority-based promotions as a policy and in equilibrium: if a firm maintains a strict chain of command, managers making promotion decisions may have to choose from the employees one or two levels below them, whom they know, ignoring those at lower ranks. Thus, promotions can in equilibrium be correlated with seniority even if seniority is not an explicit criterion for promotion. In other words, hierarchical communication and promotion by seniority as policies can be substitutes even if observed hierarchical communication and promotions by seniority are positively related.

Job rotation. This is also a possible remedy if it takes time for a subordinate to assess her superior’s productivity. If subordinates are rotated before a productive subordinate can learn and credibly communicate that her boss is incompetent, the latter is better protected and hence will be less inclined to abuse his authority. At the margin, the organization can then allow for more open communication.19 Consistent with this argument, Osterman (1994) finds that job rotation is positively correlated with practices that enhance intrafirm communication, such as total quality management.

□ Implementation. An important issue is how hierarchical communication can be implemented in practice—specifically, how employees can be prevented from communicating with their bosses’ superiors. Rules on communicating are part of the culture of an organization, and they can be defined in general terms as “assumptions organizational members make about the right way to communicate in a given situation in their particular organization” (Gildsford, 1998, p. 174). A company’s management can influence the organizational culture, including communication rules, in many ways.

First, the openness of communication depends on what De Long and Fahey (2000) call the “approachability” of superiors, which is shaped by both architecture and symbols. The lockers of blue-collar workers can be close to or remote from the offices of management. People at different levels in the hierarchy may work in physical proximity to each other, or the location of an office may reflect the hierarchy, with top management on the top floors and lower-level employees on lower floors.20 Management can also influence communication through open- or closed-door policies and the use of information technology.

As De Long and Fahey point out, the ability to contact higher-level managers also depends on organizational practices, such as the frequency of staff meetings, and the participation of managers of nonadjacent hierarchy levels in the same meetings.

Second, in addition to physical and institutional barriers to communication, top managers can actively discourage employees from violating the chain of command. They can build a reputation for not talking to lower-level employees and not listening to their complaints about their supervisors. The firm can encourage such behavior by fostering an organizational culture based on the chain of command and the authority of supervisors.21 Top managers may also have an individual reason to ignore or punish a subordinate whose comments about her supervisor’s competence identifies her as a “troublemaker,” even if the information thus obtained is useful.22

Third, openness is affected by the ability of a subordinate to provide top management with convincing evidence that she is more qualified than her superior. This factor, too, is influenced

19 We would like to thank the Editor for pointing out this argument to us.
20 See also Glauser (1984) and the references therein for evidence that “physical or structural inaccessibility is a deterrent to superior/subordinate interaction.”
21 In line with this reasoning, the Bureau of National Affairs found in a survey of formal complaint procedures within firms that managers’ decisions are almost always upheld by higher levels in response to complaints (Bureau of National Affairs, 1979). An alternative explanation for this finding, however, would be that higher levels refrain from “undermining the authority” of supervisors because their trustworthiness is important for the subordinates’ work morale; see Prendergast (1994).
22 As Caesar put it, “I love treason but hate a traitor” (Bartlett and Kaplan, 1992, p. 88). Employees who make negative remarks about their superiors are likely to face retaliation like that against whistle blowers, even if their complaints are justified (for evidence on retaliation against whistle blowers, see Rothschild and Miethe (1999)).
by the firm’s organizational procedures and policies. We conclude that while the openness of communication cannot be fine-tuned, there are many mechanisms that an organization can use to make it harder (or easier) for some of its members to communicate openly with each other, and top managers themselves can influence the openness of communication to a considerable extent.

7. Conclusion

In this article we have proposed an incentive-based explanation for hierarchical communication. Managers who fear being replaced by their subordinates have an incentive to recruit and develop weaker but less dangerous subordinates. This incentive is mitigated if communication between subordinates and top management is disrupted. Trading off the benefits of open communication against the costs of suboptimal personnel decisions, firms may choose to restrict or even completely prohibit skip-level communication.

Our analysis suggests that the design of an intrafirm communication structure must take into account the firm’s human resource practices and the employees’ possible strategic behavior. As we have shown, the wage structure, the effectiveness of recruiting good line managers (which also depends on resources spent), the monitoring of personnel decisions, and job design all affect the firm’s optimal level of communication openness.

It follows from our analysis that it is unwise to allow or even encourage communication between lower and higher levels in the hierarchy without considering the consequences for managers and their strategic responses. More generally, in organizations that do not restrict communication, the flow of information in equilibrium may be limited if people anticipate that what they say to others might be used against them. Similarly, if we interpret negative comments about the abilities of one’s superior as a form of “disloyal” behavior, our results suggest that organizations take considerable risks when tolerating or even encouraging disloyalty. While disloyalty may be directly beneficial in helping to detect and replace unproductive employees, harm is caused in an indirect way through the counterproductive activities of supervisors who see their positions threatened by disloyal subordinates.

Appendix

Proofs of Propositions 1–5 follow.

Proof of Proposition 1.

Preliminaries: notation and updating procedure.

(i) For a given belief \( p = (p_{M0}, p_{W0}, p_{M1}, p_{W1}) \) about the composition of the (M,W) team, denote by \( p_M(p) \) and \( p_W(p) \) the marginal probabilities that M and W are good, respectively. That is, \( p_M(p) = p_{M0} + p_{M1} \) \( p_W(p) = p_{W0} + p_{W1} \).

(ii) In some situations the types of M and W can be seen as stochastically independent. Here, if, e.g., \( \text{prob}(M = g) = a \) and \( \text{prob}(W = g) = b \), we will use the shorthand notation \([a, b] := (ab, a(1 - b), (1 - a)b, (1 - a)(1 - b)) \) for a team belief. Then, the expected output \([a, b] \cdot q \) is increasing in both \( a \) and \( b \). Moreover, the assumption \( q_{gb} \geq q_{gb}, i.e., that M is relatively more important than W, implies that \([a, b] \cdot q \geq [b, a] \cdot q \) if and only if \( a \geq b \).

(iii) A good M is hired with probability \( a_0 \), and hires a good W with probability \( a_g \). A bad M hires a good W with probability \( a_0 \). Hence, the prior for \( P \)’s belief about the team is \( p_1 = (a_0a_g, a_0(1 - a_g), (1 - a_0)a_g, (1 - a_0)(1 - a_g)) \).

(iv) Next, consider how the signals \( y \) and \( z \) affect \( P \)’s beliefs, starting from any prior \( p = (p_{M0}, p_{W0}, p_{M1}, p_{W1}) \). If W reveals that she is good and M is bad, P has perfect information about (M,W). Hence, P’s updated belief about the team is \( r^w(p) = (0, 0, 1, 0) \). On the other hand, if \( z = c \), then her posterior is

\[
 r^c(p) = \frac{1}{1 - \phi p_{M1}} \left( p_{M0}, p_{W1}, (1 - \phi) p_{M1}, p_{W0} \right) . \tag{A1}
\]

Depending on whether \( y = 1 \) or \( y = 0 \) is observed, the posterior of \( p \) is

\[
 r^y(p) = \frac{1}{p \cdot q} \left( p_{M0}q_{M0}, p_{W0}q_{W0}, p_{M1}q_{M1}, p_{W1}q_{W1} \right) . \tag{A2}
\]
\[ t^0(p) = \frac{1}{1 - p \cdot q} (p_{gg}(1 - q_{gg}) \cdot p_{gb}(1 - q_{gb}) \cdot p_{bb}(1 - q_{bb}) \cdot p_{bg}(1 - q_{bg})). \] (A3)

(v) Finally, we determine how P’s beliefs are affected by her decision regarding M. If P promotes W and a new W is hired, her belief is

\[ t^p(p) = [p_W(p), a_0]. \] (A4)

If she hires a new M, this M is good with probability \( a_0 \). By assumption, W is retained if and only if she is good (the probability of which is \( p_W(p) \)). Otherwise, a new W is hired and is good with probability \( a_0 \). Thus, P’s belief upon hiring a new M is

\[ t^p(p) = [a_0, p_W(p) + a_0(1 - p_W(p))] = [a_0, p_{gg} + a_0(p_{gb} + p_{bb})]. \] (A5)

If P retains M, her belief is

\[ t^r(p) = (p_{gg} + a_0 p_{gb}, (1 - a_0)p_{gb}, p_{bb} + a_0 p_{bb}, (1 - a_0)p_{bb}). \] (A6)

This transition function is obtained as follows: If the team \((M, W)\) is \((g, g)\) or \((b, g)\), the team is not changed if M is retained, since M always retains a good W. On the other hand, if the team is \((g, b)\) or \((b, b)\), then a new W is hired, in which case the composition of the team remains unchanged with probability \((1 - a_0)\) and is “upgraded” (from \((b, b)\) to \((g, b)\) or from \((g, b)\) to \((g, g)\)) with probability \(a_0\).

**P’s best response.** We determine P’s best response to M’s strategy under the assumption that \(a_f \geq a_0\). Later, we show that \(a_f \geq a_0\) must hold in any equilibrium of the game, which establishes uniqueness of the equilibrium for any set of parameters.

(i) If \( z = d \), P knows that M is bad and W is good. If P promotes W, her new expected team is \( t^p(0, 0, 1, 0) = [1, 0_0] \). If she hires a new M, her new expected team is \( t^h(0, 0, 1, 0) = [a_0, 1] \). If she retains M, her belief is \( t^r(0, 0, 1, 0) = [0, 0, 1, 0] \). Since \([1, a_0] - q \geq [a_0, 1] - q \geq [0, 1] - q\), (see Preliminaries (ii)), it follows that to promote W is P’s best action.

(ii) If \( z = c \) and \( y = 0 \), then P will hire a new M, retain him, or promote W, depending on which of the expected second-period payoffs \( t^h(t^p(p_0)), t^r(t^p(p_0)) \) or \( t^r(t^r(p_0)) \) is maximal. These payoffs have the common denominator

\[ \tau_0 = 1 - a_0[q_{gg} \alpha_y + (1 - \alpha_y)q_{gb}] - (1 - a_0)[q_{bb} \alpha_y + \phi(1 - q_{gb})] + (1 - a_0)q_{bb} > 0, \]

so it suffices to compare the numerators only. To simplify the resulting expressions, define

\[ \mu = q_{gg} + \phi \beta - q_{gb} - q_{bb} > 0, \quad \rho = a_0 \mu + q_{gb} - q_{bb} > 0, \quad \sigma = (1 - a_0)q_{bb} - q_{gg}. \]

Using (A1) and (A3)–(A6), hiring is preferred to promoting if

\[ a_0 \left( 1 - a_0 \right)(1 - \alpha_y)(1 - q_{gb}) + a_0(1 - \alpha_y)(1 - q_{gb}) > 0. \]

and hiring is preferred to retaining if

\[ a_0 \left( 1 - a_0 \right) \left[ a_0(1 - \beta)(1 - q_{gb})q_{gg} - q_{gb} - \alpha_y(1 - q_{gg})q_{gg} - q_{bb} \right] + b(1 - \alpha_y)q_{gb} - q_{gb} + (\alpha_y - a_0)(1 - q_{gb}) > 0. \] (A7)

We discuss in item (iv) below for which parameters (A7) and (A8) are satisfied.

(iii) If \( z = c \) and \( y = 1 \), P’s optimal action depends on which of \( t^h(t^r(t^p(p_0))) \cdot q, t^r(t^r(t^p(p_0))) \cdot q \), and \( t^r(t^r(t^r(p_0))) \cdot q \) is maximal. These payoffs have the common denominator

\[ \tau_1 = (1 - a_0)(1 - a_0)q_{gb} + a_0(1 - a_0)(1 - \phi)q_{gb} + a_0(q_{gb} + \alpha_y(q_{gg} - q_{gb})). \]

so it suffices to compare the numerators only. To simplify the resulting expressions, define \( \psi = q_{gb} - q_{bb} + a_0(q_{gg} - q_{gb}) \).

Using (A1)–(A2) and (A4)–(A6), retaining is preferred to promoting if

\[ a_0(1 - \alpha_y) \left[ a_0[q_{gg}(q_{gg} - q_{gb}) + q_{gb}\mu] - [q_{gg}(q_{gg} - q_{gb}) - q_{gb}(q_{gb} - q_{bb})] \right] > 0. \]

\[ \psi = q_{gb} - q_{bb} + a_0(q_{gg} - q_{gb}). \]
+ (1 - \alpha_b)\{\alpha_0 [q_{gb} (q_{gs} - q_{gb} - q_{gb}) + q_{gb}^2] + (1 - \alpha_0)q_{gb} [q_{gs} - q_{gb}] + [\alpha_0 - \alpha_b (1 - \phi)q_{gb}] \} \\
> 0, \quad \text{(A9)}

or equivalently

\[
\alpha_0 [\alpha_0 (1 - \alpha_b)q_{gs} (q_{gb} - q_{gb}) + (1 - \alpha_0)q_{gb} (1 - \alpha_0)] + q_{gb} (1 - \alpha_0)q_{gb} q_{gb} + (1 - \alpha_0) \alpha_b q_{gb} q_{gb} q_{gb} \\
+ \alpha_0 (1 - \alpha_0)q_{gs} (q_{gb} - q_{gb}) + [\alpha_0 - \alpha_b (1 - \phi)q_{gb}]q_{gb} (q_{gb} - q_{gb}) > 0, \quad \text{(A10)}
\]

and retaining is preferred to hiring if

\[
\alpha_0 (1 - \alpha_0) \left[ (q_{gb} - q_{gb})^2 + \alpha_0 q_{gb} (q_{gs} - q_{gb}) \phi + (\alpha_0 - \alpha_b) \left( (q_{gs} - \alpha_0 q_{gb}) \mu + q_{gs} - q_{gb} \phi q_{gb} - q_{gb} \right) \right] \\
+ \mu \left[ \alpha_0 (1 - \alpha_0) (q_{gs} - q_{gb}) + \alpha_0 q_{gs} + q_{gb} - q_{gb} - q_{gb} \right] > 0. \quad \text{(A11)}
\]

(iv) The principal’s equilibrium strategy takes the form described in Proposition 1 if (A7)–(A11) all hold. Inspection shows that (A11) always holds. Given the assumption \alpha_0 \geq \alpha_b, a sufficient condition for both (A7) and (A8) is \(q_{gs} = 1\).

A sufficient condition for (A9) and (A10) is \(q_{gb} + q_{gb} < q_{gs}\), the assumption stated in the proposition: since the left-hand sides of both inequalities are linear in \(\alpha_0\), the minimum of each expression is attained at either \(\alpha_0 = 0\) or \(\alpha_0 = 1\). If \(\alpha_0 = 0\), then (A10) is satisfied, whereas if \(\alpha_0 = 1\), (A9) is satisfied whenever \(q_{gb} + q_{gb} < q_{gs}\).

M’s best response. Given P’s strategy, the probability of retention is \(P_{ret}(c) = \alpha_0 q_{gs} + (1 - \alpha_0) q_{gb}\) for a good M and \(P_{ret}(c) = \alpha_1 (1 - \phi) q_{gb} + (1 - \alpha_1) q_{bg}\) for a bad M. After substituting these expressions into (3), maximization with respect to \(\alpha_0\) leads to the expressions for \(\alpha_0\) and \(\alpha_1\) stated in the proposition.

Uniqueness. Since P’s best response was derived for any \(\alpha_0 \geq \alpha_b\), the equilibrium derived is unique unless there exists an equilibrium in which \(\alpha_0 < \alpha_b\). This would require that P provide negative incentives, i.e., since she retains M if \(\alpha_0 < \alpha_b\), the assumption stated in the proposition: since the left-hand sides of both inequalities are linear in \(\alpha_0\), the minimum of each expression is attained at either \(\alpha_0 = 0\) or \(\alpha_0 = 1\). For such an equilibrium to exist in turn requires that, for some \(\phi\), both \(A8\) and \(A11\) be negative. We show that this can never be the case. To see this, notice that the numerator in \(A8\) is decreasing in \(\phi\), whereas the numerator of \(A11\) is increasing in \(\phi\). Specifically, \(A8\) can be negative only if \(\phi\) exceeds

\[
\frac{\rho [q_{gb} - q_{bg} + \alpha_0 (1 - q_{gb}) - \alpha_b (1 - q_{gb})] + (q_{gs} - q_{gb}) [\alpha_0 (1 - q_{gb}) - \alpha_b (1 - q_{gs})]}{
\alpha_b (1 - q_{gb}) (q_{gs} - q_{gb})}
\]

However, substituting this value for \(\phi\) into the numerator of \(A11\) yields \(\alpha_0 (1 - \alpha_0)\) times

\[
\frac{(q_{gb} - q_{bg} + \alpha_0 [q_{gs} - \alpha_0 q_{gb} - (1 - \alpha_b) q_{gb}] + \alpha_b [q_{gs} - q_{gb}] q_{gb} - q_{gb}) + (1 - \alpha_0) q_{gb} - q_{gb} \mu]}{1 - q_{gb}}
\]

which is positive, so that \(A11\) is also positive for any larger \(\phi\).

Comment on other equilibria. If (A7)–(A11) are not all satisfied, different equilibria result, where for any set of parameters there is a unique equilibrium. Depending on which of (A7)–(A11) hold, we obtain equilibria in which P’s strategy in the case \(\varepsilon = c\) is as described in Table A1.

<table>
<thead>
<tr>
<th>TABLE A1</th>
<th>Characterization of Equilibrium Outcomes</th>
</tr>
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<tbody>
<tr>
<td>Conditions Satisfied</td>
<td>P’s Action</td>
</tr>
<tr>
<td>(A7)</td>
<td>(A8)</td>
</tr>
<tr>
<td>Yes</td>
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</table>

Proof of Proposition 2. In equilibrium, the firm’s ex ante expected composition of the (M,W) team after the first period is

\[ E(p_2) = \phi(1 - \phi_0)\phi_0^\theta \cdot \mathcal{L}(1) \]

\[ + \left[ 1 - \phi(1 - \phi_0)\phi_0^\theta \right] \left[ r(p_1) \cdot q \cdot r'(1) + 1 - r(p_1) \cdot q \cdot r'(1) \right] . \]

The first term is the probability that W is promoted, multiplied by the associated probability \( r'(1) \cdot q \) and fired with probability \( 1 - r(p_1) \cdot q \). Plugging \( p_2 \) into (3), the firm’s expected profit can be expressed in the form \( \pi = A + B\alpha_\phi + C\phi\alpha_\phi + D\phi \), where

\[ A = \alpha_\phi q_{EE} + \alpha_\phi (1 - \alpha_\phi)q_{EB} + (1 - \alpha_\phi)q_{BB} - (1 + \phi)(r_M + r_W) \]

\[ + \delta \left[ \alpha_\phi (1 - \alpha_\phi)^2 \left[ 1 - \alpha_\phi \right] q_{EB} - q_{BB} q_{EB} + q_{BB} + q_{EB} \right] + \alpha_\phi (1 - \alpha_\phi)q_{EB} + \alpha_\phi (1 - \alpha_\phi)q_{EB} - q_{EB} \]

\[ + \alpha_\phi (1 - \alpha_\phi)q_{EB} - q_{EB} + (1 - \alpha_\phi)q_{EB} + (1 - \alpha_\phi)q_{EB} + (1 - \alpha_\phi)q_{EB} \]

\[ + \alpha_\phi (1 - \alpha_\phi)q_{EB} - q_{EB} + (1 - \alpha_\phi)q_{EB} - q_{EB} \]

\[ + \alpha_\phi (1 - \alpha_\phi)q_{EB} - q_{EB} + (1 - \alpha_\phi)q_{EB} - q_{EB} \]

\[ + \alpha_\phi (1 - \alpha_\phi)q_{EB} - q_{EB} + (1 - \alpha_\phi)q_{EB} - q_{EB} \]

\[ \geq 0, \]

\[ B = (1 - \alpha_\phi)q_{EB} + (1 - \alpha_\phi)q_{EB} - q_{EB} + \alpha_\phi q_{EB} q_{EB} - q_{EB} \]

\[ - \delta (q_{EB} - \alpha_\phi q_{EB} + \alpha_\phi q_{EB} - q_{EB}) < 0, \]

\[ C = (1 - \alpha_\phi)[(1 - \alpha_\phi)q_{EB} - q_{EB}] + \alpha_\phi q_{EB} - q_{EB}] > 0, \]

and

\[ D = (1 + \delta)\omega > 0, \]

(A12)

and A through D are independent of \( \phi \) and \( \alpha_\phi \). Differentiate \( \pi(\phi, \alpha_\phi) \) twice with respect to \( \phi \) to obtain \( d^2\pi / d\phi^2 = 2C\partial\alpha_\phi / \partial\phi \), where \( C \) is positive, and according to Proposition 1, \( \alpha_\phi \) is decreasing in \( \phi \). Hence, \( \pi \) is concave in \( \phi \).

Q.E.D.

Proof of Proposition 3. If \( k_1 = 0 \), then from Proposition 1 it follows that for any \( \phi \geq 1 - q_{EB}/q_{BB} \), \( \alpha_{\phi} \) equals zero. Thus, expressing \( \pi \) and \( \alpha_{\phi} \) as functions of \( \phi \), we have \( \pi(0) = \pi(\phi) = B|\alpha_{\phi}(0) - \alpha_{\phi}(\phi)| - C\alpha_{\phi}(\phi) = B\alpha_{\phi}(0) \), using the notation of (A12). The middle term in curly brackets in B is positive, and if \( \delta \leq 1 \), the first term exceeds the third, so that B is positive.

Q.E.D.

Proof of Proposition 4. With a bonus \( b \) paid to M whenever \( \gamma = 1 \), a raise \( \Delta_\gamma \) for M in the second period if M is retained, and a severance payment \( s \) that is paid whenever M is fired even though \( \gamma = 1 \) (which can happen only if M is bad), straightforward generalization of M’s payoff function (2) leads to the recruiting efforts

\[ \alpha_\phi = \frac{1}{2(k_0 + k_1)} \left[ 2k_1 + (q_{EB} - q_{EB})b + \delta (q_{EB} - q_{EB})(r_M - r_M + \Delta_\gamma) \right] \]

and

\[ \alpha_\phi = \frac{1}{2(k_0 + k_1)} \left[ 2k_1 + (q_{EB} - q_{EB})b + \delta (1 - \phi)q_{EB} - q_{EB}(r_M - r_M + \Delta_\gamma) + \phi q_{EB}s \right]. \]

Moreover, the firm’s profit function contains the terms

\[ -r(p_1) \cdot q \cdot \phi(1 - \alpha_\phi)q_{BB} - s \cdot \delta(1 - \phi(1 - \alpha_\phi)q_{EB}) \Delta_\gamma \]

in addition to (A12). Then, because

\[ \delta \frac{\partial \alpha_\phi}{\partial b} = \frac{\partial \alpha_\phi}{\partial \Delta_\gamma} + \delta \frac{\partial \alpha_\phi}{\partial \Delta_\gamma} + \delta \frac{\partial \alpha_\phi}{\partial \Delta_\gamma} + \delta \frac{\partial \alpha_\phi}{\partial \Delta_\gamma} + \delta \frac{\partial \alpha_\phi}{\partial \Delta_\gamma} \]

it follows that

\[ \delta \left( \frac{\partial \pi}{\partial \Delta_\gamma} + \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} \right) = \frac{\partial \pi}{\partial \Delta_\gamma} + \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} + \delta \frac{\partial \pi}{\partial \Delta_\gamma} \]

which is the statement of the proposition.

Q.E.D.
Proof of Proposition 5. Assuming that the optimal \( \phi^* \) is interior, this \( \phi \) is given by the first-order condition
\[
\frac{d\pi}{d\phi} = C\alpha_0(\phi) + D + (B + C\phi) \frac{\partial\alpha_0(\phi)}{\partial\phi} = 0, \tag{A13}
\]
in the notation of (A12). Since \( \pi \) is concave in \( \phi \), it follows that \( d\phi^*/dx \), the response of the optimal \( \phi \) to a change in any parameter \( x \) of the model, has the same sign as \( d^2\pi/(d\phi dx) \), which is obtained by differentiating (A13) with respect to \( x \).

For parts (i) through (iii) of the proposition, notice that in (A13), the parameters \( r_M \), \( k_0 \), and \( k_1 \) affect only \( \alpha_0 \) but not \( B \), \( C \), or \( D \). Differentiating (A13) and substituting for \( (B + C\phi) \) from (A13), we obtain
\[
\frac{d^2\pi}{d\phi dx} = C\frac{\partial\alpha_0}{\partial x} + (B + C\phi)\frac{\partial^2\alpha_0}{\partial\phi \partial x} = C\left( \frac{\partial\alpha_0}{\partial x} - \alpha_0 \frac{\partial\alpha_0}{\partial\phi \partial x} \right) - \frac{D}{\partial\alpha_0/\partial x} \frac{\partial^2\alpha_0}{\partial\phi \partial x}. \tag{A14}
\]

Evaluating (A14) for \( r_M \), \( k_0 \), and \( k_1 \) in place of \( x \), we get
\[
\frac{d^2\pi}{d\phi dr_M} = \frac{k_1}{k_0 + k_1}, \quad \frac{d^2\pi}{d\phi dk_0} = \frac{D}{k_0 + k_1} \geq 0
\]
and
\[
\frac{d^2\pi}{d\phi dk_1} = C + D \frac{k_0 + k_1}{k_0 + k_1} > 0,
\]
since \( C \) is positive and \( D \) is nonnegative.

Part (iv). A change in \( \alpha_0 \) affects \( B \) and \( C \) in (A13) but not \( \alpha_0 \). Therefore, we have
\[
\frac{d^2\pi}{d\phi d\alpha_0} = \frac{\partial C}{\partial \alpha_0} + \left( \frac{\partial B}{\partial \alpha_0} + \frac{\partial C}{\partial \alpha_0} \right) \frac{\partial \alpha_0}{\partial \phi} \frac{\partial \alpha_0}{\partial \phi} = \frac{1}{C} \left[ \left( C \frac{\partial B}{\partial \alpha_0} + \frac{\partial C}{\partial \alpha_0} \right) \frac{\partial \alpha_0}{\partial \phi} \phi + \frac{\partial C}{\partial \alpha_0} \right],
\]
after substituting for \( \alpha_0 \) from (A13). Here, the sign of the term in parentheses on the right-hand side is indeterminate, whereas \( \partial C/\partial \alpha_0 \) is negative, since both factors of \( C \) are decreasing in \( \alpha_0 \). Thus, \( \phi^* \) is increasing in \( \alpha_0 \) if \( D = (1 + \delta) \omega \) is sufficiently large.

Part (v). This part is obvious, since from (A12), \( d^2\pi/(d\phi d\omega) = 1 + \delta \). \( \Box \)

References


