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Disobedience and Authority*

Anthony M. Marino
University of Southern California

John G. Matsusaka
University of Southern California

Ján Zábojník*
Queen's University

This article presents a theory of the allocation of authority in an organization in which centralization is limited by the agent's ability to disobey the principal. We extend the concept of real authority by observing that not only does the principal have to be informed to give an order but also the worker must be willing to follow the order. We show that workers are given more authority when they are costly to replace or do not mind looking for another job, even if they have no better information than the principal. The allocation of authority thus depends on external market conditions as well as the information and agency problems emphasized in the literature. We explore the implications of this insight for hiring policies and managerial styles.

1. Introduction

The allocation of authority is a critical part of the architecture of an organization. The traditional view is that decision rights ought to be placed in the hands of those with relevant information—retained by the manager when coordination is important and delegated to subordinates when their local expertise is critical (Barnard 1938/1968; Simon 1945/1997; Arrow 1974). A more recent literature formalizes this trade-off, showing how decision rights affect incentives to acquire and accurately communicate information as well as impact agency problems (Aghion and Tirole 1997; Dessein 2002; Marino and Matsusaka 2005). Yet even when information and agency conditions are such that a manager would like to make the decision, casual observation suggests he

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* Department of Economics, Queen's University, Dunning Hall, Room 319, Kingston, Ontario, Canada K7L3N6. Email: zabojnik@econ.queensu.ca

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may lack the means to induce the worker to carry it out. A manager can tell his sales force to push one of the firm's products over the other, but if the workers in the field can undermine the order with a lackluster effort for the product they dislike, the manager may have no choice but to delegate decision authority to individual sales people. The sales people may then enjoy significant control over how they do their jobs not because such an assignment of authority is optimal from an information or agency perspective, but because there is no way for the manager to centralize authority.

Although the idea that authority is limited by ineffective enforcement was noted in the classic texts on management and organization, it is largely absent from the modern literature.[1] The notion that managers have to rely on agents who could act against the managers' wishes is the central theme of the principal-agent literature. However, the basic principal-agent model does not speak to the question of how disobedience affects the optimal allocation of authority because it allows for no meaningful distinction between centralization and delegation: Once the incentive scheme is in place, there is no need for the principal to tell the agent what to do, as the principal and the agent share symmetric information about payoffs. To provide a meaningful role for the allocation of authority, we therefore assume that the principal can have private information about his preferred action, so that there is a benefit to issuing an order.

The purpose of our article is to spotlight the importance of disobedience for the allocation of authority in organizations by developing a formal framework in which decision-making authority matters and tracing out some of its implications. In our model, disobedience not only affects the firm's choice between centralization and delegation but also gives rise to a new and distinct decision-making arrangement, characterized by disobedience as an equilibrium outcome. Such an arrangement appears to be empirically relevant but has been ignored by the previous literature.

Our analysis focuses on two important tools that managers can use to enforce orders. One is the threat of dismissal: "Within the firm, the sanctions which authority can use are basically those of hiring and firing" (Arrow 1974: 71). Authority is limited when workers do not fear being fired or when the manager finds it very costly to find and train a replacement worker. Workers who are costly to replace or who do not mind looking for another job have more scope to disobey an order and in our analysis end up being given more control over how they carry out their assignments.

One implication is that if white-collar workers are more costly to replace than blue-collar workers, as survey evidence suggests, white-collar workers

1. For example, "Disobedience to orders, organized or unorganized, frequently sets limits to authority," Arrow (1974: 75); "Now a most significant fact of general observation relative to authority is the extent to which it is ineffective in specific instances. It is so ineffective that the violation of authority is accepted as a matter of course and its implications are not considered," Barnard (1938/1968: 161); "The real limiting factors [in a military operation] are the psychological factors which determine when the soldiers will refuse further obedience to commands," Simon (1945/1997: 200).

may be given more autonomy than blue-collar workers, even when it comes to routine tasks where they have no information advantage. Our approach also implies that authority hinges not only on an internal calculus involving hidden information or action, as in the traditional approach, but on surrounding market conditions because a worker's cost of being fired depends on the quality of the external labor market. A broadening and deepening of labor markets that reduces a worker's cost of finding a new job would make workers less obedient and result in more worker autonomy, consistent with a long-run trend that some have observed (Simon 1945/1997, chapter 7). Similarly, we predict more delegation in nonmanufacturing industries because they are characterized by higher job destruction rates than manufacturing industries (Davis and Haltiwanger 1999). A high job destruction rate means a low probability of a continuing employment relationship, which makes disobedience hard to punish. This prediction is supported by our empirical finding that service-oriented firms tend to be less centralized.

Monetary incentives are another important tool to enforce commands. When we introduce contingent performance contracts into our model with limited liability, we find that the effect of monetary incentives depends on the firm's cost of dismissing a worker. When the firm's dismissal cost is low, monetary incentives can lead to more centralization by allowing the manager to enforce a command that would not be enforceable with only the threat of dismissal. When the firm's dismissal cost is high, monetary incentives can lead to more delegation by making the threat of dismissal less credible. One implication is that new information technologies that allow more accurate monitoring of worker performance and hence facilitate formal incentive contracts will lead to more delegation for workers who are costly to replace, consistent with the evidence in Moers (2006).

The fact that managers may be forced to delegate decisions for certain workers has implications for hiring policies and managerial styles.

- Hiring policy. If there are certain jobs for which decisions must be delegated, it is important to fill those jobs with workers whose preferences are aligned with the organization's interests. In contrast, for jobs where workers will be told what to do, preference alignment is less important than having workers whose actions have a large effect on payoffs. Thus, to the extent that white-collar workers are intrinsically harder to replace and given more decision authority than blue-collar workers, managers will be relatively more interested in hiring workers who "share the organization's values" when it comes to white-collar jobs and more interested in raw ability when it comes to blue-collar jobs.
- Managerial traits. Evidence in economics and psychology suggests that managers may be inherently different in their empathy toward workers, desire for power, and other attributes. We show that a manager with empathy for his workers tends to delegate more because he seeks to avoid giving orders that are disobeyed and require disciplinary action, but will also experience more disobedience. A manager with a lust for power will also experience

more disobedience, resulting in an ambiguous net effect on the degree of centralization.

We view this as a theoretical article and do not attempt a rigorous empirical evaluation. However, to flesh out the analysis, we report some descriptive evidence from two recent surveys of organizational practices. The surveys ask sample firms how much autonomy workers have in carrying out their tasks, and we explore the factors that are correlated with the granting of more or less autonomy. Consistent with the spirit of the model, we find that workers enjoy more autonomy when it is costly for firms to replace them and when workers have good outside job opportunities.

Related literature. Our analysis is related to several strands of the literature. A growing body of research often associated with Aghion and Tirole (1997) considers the limits on authority that arise from the principal's limited information— without information to direct the agent, the principal may have formal authority but lack real authority.[2] We emphasize that the principal's authority is also limited by the agent's ability to disobey orders. Following Simon (1945/1997, 1991) and Barnard (1938/1968), our analysis yields a concept of real authority that not only requires the principal to have the information necessary to direct the agent but also requires the worker to be willing to carry out the principal's orders. Baker et al. (1999) assume, in contrast, that managerial authority is unlimited and can never be transferred to a subordinate. They study how reputation can be used to effectively delegate authority to agents. Our article and that of Baker et al. can be thought of as focusing on different types of decisions: Baker et al. study applies to decisions that do not require implementation by the agent (perhaps certain types of promotion decisions), whereas we focus on decisions that can only be implemented by the agent. Disobedience is also the focus of Landier et al. (2005), who investigate when disobedience can be optimal for an organization. Van den Steen (2005) points out that when the principal and agent disagree on the proper course of action, high-powered incentives can lead to disobedience, resulting in a connection between centralization and low-powered incentives. This parallels our finding that monetary incentives can lead to more delegation, but we show that the opposite relationship, where monetary incentives and centralization are complements, is also plausible. Van den Steen (2007) shows that shifting ownership of assets from the agent to the principal can reduce disobedience by lowering the principal's separation cost and raising the agent's separation cost, leading to predictions concerning separation costs that mirror ours.

Finally, our consideration of the threat of dismissal as one tool for disciplining workers makes our article related to the shirking models of efficiency

2. Work in this vein includes Holmstrom (1977, chapter 2), Dessein (2002), Prendergast (2002), Zabojnik (2002), Marino and Matsusaka (2005), and Alonso and Matouschek (2007). The theoretical trade-offs affecting the incentive to acquire and transmit information were also developed by Gilligan and Krehbiel (1987, 1989) in the context of legislative organization.

wages (e.g., Shapiro and Stiglitz 1984). In this strand of literature, the closest article to ours is that of Acemoglu and Newman (2002), which shows how the amount of monitoring within a firm is influenced by external labor market conditions. The main difference of our analysis is that we endogenize the allocation of decision-making authority, assumed to be delegated to the worker in the efficiency wage literature. The articles of Calvo and Wellisz (1978) and Qian (1994) are also in this strand of the literature. They find that the effort levels of workers are reduced as the hierarchy becomes larger and interpret this as a loss of control due to size.

The outline of the article is as follows. Section 2 lays out the model. Section 3 identifies the key factors limiting the authority of the manager and derives the main implications. Section 4 introduces monetary incentives. Section 5 extends the basic model to consider hiring policies and managerial traits. Section 6 identifies some firm factors associated with worker autonomy based on the National Organizations Survey. Section 7 concludes.

2. The Model

A principal supervises an agent on a project that takes two periods ($t = 1, 2$) to complete. This can represent a manager and worker, a CEO and division manager, a dean and professor in a university, and so on. The principal cannot implement the project himself—he requires the agent to do it—but he can replace an unsatisfactory agent with another agent. All actors are risk neutral and discount the future at $\delta \in (0, 1)$.

Actions and Payoffs. The payoff structure in each period resembles the one used in Aghion and Tirole (1997). In each of the two periods, the agent chooses one of $n \geqslant 3$ ex ante identical actions, where action $k \in \{1, \ldots, n\}$ yields revenue v_k to the principal and a private benefit b_k to the agent. The actions and payoffs are identical in each period. Let j be the principal's preferred action and denote as $v \equiv v_j = \max\{v_k\} > 0$ the principal's payoff from this action. Similarly, $b \equiv b_i = \max\{b_k\} > 0$ will denote the agent's payoff from his preferred action i. We will normalize the payoffs so that the principal's payoff at the agent's best action (i) and the agent's payoff at the principal's best action (j) are such that $v_i = b_j = 0$, if $i \neq j$. Actions other than j and i yield nonpositive payoffs to both parties, with at least one action ℓ yielding $v_\ell = -\infty$ and $b_\ell = 0$.[3] The ex ante probability that $i = j$ is α; this parameter represents the degree of congruence between the principal's and the agent's interests.[4]

The agent receives his private benefit at the end of each period, but the principal's total return is realized at the end of the second period, although

3. As in Aghion and Tirole (1997), all we need is that the principal's payoff from this action is "sufficiently negative."

4. Whether the agent's interests are congruent with those of the principal is project specific. The disobedience problem therefore cannot be resolved by the agent's concerns about labor market reputation or by principals and agents matching in the long run according to their revealed preferences.

it consists of a payoff generated in each period. For example, in the first period a sales person makes an initial visit to a potential customer, and in the second period the deal is closed. The final revenue is the combination of returns generated in both periods (both visits). Thus, if the project generates a payoff of v in the first period and v in the second period, the return at the end of the second period is $2v$.[5]

Information. The principal's and the agent's maximum returns v and b are their respective private information. In particular, at the time of contracting, the principal knows whether his maximum return is high ($v = H$) or low ($v = L$), where $H > L > 0$, whereas the agent only knows that $v = H$ with probability $\gamma \in (0,1)$ and $v = L$ with probability $1-\gamma$. Similarly, the agent observes his b after being hired, but the principal only knows that b is drawn from the interval $(0,B]$ according to a cumulative distribution function $F(b)$ with density function $f(b)$.

At the time of hiring, neither the principal nor the agent know which action yields which payoffs, but after being hired, the agent learns for free his payoffs associated with each action. The principal may also learn the actions' payoffs, but has to spend resources to do it. Specifically, at the cost $C(q) = cq^2/2$, where c is a constant, the principal learns all payoffs with probability q and learns nothing with probability $1-q$. Continuing the previous example, the principal learns which of the products should be emphasized by the salesman in order to maximize the firm's overall profit.

Authority, Disobedience, and Contracting. The principal can give an order or delegate the decision to the agent. If the decision is delegated, the agent takes his preferred action because he does not know the principal's payoffs.[6] If an order is given, the agent may follow the order or may disobey and choose another action. The principal observes the agent's action, but cannot overrule or otherwise directly force a particular action. That is, the sales manager cannot go into the field himself, and the dean cannot teach the classes himself. Contingent contracts based on output are feasible, but the agent is protected by limited liability so that each period's wage is nonnegative.[7] Also, we focus on short-term contracts; that is, we assume that the principal is not able to commit to second-period incentives. Let w_t denote the wage at time t if output is v. When output is different from v, the principal sets the wage equal to zero, to minimize the rents received by the agent.

5. This setup guarantees that the principal cannot learn about the actions' payoffs by simply observing his first-period payoff. We could easily restore formal symmetry here by postponing the agent's first-period payoff to the second period, but the current setup is easier to interpret when the agent is dismissed after the first period.

6. The assumption that the agent does not know the best action from the principal's viewpoint is in line with information and coordination theories of centralization, such as Aoki (1986), that allow for the possibility that the boss knows better than the subordinate what is good for the firm.

7. Allowing the contract to be conditional on whether an order is obeyed would not change anything.

In addition to using monetary incentives, the principal may choose to dismiss the agent after the first period and hire a new agent to complete the project in the second period. The new agent's probability of being congruent is β. The parameters α and β may differ if the principal has learned something about the incumbent agent at some time before the start of our model or if screening applicants is easier if the principal knows his preferred action than if he does not.[8] An incongruent agent's desire to appear to be congruent is what may induce him to obey an order from the principal.

If an agent is dismissed, the principal incurs a cost s_P to find and train a replacement, where $\beta H > s_P > \beta L$. As will become clear later, this condition guarantees that the principal is willing to fire a disobedient agent when $v = H$ but not when $v = L$. Similarly, if dismissed, the agent incurs a cost s_A to find a new job that pays his reservation utility of zero.[9]

As discussed above, all the principal's payoffs arrive at the end of the second period. Since the principal has no payoff at the end of the first period, an uninformed principal cannot determine the agent's type until the project is over. The agent's private benefits are received instantaneously in the first and second period and the separation costs are paid in the second period.

3. Basic Trade-offs When Monetary Incentives Are Not Feasible

In order to highlight the basic intuition of our analysis, we start by considering the case where the agent receives no monetary compensation. We introduce wages and contingent monetary contracts in the next section.

3.1 Feasibility of centralization

We will refer to the arrangement in which the principal becomes informed and issues an order as "centralization." Observe first that the very bad action ℓ ensures that the principal only issues an order if informed.

If the agent disobeys the order, the principal's only recourse is to replace the agent with another who he hopes will be better. Only an incongruent agent would consider disobeying an order. The principal is willing to dismiss an incongruent agent at the end of the first period if $-\delta s_P + \delta\beta v \geqslant 0$, so that the principal's incentive compatibility condition is

$$\beta v \geqslant s_P. \qquad (IC_P)$$

If the principal's cost of firing is greater than the marginal value of employing a congruent agent rather than an incongruent agent in the second period, weighted by the probability of hiring a congruent agent, then centralization is not feasible. Our assumptions on H and L imply that (IC_P) holds when the project value is high ($v = H$), but not when it is low ($v = L$).

8. Separate congruence parameters for incumbent and replacement workers allow us to study how changes in the incumbent's congruence affect the allocation of authority, holding constant the congruence of the pool of replacement workers.

9. We could allow the agent to obtain private benefits in his new job without affecting our qualitative results.

The other feasibility condition is that at least some incongruent agents must prefer obeying and keeping their jobs to disobeying and being dismissed. The benefit of staying into the second period is that the agent can choose his preferred action without consequence from the principal. An incongruent agent therefore obeys an order if and only if $\delta b \geqslant b - \hat{\gamma}\delta s_{\mathrm{A}} + (1-\hat{\gamma})\delta b$, where $\hat{\gamma}$ is the agent's posterior belief (conditional on receiving an order) that $v = H$. In other words, an incongruent type obeys if and only if his private benefit from disobeying is sufficiently small:

$$b \leqslant \frac{\hat{\gamma}\delta s_{\mathrm{A}}}{1-\hat{\gamma}\delta} \equiv b^*. \tag{1}$$

We eliminate less interesting cases by assuming that $B > b^*$, that is, $\frac{\delta s_{\mathrm{A}}}{1-\delta} < B$.

To obtain the agent's posterior $\hat{\gamma}$, note that the principal never gives an order when uninformed and always gives an order when informed. Thus, the principal's probability of giving an order is his probability of being informed, $q(v)$. Using Bayes rule,

$$\hat{\gamma} = \frac{\gamma q(H)}{\gamma q(H) + (1-\gamma)q(L)}. \tag{2}$$

This is the agent's posterior belief that an informed principal will fire the agent if he disobeys.

3.2 The principal's problem

The principal chooses the probability of becoming informed, q, to maximize his expected payoff

$$E\pi(q) = 2\alpha\delta v + \delta q(1-\alpha)[F(b^*)v + (1-F(b^*))\max\{0, \beta v - s_{\mathrm{P}}\}] - C(q).$$

The first term indicates that a congruent agent takes the right action whether the principal is informed or not. The second term says that if the principal becomes informed and issues an order, an incongruent agent will obey in the first period if $b \leqslant b^*$ and then disobey in the second period (which yields zero for this period to the principal). If $b > b^*$, an incongruent type disobeys in the first period, yielding zero to the principal, who then replaces the agent if $\beta v - s_{\mathrm{P}} > 0$.

Let q_L^* and q_H^* denote the principal's optimal investment in information gathering when $v = L$, respectively $v = H$. The strict concavity of the principal's problem in q implies that q_L^* and q_H^* are determined by the first-order conditions

$$\delta(1-\alpha)F(b^*)L = cq_L^*; \tag{3}$$

$$\delta(1-\alpha)[F(b^*)H + (1-F(b^*))(\beta H - s_{\mathrm{P}})] = cq_H^*. \tag{4}$$

Clearly, $q_H^* > q_L^*$; that is, the principal is more likely to become informed and issue an order when the value of the project is high than when the value is low.

3.3 Disobedience

In this subsection, we characterize how the incongruent agent's willingness to obey an order depends on the model's primitives. We start by noting that $q_H^* > q_L^*$ implies $\hat{\gamma} > \gamma$ and $b^*(\hat{\gamma}) > b^*(\gamma)$. That is, the fact that the principal issued an order increases the agent's belief that the principal has a high-value project, which makes the agent more willing to obey the order, because he finds it more likely that he would be dismissed for disobedience. This effect also plays a role in the interaction between the model's parameters and the incongruent agent's willingness to obey an order.[10]

Proposition 1. An incongruent agent is more likely to obey an order (i.e., b^* is larger) the larger are H, γ, s_A, δ, and β, and the smaller are L and s_P. The agent's willingness to obey an order is unaffected by c and α

The effect of the agent's separation cost s_A is straightforward, as b^* increases in s_A and equations (3) and (4) do not directly depend on s_A. The other effects operate in a more subtle way through the agent's inferences about project quality. An increase in H increases the probability that the principal becomes informed when $v = H$ but not when $v = L$, by the first-order conditions (3) and (4). As a result, an order becomes stronger evidence for the agent that $v = H$, increasing the cutoff level b^*. Similarly, an increase in the principal's separation cost s_P decreases the value of becoming informed when $v = H$, lowering the posterior $\hat{\gamma}$ and the cutoff level b^*. Finally, c and α do not affect b^* because they change both q_L^* and q_H^* by the same proportion, leaving the agent's posterior unaffected.[11]

3.4 The principal's decision to centralize decision making

One measure of centralization is the probability of becoming informed/issuing an order. The following proposition describes how this probability depends on the model's parameters.

Proposition 2. The principal's probability of issuing an order (q_i^*, $i = L, H$) increases in H, γ, s_A, δ, and β and decreases in s_P, c, and α. The probability q_H^* decreases in L, but q_L^* is ambiguous in L.

Whereas previous research has studied how changes in information and agency problems alter the optimal assignment of decision authority, our model highlights how changes in the principal's ability to control disobedience can drive the delegation decision. Moreover, our article shows how disobedience of orders and dismissal can be an equilibrium outcome. Here we discuss how the allocation of authority depends on the parameters.

10. All proofs are in the Appendix.

11. This point also illustrates why assuming a quadratic $C(q)$ simplifies things tremendously: The agent's posterior depends on the ratio q_H^*/q_L^*, which is hard to characterize when $C(\cdot)$ is a general function, but becomes easy to work with when the first-order conditions (3) and (4) yield closed-form solutions for q_L^* and q_H^*.

Principal and Agent Separation Costs. A key idea of our article is that the amount of centralization is limited by the principal's and agent's separation costs. The principal's separation cost comprises the direct cost of dismissing a worker (creating a paper trail, counseling out, potential lawsuits, and separation payments), locating and hiring a replacement, as well as the cost of training the new worker. Survey evidence indicates that managers and professionals are more costly to replace than manual workers, secretaries, and administrative and technical assistants.[12] Our model thus implies that managers and professionals will be given more decision rights, which may help explain why white-collar workers seem to have more autonomy in how they perform their jobs than blue-collar workers. The information view of delegation also suggests giving white-collar workers more control when they are more informed about the best course of action but does not predict giving them control over aspects of their job where their information advantage is less obvious, such as scheduling of work hours and attire. Similarly, because workers are easiest to fire in the private sector, more difficult to fire in government jobs (because of civil service laws), and extremely difficult to fire in higher education (because of tenure), our model implies significant centralization in firms, moderate centralization in government, and extensive delegation in universities. This squares with the assessment of George P. Shultz, former US Secretary of State and the Treasury, who was also a top executive at Bechtel Group and dean of the Graduate School of Business, University of Chicago: "In private enterprise you give an order and expect it to be carried out. In government, you give an order and hope that it will be carried out. And in higher education, you give no orders."[13]

The cost of replacing a worker is likely to be lower in a large firm than a small firm because large firms have more coworkers who can step in and cover for a dismissed worker until a replacement is found. Therefore, workers in small firms should have more autonomy than workers in large firms. We provide evidence on this implication later.

When the worker's separation cost is low, the firm will delegate more because the principal has no stick to enforce his commands if the worker does not fear dismissal. This formalizes Arrow's (1974: 64) observation: "The scope of this authority will usually be limited by the terms of the contract, and, more fundamentally, it is limited by the freedom with which an employee can leave the job." The worker's cost of being dismissed depends on worker characteristics as well as general market conditions. Well-developed labor markets are likely to reduce the cost of finding a new job by reducing the amount of search required. They are also likely to reduce the firms' costs of replacing workers, which in principle makes any empirical predictions ambiguous. However, we

12. See the series of surveys by the Chartered Institute of Personnel and Development available at www.cipd.co.uk/subjects/recruitmen/general/recruitretnt.htm, for example, Tables 26 and 28 in *Recruitment, Retention, and Turnover 2004: A Survey of the UK and Ireland* (Chartered Institute of Personnel and Development, 2004).

13. The quote is attributed to Shultz by former US Senator and Washington Governor Daniel Evans (McReynolds, 2006: 23).

would expect the effect of the workers' separation costs to dominate, because in many firms a large part of the cost of hiring a new worker consists of training, which does not directly depend on the quality of the labor market.

Our model thus identifies a link between the centralization of authority and general market conditions. This gives one way to understand the long-run trend toward more autonomy in the workplace (Simon 1945/1997, chapter 7). As labor markets have expanded and workers have become more mobile, workers are less averse to losing their jobs, and firms must delegate more decision rights to them. Our analysis suggests that workers in economies with less developed labor markets will be given less flexibility in how they accomplish their tasks than workers in developed economies, and workers in a town dominated by a single employer will have fewer decision rights than workers in a city with competing employers.

Discount Rate. The discount rate does not play a role in most existing models of delegation, but it is crucial in our analysis because the willingness of a worker to obey a command he dislikes today depends on how he values continuing on the job tomorrow. An increase in δ makes it easier to satisfy the agent's incentive compatibility condition (1) because the agent places a higher value on keeping his job. An increase in δ also increases the principal's value of centralization because it increases the present value of the benefits from being informed.

In short, the model suggests a greater degree of delegation when the principal and agent heavily discount their future relationship. Since workers and managers of firms in distress are likely to discount the future at a higher rate, one implication is that distressed firms delegate more authority to workers. Similarly, firms in industries that are downsizing would delegate more, assuming their separation costs do not change. Finally, the job destruction rate in nonmanufacturing industries is greater than in manufacturing industries (Davis and Haltiwanger 1999). We would therefore expect greater delegation in nonmanufacturing industries, a prediction consistent with our empirical evidence in Section 6.[14]

The discount rate is also important in Baker et al. (1999), but it works in the opposite direction. In their model, the principal has unlimited ability to enforce orders and his problem is to find a way to credibly delegate. When the principal and agent discount the future, it is harder for the principal to commit not to intervene, and less delegation is the result. Alonso and Matouschek (2007) present a repeated game model which predicts that the principal will delegate if the discount rate is high, as in our model, but they focus on the trade-off between information loss under centralization and agency problems under delegation rather than disobedience.

14. An alternative formulation of the model would let $1-\delta$ be the probability that the firm goes out of business or is forced to lay off the worker in the second period. If worker and firm do not otherwise discount the future, it can be shown that payoffs and incentive conditions are similar to the current formulation.

Congruence, Cost of Information, Private Benefits, and Task Importance. Proposition 2 shows that centralization is more likely when the principal's cost of becoming informed (c) is low, when the agent's preferences differ from the principal's preferences (α is small), and when the agent's action choice has a significant impact on the principal's return (γ and H are large), that is, it is an "important" decision from the principal's perspective.[15] These trade-offs are fairly standard in models of delegation and appear in a variety of models where the principal's orders are automatically accepted by the agent (e.g., Aghion and Tirole 1997; Baker et al. 1999). One feature of the effect of H stands out, however: In Aghion and Tirole (1997), only the relative importance of the decision matters—centralization is more likely if the decision is relatively more important to the principal than to the agent. Our theory, in contrast, highlights that the importance of a decision matters also in absolute terms. As can be seen from the principal's incentive compatibility condition (IC_P), the principal cannot credibly commit to replace disobedient agents if the decision is unimportant (v is small) and therefore has little incentive to give orders.

Another distinctive implication concerns β, the probability that a new hire will share the preferences of the principal. This parameter could be high for firms that are admired by some outsiders because of their innovative nature (Apple) or because of their association with social objectives that some workers share (Whole Foods). A high value of β makes the firm more willing to dismiss a disobedient worker, increasing the degree of centralization. Somewhat counterintuitively, firms that can rely on outside workers to share their values may be less likely to delegate, even if the average congruence of existing workers (α) is also higher.

3.5 Real authority

Aghion and Tirole (1997) draw a distinction between formal authority and real authority. In their context, a principal has real authority when he is sufficiently informed to be able to make a decision. Our analysis extends this line of thinking by observing that disobedience can also curtail the principal's authority. In our model, even if the principal is informed and able to identify the most profitable action, he may lack real authority if he does not have the tools to ensure that the agent obeys. A key insight from our analysis, then, is that real authority requires the principal to be able to enforce his orders in addition to being informed. Formally, the degree of real authority in our model can be captured by a variable R_i^*, $i = L, H$, defined as $R_i^* \equiv q_i^* F(b^*)$.[16]

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15. Our result that centralization is more valuable when α is low stems from the fact that a good agent makes the right choice from the principal's perspective, whereas the bad agent requires direction. If the model were set up so that the good agent requires direction from the principal to make the right choice, this result would be reversed. Our choice is consistent with Aghion and Tirole (1997) but our main conclusions with respect to separation costs do not depend on this modeling decision.

16. Alternatively, we could define R^* using the expected probability that the principal will get informed, $\gamma q_H^* + (1-\gamma) q_L^*$. This would not change our conclusions.

Proposition 3. The principal's real authority, R_i^*, increases in H, γ, s_A, δ, and β and decreases in s_P, c, and α. Real authority also decreases in L when $v = H$, but is ambiguous in L when $v = L$.

Proposition 3 demonstrates that all the factors that we discussed earlier have the same effects on the principal's real authority as they have on his decision to become informed and issue an order.

4. Monetary contracts

This section adds monetary incentives to the model, with several goals in mind. The first is to examine to what degree our results on separation costs are robust to inclusion of incentive contracts. More substantively, we are interested in how the availability of monetary incentives influences the allocation of authority: Are monetary incentives complements or substitutes for delegation? This sheds light on differences in centralization between organizations that can use strong monetary incentives, such as firms, and organizations that cannot, such as government. It also provides insight into how new information technologies that allow finely tuned performance measurement, and hence greater use of monetary incentives, may change the use of authority in the workplace. And finally, we want to explore how availability of monetary incentives affects the principal's welfare.

Recall that the monetary contract pays the agent zero if output is zero and w_t if output is v at time t. Both w_1 and w_2 are paid in the second period when output is observed. In order to keep the analysis tractable, we will make here the following simplifying assumptions. First, we let $\alpha = \beta$, although we will continue distinguishing between the two in order to help the reader see where the expressions come from. Second, we will assume that the project value v is known at the time of contracting to both the principal and the agent. Finally, b will be assumed to be distributed uniformly on $(0, B]$.

4.1 Monetary incentives in period two

In the second period, an incongruent agent obeys an order if and only if $b \leqslant w_2$. In the first period, the incongruent agent's decision to obey depends on whether disobedient agents are fired or not. If disobedient agents are not fired, then small changes in s_A and s_P affect neither the optimal monetary contract nor the principal's real authority and his decision to become informed and issue an order. Suppose therefore that disobedient agents are dismissed. The principal's second-period profit is then $[\hat{\alpha} + (1-\hat{\alpha})G(w_2)](v - w_2)$, where $\hat{\alpha}$ is the principal's posterior belief that he is facing a congruent agent and $G(b)$ is his posterior belief about the distribution of the incongruent agent's private benefits.

If the agent disobeyed in the first period, then the principal knows the agent is not congruent.[17] In this case, $G(b) = \frac{F(b)-F(b^{**})}{1-F(b^{**})}$ for $b \geqslant b^{**}$ and $G(b) = 0$ for

17. When disobedience is punished by dismissal, a congruent agent never considers disobeying, regardless of the wages specified by the monetary contract.

$b < b^{**}$, where b^{**} is the equilibrium cutoff level of the incongruent agent's private benefit below which he obeys in the first period when monetary contracts are feasible. The second-period expected profit from retaining the disobedient agent (an out of equilibrium strategy) would therefore be $E\pi_2(w_2, v) = \frac{w_2 - b^{**}}{B - b^{**}}(v - w_2)$, which is maximized at

$$w_2^{**}(\text{disobedient}) = \min\left\{\frac{v + b^{**}}{2}, B\right\}.$$

If the agent obeyed in the first period, then $\hat{\alpha} = \frac{\alpha}{\alpha + (1-\alpha)F(b^{**})}$ and $G(b) = \frac{F(b)}{F(b^{**})}$ for $b \leqslant b^{**}$ and $G(b) = 0$ for $b > b^{**}$. Maximizing the second-period expected profit, $\pi_2(w_2, v) = \left[\hat{\alpha} + (1-\hat{\alpha})\frac{w_2}{b^{**}}\right](v - w_2)$, then yields

$$w_2^{**}(\text{obedient}) = \max\left\{0, \frac{v}{2} - \frac{\alpha B}{2(1-\alpha)}\right\}.$$

Finally, $\hat{\alpha} = \beta = \alpha$ and $G(b) = F(b)$ for a new agent, yielding the expected profit $\left[\beta + (1-\beta)\frac{w_2}{B}\right](v - w_2)$, and the optimal wage $w_2^{**}(\text{new}) = w_2^{**}(\text{obedient})$.

A comparison of the two wages reveals that a disobedient agent, if retained, would receive stronger second-period incentives than a new (or obedient) agent would. This makes sense—an agent who disobeyed in the first period will obey in the second period only if induced by monetary incentives. A new agent, in contrast, might obey in the second period even without monetary incentives if he is congruent. The marginal benefit from strengthening second-period incentives is therefore smaller for a new agent than for a disobedient agent. This difference between disobedient and replacement agents is extreme when the congruence parameter $\beta = \alpha$ is large, so that $w_2^{**}(\text{new}) = 0$ and when the agent's separation cost s_A is large, so that $w_2^{**}(\text{disobedient}) = B$.

Due to space considerations, we will not analyze all four parameter regions defined by the above wage solutions. Instead, we will focus on the parameter space in which the difference in the second-period incentives for disobedient and for new agents is most pronounced, that is, $w_2^{**}(\text{new}) = 0$ and $w_2^{**}(\text{disobedient}) = B$. We find this to be the most interesting case, because it leaves substantial room for the role of the separation costs. To see why, consider the other polar case, where the two wages are equal to each other: $\alpha = b^{**} = 0$ and $v < 2B$, so that $w_2^{**}(\text{new}) = w_2^{**}(\text{disobedient}) = \frac{v}{2}$. In this case, the profit from retaining a disobedient agent is the same as the profit from hiring a new agent (gross of the replacement cost s_P), which means that the principal never fires a disobedient worker and s_P and s_A play no role in the allocation of authority.

The case where $w_2^{**}(\text{new}) = w_2^{**}(\text{obedient}) = 0$ and $w_2^{**}(\text{disobedient}) = B$ is ensured by the following assumption.

Assumption 1. $\alpha \geqslant \frac{v}{v+B}$, $B < v$, and $s_A \geqslant \frac{(1-\delta)}{\delta}(2B - v)$.

Under Assumption 1, a disobedient worker is replaced if and only if $\beta v - s_P \geqslant v - B$, or

$$s_P \leqslant \beta v - (v - B). \qquad (IC'_P)$$

Note that the cost of separation still matters here, but less than in the absence of monetary incentives, where the cutoff cost for replacing a disobedient agent is equal to $\beta v > \beta v - (v - B)$. The availability of monetary incentives reduces the principal's willingness to dismiss an incongruent agent because the principal can get compliance in the second period with a wage scheme instead of having to hire and train a new worker.

4.2 Monetary incentives in period one

Turning to the first period, if (IC'_P) does not hold, the principal will not fire a disobedient agent, but retain him and use monetary incentives in the second period. It is straightforward that in this case small changes in s_P and in s_A affect neither the optimal monetary contract nor the principal's real authority and his decision to become informed and issue an order.

Suppose therefore that the (IC'_P) is satisfied and a disobedient agent gets replaced. Under these parameter values, the incongruent agent obeys an order in the first period if and only if $\delta(b + w_1) \geqslant b - \delta s_A$, or

$$b \leqslant \frac{\delta(w_1 + s_A)}{1 - \delta} \equiv \hat{b}. \qquad (5)$$

We use $\hat{b}$ to denote the cutoff benefit for an arbitrary first-period wage and reserve b^{**} to be the cutoff level based on the equilibrium wage w_1^{**}. Note that $\hat{b} > b^*$ whenever $w_1 > 0$ and that monetary incentives and a threat of dismissal work as substitutes in inducing obedience by the incongruent agent.

The principal's expected profit in an equilibrium with dismissal is then given by

$$E\pi(w_1, q) = \delta\alpha(2v - w_1) + \delta q(1 - \alpha)[F(\hat{b})(v - w_1) + (1 - F(\hat{b}))(\beta v - s_P)] - C(q).$$

The optimal first-period contract in this equilibrium and the optimal probability of giving an order maximize $E\pi(w_1, q)$ subject to equation (5).

Let q^{**} and R^{**} be the equilibrium levels of centralization and first-period real authority in the presence of monetary incentives, respectively.[18,19] The following result describes how monetary incentives affect our earlier results regarding the role of separation costs in determining authority in the organization.

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18. We drop the subscripts $i = L, H$ here to simplify notation and to avoid confusion that could be caused by the fact that (IC'_P) holds for different values of v than (IC_P).

19. In general, monetary incentives make real authority feasible also in the second period. However, because the optimal second-period wage for retained workers is zero when (IC'_P) holds, the equilibrium second-period authority is zero in this case.

Proposition 4. When monetary contracts are available and Assumption 1 holds, both the probability that the principal issues an order (q^{**}) and the principal's real authority (R^{**}) weakly increase in s_A. The effects of s_P are ambiguous.

Proposition 4 demonstrates that when monetary incentives are available, the effects of the agent's separation cost s_A are similar to those in our base model without monetary incentives, but the effects of the principal's separation cost s_P are less clear. A change in separation costs affects authority by changing b^{**} and q^{**}. An increase in the agent's separation cost s_A increases both the agent's willingness to obey an order and the principal's likelihood of becoming informed. This can be seen from $E\pi_{\hat{b}s_A} = \delta q(1-\alpha)f(\hat{b}) > 0$ and $E\pi_{qs_A} = \delta(1-\alpha)F(\hat{b}) > 0$. Moreover, these two effects reinforce each other because $\hat{b}$ and q are complements in the principal's profit function.

In contrast, an increase in the principal's separation cost makes the principal less willing to dismiss the agent and more reliant on monetary incentives. Incongruent agents become more willing to obey, but disobedient agents are dismissed in an interior equilibrium. An increase in s_P then decreases the principal's expected profit from issuing an order, reducing the value of becoming informed and this tends to decrease q. However, the increase in b^{**} tends to increase q^{**}, so that the overall effect of s_P on q^{**} and on the principal's real authority $R^{**} = q^{**}F(b^{**})$ is ambiguous.

4.3 How Monetary Incentives Change Authority

This section studies how the allocation of authority varies depending on whether monetary incentives are or are not available. We can then ask, for example, how does centralization in government jobs, where political considerations limit the use of monetary incentives, compare to centralization in firms? And will firms delegate more or less if new information technology allows better measurement of worker performance and closer links between pay and performance?

In the second period, monetary incentives have no effect on real authority if the principal's incentive compatibility constraint (IC_P') holds, because retained agents do not receive positive wages. If (IC_P') does not hold, then monetary incentives increase the principal's second-period real authority, because disobedient agents are retained and offered monetary incentives.[20] The next proposition shows that in the first period, monetary incentives can both complement and substitute for centralization.

Proposition 5. Suppose Assumption 1 is satisfied and monetary incentives become available.

(a) If (IC_P') holds, both the probability that the principal issues an order and the principal's first-period real authority weakly increase (i.e., $q^{**} \geqslant q^*$ and $R^{**} \geqslant R^*$).

20. As we show in the proof to Proposition 5, the retained disobedient workers are paid $w_2^{d**} > 0$ in the second period. The second-period real authority is then given by $q^{**}F(w_2^{d**}) > 0$.

(b) If (IC'_P) does not hold but (IC_P) holds, the principal's first-period real authority decreases ($R^{**} < R^*$). The probability that the principal issues an order can increase or decrease, depending on parameter values.

Intuitively, availability of monetary incentives changes the trade-offs in two ways. First, monetary incentives may make the threat of dismissal less credible because the principal can fall back on cash incentives in the second period instead of firing the worker and suffering the deadweight cost of dismissal. In the other direction, monetary incentives can be combined with the threat of dismissal to augment the principal's power to sanction. If the principal is willing to replace an incongruent agent ((IC'_P) holds) but the agent's private benefit is so high that the threat of dismissal alone cannot prevent disobedience, adding monetary incentives may boost the cost of dismissal enough to get compliance. This in turn strengthens the principal's incentives to get informed and to issue an order. Monetary incentives thus lead to more authority by strengthening the principal's ability to enforce commands.[21,22]

A typical finding in the literature is that more effective monetary incentives lead to more delegation since there is less need to control a worker when he is motivated by cash incentives (Holmström and Milgrom 1991; Prendergast 2002; Moers 2006). A similar relationship arises in our model, but it appears because real authority becomes less feasible not because centralization becomes less desirable. Our analysis also shows that the effect can work in the other direction, which happens when monetary incentives strengthen the principal's sanctions enough to make centralization feasible.

Availability of monetary incentives gives the principal another tool and typically makes him better off. However, as the next proposition shows, introduction of monetary incentives can make the principal worse off in some circumstances.

Proposition 6. The principal can be worse off when monetary incentives are available than when they are unavailable.

Monetary incentives can be a problem for the principal by making it more difficult to credibly threaten a worker with dismissal. This is because when monetary incentives are unavailable, the principal can elicit good behavior from some incongruent agents in the first period at no cost with the threat of dismissal. When monetary incentives are available, the threat of dismissal may not be credible, and the principal may be able to elicit good behavior only

21. If better monetary incentives are due to new information technologies, these technologies could also decrease the principal's cost of becoming informed about the right course of action. This would further increase the optimal degree of centralization.

22. It is worth stressing that monetary incentives could increase the principal's real authority even if (IC'_P) does not hold. To see this, suppose (IC_P) is violated, so that no incongruent agent obeys in the absence of monetary incentives. In this case, the principal has no real authority without monetary incentives. It is straightforward to show that when α is very small monetary incentives would be used in the first period if available, eliciting some obedience and strengthening the principal's real authority.

by paying for it. Thus, the principal may be forced to use a more costly tool to gain compliance.

Proposition 6 may provide some insight on the otherwise puzzling fact that many organizations seem to use few or no monetary incentives. If a firm can commit not to use monetary incentives, the threat of firing becomes more effective. Commitment might be achieved by not adopting monitoring technology even if it is available. The underlying logic also suggests that the principal would like to have monetary incentives available when the cost of replacing workers is high and decision making is typically delegated.

It is perhaps worth mentioning that sometimes firms may not be able to change monetary incentives in the short run or to tailor incentive contracts to individual workers. This would effectively allow the firm to commit to second-period wages and it would add the constraint that the second-period wage has to be uniform (and possibly also equal to the first-period wage). Proposition 6 would therefore not apply, because the firm could commit to not use monetary incentives by setting the wage equal to zero at the beginning of the relationship. In those cases where the wage is positive, the firm's optimization problem is substantially more complicated than in the case of short-term contracts analyzed above and we do not have a full characterization of the optimal contract. However, one general insight that emerges from our analysis of this case is that when wages have to be uniform across both periods, the role of separation costs depends on three new effects. First, unlike in the case of short-term contracts, long-term incentives with fixed wages never induce an agent who disobeyed in the first period to obey in the second period (unless δ is very small). This tends to increase the principal's benefit from replacing a disobedient agent, thus strengthening the role of separation costs. Second, any given wage is more effective in eliciting obedience from newly hired agents than from disobedient agents, because new incongruent agents have on average lower private benefits than retained disobedient agents. This further strengthens the principal's incentive to dismiss a disobedient worker. The last effect is that the new agent must receive a positive wage if he obeys, which tends to make hiring this agent less attractive, working in the opposite direction to the first two effects. A sufficient condition for the first two effects to prevail is that δ is relatively large. Consequently, when the agents are patient, the principal is more likely to replace a disobedient agent—and separation costs play a more prominent role—under long-term incentives than when monetary contracts are not available.[23] In this case, part (b) of Proposition 5 does not apply when wages are uniform.

5. Extensions

This section sketches two extensions to the basic model in order to illustrate how incorporation of disobedience into a model of authority may shed light on

23. The principal's incentive compatibility condition in this case is given by $s_P \leqslant (v-w)[\beta + (1-\beta)F(w)]$. It is possible to show that a sufficient condition for this to be less constraining than (IC_P) is that $\delta \geqslant \frac{B}{B+s_A}$.

a variety of organizational issues. To keep results uncluttered, we focus on the model without monetary incentives and, unless otherwise noted, on a setting where the project value v is known.

5.1 Hiring Policies

The fact that compliance with orders is not guaranteed has ramifications for an organization's hiring policy. When decisions must be delegated to a particular job holder, it changes the type of worker that the firm would like to have in that job. To analyze this, consider two jobs, one with high separation costs for the principal ($s_P > \beta v$), so that full delegation is optimal ($q^* = 0$), and the other with low separation costs ($s_P < \beta v$) so that a positive degree of centralization is optimal ($q^* > 0$). These jobs will be called the "delegated" and "centralized" jobs for short.

A key worker characteristic the firm might wish to influence is α, which measures how closely the worker shares the objectives of the organization. The firm can choose this worker attribute at the cost $g(\alpha)$, where $g(\cdot)$ is an increasing and convex function. Let ϕ be an indicator variable equal to 1 if the job is centralized and zero if the job is delegated. Because the project value is known to the agent, b^* is given by $b^* = \frac{\delta s_A}{1-\delta}$ if $\phi = 1$ and $b^* = 0$ if $\phi = 0$. The firm then solves

$$\max_{\alpha,q} E\pi(\alpha,q,\phi) = \max_{\alpha,q} 2\alpha\delta v + \phi\delta q(1-\alpha) \times [F(b^*)v + (1-F(b^*))(\beta v - s_P)] - C(q) - g(\alpha).$$

Because $E\pi(\alpha,q,\phi)$ is supermodular in $(-\alpha,q,\phi)$, it follows that α decreases in ϕ, that is, the firm will choose a greater level of congruence in the delegated than in the centralized job.[24]

Another worker attribute that the firm might wish to affect is the worker's ability, or more generally, his marginal productivity. In our model this characteristic can be captured by the parameter v. Assuming again an increasing cost of selecting or training workers, it is straightforward to check that the firm's profit function is supermodular in (v,q,ϕ). Consequently, the firm will choose a larger v in the centralized than in the delegated job. Ability is more important in centralized jobs than in delegated jobs because the difference between centralizing and delegation for the principal consists of forcing the agent to choose v instead of zero.[25,26]

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24. The supermodularity of $E\pi(x,q,\phi)$, where $x \equiv -\alpha$, follows from $E\pi_{xq}(x,q,\phi) > 0$, $E\pi_{x\phi}(x,q,\phi) > 0$, and $E\pi_{q\phi}(x,q,\phi) > 0$.

25. For simplicity, we keep the cost of selecting or training workers the same for both types of workers. It seems reasonable, however, to assume that it is easier to find a high-ability white-collar worker than finding a blue-collar worker of the same ability. Such different cost functions could well lead the firm to select white-collar workers of higher absolute productivity than its blue-collar workers. Our point is that even if this is the case, the firm's emphasis on congruence relative to raw productivity is higher when selecting white-collar than blue-collar workers.

26. Marino (2006), in a hidden information model where the principal relies on communication from the agent about investment opportunities, also shows that managers may place a higher

As mentioned earlier, one possible interpretation is that the delegated and centralized jobs represent white-collar and blue-collar workers, respectively. Going with this interpretation, firms will care more about recruiting workers who share their values for white-collar jobs than blue-collar jobs. Along these lines, Simon (1991: 34) observes that "Pride in work and organizational loyalty are widespread phenomena in organizations . . . These traits are more strongly evident among skilled and managerial employees than among employees engaged in very routine work." Intuitively, congruence is more important for white-collar workers than for blue-collar workers because white-collar workers are given more autonomy, making it more important that they share the organization's goals. Conversely, managers will place a greater emphasis on the marginal product of decisions when hiring blue-collar than white-collar workers assuming that blue-collar workers have less discretion in what they do.

5.2 Managerial Traits

Some evidence suggests that managers may be "hardwired" to take different approaches to their jobs (Simon 1945/1997, commentaries on chapters 7, 10). Here we sketch an approach to the relation between authority and managerial traits.

One possible trait is empathy with workers. Dial and Murphy (1995) argue that some managers may find it personally costly to dismiss workers, because of empathy or because firing a worker will subject the manager to criticism from others. We can model this as a disutility e from dismissing a worker, so that the total separation cost for an "empathetic" manager becomes $s_P + e$, that is, the inclusion of disutility e is equivalent to an increase in the principal's separation cost s_P. Proposition 2 then implies that an empathetic manager exhibits a more "hands-off" approach to managing, being less likely to become informed and to issue an order. An empathetic manager also is more likely to have a worker disobey an order (Proposition 1), because the workers anticipate that the manager will be reluctant to punish disobedience with dismissal. Empathy on the part of the principal thus decreases his real authority.

Similarly, some managers may derive utility from the exercise of power per se (Simon 1945/1997: 206–207). We can model this as a utility o from giving a command that is obeyed. Because this utility materializes with probability $q[\alpha + (1-\alpha)F(b^*)]$, the principal's problem becomes

$$\max_{\{q\}} 2\alpha\delta v + \delta q(1-\alpha)[F(b^*)v + (1-F(b^*))\max\{0, \beta v - s_P\}] + \delta q[\alpha + (1-\alpha)F(b^*)]o - C(q).$$

It is immediate that when the project value is known, a manager who enjoys exercising power chooses a greater level of centralization (i.e., a greater q^*). Such a manager not only would give more orders than a "regular" manager, as

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value on ability when decisions are centralized. The demand for talent is high in that context because low-ability agents are particularly likely to distort information when the principal makes the decision.

one would expect, but also enjoys a greater degree of real authority, because when v is known, q does not affect the likelihood that the order is obeyed, $F(b^*)$.

Things are more complicated when the project value is not known ex ante. Because an increase in o increases both q_L^* and q_H^* by the same amount, the ratio q_L^*/q_H^* increases and the agent's belief that a disobedient agent will be dismissed, $\hat{\gamma}$, falls. This leads to our next result.

Proposition 7. When the project value is not known ex ante, the manager's lust for power leads to more disobedience (a smaller b^*).

Thus, a somewhat surprising implication of the analysis in this section is that the orders given by a power-hungry manager are less likely to be obeyed. With more disobedience, the manager's marginal benefit of becoming informed can be low enough to offset his lust for power and reduce centralization. As a result, a greater lust for power has an ambiguous effect on real authority—the manager may give more orders but they are less likely to be obeyed. Note that because a power-hungry manager experiences more disobedience, such a manager could end up dismissing more workers. In this way, the model suggests how a manager's lust for power can give rise to a dysfunctional organization characterized by conflicts between workers and management and by a high level of turnover.

6. Evidence on Authority and Separation Costs

The literature on allocation of authority is overwhelmingly theoretical in nature, driven by anecdotes and intuitions; there is almost no statistical evidence on the factors that determine the allocation of authority. It is beyond the scope of our article to provide rigorous evidence on the determinants of authority, but this section reports some interesting patterns that emerge from two recent surveys of organization practices. We do not view this evidence as a formal test of the model, but given the paucity of evidence on the allocation of authority, we believe the survey responses may be useful in thinking about the allocation of authority.

The data are drawn from the National Organizations Survey, 1996–97 and 2002 (Kalleberg et al. 2001; Smith et al. 2005). These surveys of managers and personnel officers contain a variety of information on employment policies, contracts, benefits, and the structure of organizations from across the United States. Our analysis uses data on corporations with at least 20 employees. Summary statistics of the variables we use are in Table 1.

One question asked in the survey is

How much choice do (workers) have concerning the best way to accomplish their assignments?

1) No choice, 2) Small amount, 3) Moderate amount, 4) Large amount, 5) Complete choice

We use a regression framework to identify factors that can "explain" the answers to this question. The dependent variable in all regressions takes on a

Table 1. Summary Statistics and Variable Descriptions

	Mean	SD	Min	Max	N	Description
				1996–97		
Worker choice (1 = no choice, 5 = complete choice)	3.17	0.90	1	5	321	How much choice do employees have concerning the best way to accomplish their assignments?
Difficulty of hiring (1 = very easy, 4 = not at all easy)	2.58	0.92	1	4	313	How easy is it to hire employees with necessary skills?
General training (1 = yes, 0 = no)	0.33	0.47	0	1	316	Was there formal job training in last 2 years and were skills to a great extent useful to other employers?
General and firm-specific training (1 = yes, 0 = no)	0.24	0.43	0	1	316	Was there formal job training in last 2 years and were skills to some extent useful to other employers?
Firm-specific training (1 = yes, 0 = no)	0.06	0.24	0	1	316	Was there formal job training in last 2 years and were skills not at all useful to other employers?
Employees	1.03	2.44	0.02	30.00	331	Full-time employees (in thousands)
Main business involves a product (1 = yes, 0 = no)	0.56	0.50	0	1	331	Main business can involve product, service, or both. This variable is 1 if product or product and service.
				2002		
Worker choice (1 = no choice, 5 = complete choice)	3.12	0.83	1	5	97	How much choice do employees have concerning the best way to accomplish their assignments?
Difficulty in hiring (very easy = 1, not at all easy = 4)	2.36	0.92	1	4	99	How easy is it to hire employees with necessary skills?
Job training (1 = yes, 0 = no)	0.76	0.43	0	1	100	Was there formal job training in last 2 years?
Employees	0.41	0.78	0.02	4.5	100	Full-time employees (in thousands)
Low-wage employees	0.26	0.28	0	1	94	% employees earning less than $10 per hour
Middle-wage employees	0.30	0.23	0	1	89	% employees earning $10-$15 per hour

Note. The sample includes only corporations (i.e., it excludes sole proprietorships and partnerships). Also, only firms with more than 20 workers in the core area are included. Worker choice, difficulty in hiring, and training variables apply only to core employees.

Table 2. Regressions Explaining the Amount of Choice Workers Have in Completing Their Assignments

	1996–97			2002		
	(1)	(2)	(3)	(4)	(5)	(6)
Difficulty of hiring (1 = very easy, 4 = not at all easy)	0.11** (0.06)	—	0.09* (0.05)	0.21** (0.09)	—	0.30*** (0.09)
Dummy = 1 if firm provides mostly general training	—	0.37*** (0.12)	0.38*** (0.12)	—	—	—
Dummy = 1 if firm provides general and firm-specific training	—	0.24* (0.13)	0.30** (0.13)	—	—	—
Dummy = 1 if firm provides mostly firm-specific training	—	0.18 (0.22)	0.31 (0.22)	—	—	—
Dummy = 1 if firm provides any kind of job training	—	—	—	—	0.22 (0.20)	0.17 (0.20)
Employees (thousands)	—	—	−0.04* (0.02)	—	— (0.11)	−0.17
Dummy = 1 if main business involves product	—	—	−0.27*** (0.10)	—	—	—
% employees earning <$10 per hour	—	—	—	—	—	−0.57* (0.32)
% employees earning $10–$15 per hour	—	—	—	—	—	0.04 (0.39)
Intercept	2.89*** (0.15)	2.98*** (0.08)	2.91*** (0.17)	2.64*** (0.23)	2.96*** (0.17)	2.46*** (0.31)
R^2	0.013	0.031	0.074	.051	.013	0.159
N	310	313	309	97	97	86

Note. Each column is a regression. The main entries are the coefficients, and standard errors are in parentheses. The dependent variable is the numerical response to the question: How much choice do employees have concerning the best way to accomplish their assignments? (1 = no choice,. . . , 5 = complete choice). Variable definitions and summary statistics are in Table 2. Significance levels: *10%, **5%, and ***1%.

value 1–5 corresponding to the answers. High values mean the firm has delegated authority to workers.

Table 2 reports the results. The first three columns use data from the 1996–97 survey and the last three columns use data from 2002. We do not combine the samples because the questions asked differ somewhat between the two surveys. We first investigate how worker autonomy is related to the firm's cost of replacing a worker. In column (1), worker choice is regressed on a variable measuring how difficult it is for the firm to replace a worker. The coefficient on the proxy for replacement costs (0.11) is positive and different from zero at better than the 5% level, suggesting that workers have more autonomy when they are costly to replace. Column (4) reports the analogous regression for 2002. The coefficient (0.21) is positive and statistically different from zero. Again we see that firms give their employees more authority when replacements are costly to hire. Columns (1) and (4) provide fairly direct evidence for a central premise of our analysis, that centralization is related to separation costs.

The remaining columns provide more indirect evidence using variables that may proxy for the worker's separation cost. Each firm was asked if it had provided worker training in the previous 2 years, and if so, if the training was valuable for other employers or only the firm itself. Based on the responses, each firm was assigned to one of four categories: provided only general training, provided only firm-specific training, provided both general and firm-specific training, and provided no training. Dummy variables for the first three categories are the explanatory variables in column (2). To the extent that general training increases an employee's outside options, our model suggests that employees will be given more decision authority. Consistent with this idea, the coefficient on general training (0.37) is positive and highly significant. The effect of firm-specific training is ambiguous in our model, possibly implying a modest effect on delegation. The coefficient (0.18) is smaller than that for general training and not statistically distinguishable from zero. The coefficient on the intermediate variable (0.24) is between the other two.

In column (3), the variables for firm and worker separation costs are included in the regression at the same time as well as two other control variables. The number of employees is included as a measure of firm size to capture the possibility that the amount of delegation is different in large and small firms. We might expect that coworkers can more easily cover for a fired worker in a large than small firm, making a large firm's separation cost lower than a small firm's. Consistent with this view, the estimate on firm size (-0.04) indicates that large firms delegate less. The other control variable is a dummy variable equal to 1 if the firm sells a product instead of only a service. This is included to allow the amount of delegation to vary with the nature of the business. Firms that sell products give workers less choice than service firms, all else equal, and the difference is significantly different from zero. The correlation can support more than one implication. In terms of our model, firms in nonmanufacturing industries could delegate more because these industries exhibit higher job destruction rates than manufacturing industries (Davis and Haltiwanger 1999). The pattern could also be consistent with information-based theories of delegation if worker information is more important in service firms than manufacturing firms. When the controls are included, the coefficients on the critical variables increase in magnitude. A high cost of replacing a worker and firm-provided general training continue to be positively related to the amount of worker autonomy in carrying out assignments. Both coefficients are significantly different from zero at the 5% level or better.

In column (5), worker choice is regressed on a dummy variable for firm-provided training. The 2002 survey does not include information that can break down training into general and firm specific. The summary statistics for Table 2 indicate that most training in 1996–97 was general in nature. If the same pattern holds in 2002, then the coefficient on the job training variable could represent primarily the effect of general training. The coefficient on job training is positive (0.22); however, it is not significantly different from zero.

In column (6), the regression includes both explanatory variables as well as three additional control variables. One control variable, as before, is the

number of employees. The coefficient (−0.17) again is negative but not different from zero at conventional levels of significance. The two other control variables are the fraction of employees earning less than $10 per hour ($20,000 per year) and the fraction earning between $10 and $15 per hour ($20,000 to $30,000 per year). The omitted category is the fraction of employees earning more than $15 per hour. These variables may capture differences in the skill level (or expertise) of workers. Consistent with existing theory, workers in the lowest wage category (interpreted as least expert) are given less freedom about how to complete their assignments. Workers in the middle-wage category appear to have no more or less authority than high-wage workers. As for the variables of primary interest: The coefficient on the difficulty of hiring a replacement (0.30) remains positive and is significant at better than the 1% level, whereas the coefficient on the training variable is positive (0.17) but too noisy to distinguish from zero.[27]

To sum up, the survey evidence suggests that the amount of worker autonomy is associated with the cost of separation for the firm and worker. Because the survey does not contain variables that capture information and agency problems stressed in previous theoretical work, it is not possible to rigorously test our variables compared to the standard variables. Nevertheless, since statistical evidence on the determinants of authority is virtually nonexistent, we believe the correlations that emerge from these surveys are useful in providing a rough picture of some of the factors that may be important for the allocation of authority.

7. Conclusion

In a general sense, our article is intended to suggest that the emerging theory of authority hinging on agency and information problems is missing an important ingredient. Managers of an organization can give orders, but they rely on the willingness of subordinates to carry them out. In a world of imperfect contracting, a manager may not be able to enforce compliance with his instructions and this may compel him to delegate decision rights to workers—even if the manager has superior information or the agent's private benefits will lead him astray. Our article explores the consequences of this reasoning for the allocation of decision-making authority within organizations. In our theory, the key variables determining decision-making arrangements are the worker's separation cost if he is dismissed and the firm's cost of hiring a replacement. We formalize the intuition that high worker separation costs promote centralization, whereas high replacement costs for the firm lead to greater delegation, and provide evidence from a sample of firms consistent with these implications.

Assigning an important role to the possibility of disobedience adds an intuitive dimension to the theory of authority and also revives a theme that was central to classic treatments of organization such as Barnard (1938/1968) and

27. The main findings from Table 2 are robust to a firm cutoff size of 30 workers, and to logistic regressions that measure autonomy as a discrete variable with 1 indicating "complete" or "a lot" of choice.

Simon (1945/1997). It also provides a natural explanation for anecdotes that are not easy to square with information theories, such as why professors are delegated more decision rights (e.g., over work hours, attire, and content) than workers in firms, even though professors do not have an obviously larger information advantage over their "manager" (the dean or department chair) than workers in corporations. A model with disobedience also has implications for the role of monetary incentives, which we show can increase or decrease the manager's authority and can even make the manager worse off. We also show that the inability to enforce orders has implications for hiring policy and managerial style. For example, in jobs where significant decision authority must be delegated, the manager will make a greater effort to hire workers who share his values, whereas in jobs that are centralized, the manager will emphasize ability when hiring.

There are a number of interesting avenues for future research. Our model does not distinguish the managers' from the organizations' interests, so it is not well suited for studying when disobedience might be efficient for an organization. Incorporating agency problems between the shareholder and managers is a natural extension, one that Landier et al. (2005) explore. Our analysis, in keeping with the rest of the economics literature, emphasizes monetary and employment sanctions as the foundation for authority. However, as Simon (1945/1997: 184) observes, "There are a number of other . . . factors which may induce acceptance of authority in organization. . . . The social sanctions are the first to be noted, and perhaps the most important. Not only does society set up the individual expectations of obedience in certain social situations, but the individual who fails to accept his role will feel, in one way or another, the social disapprobation of his fellows." Another interesting extension would be to explore how social sanctions affect the benefits and costs of disobedience and centralization. Such an extension would capture an effect that seems important a priori and would allow analysis of how and when organizations should nurture social sanctions and rewards in order to affect organizational performance (Lazear 1991).

Appendix A

Proof of Proposition 1. Combining equations (1)–(4) yields

$$b^* \left[1 - \delta + \left(\frac{1-\gamma}{\gamma} \right) \frac{L}{H + T(b^*)(\beta H - s_P)} \right] = \delta s_A, \tag{A1}$$

where $T(b^*) \equiv \frac{1-F(b^*)}{F(b^*)}$. It is immediate from equation (A1) that b^* is independent of c and α.

Next, define $D(b^*,k) \equiv \left[1 - \delta + \left(\frac{1-\gamma}{\gamma} \right) \frac{L}{H+T(b^*)(\beta H - s_P)} \right]$, where $k \in \{\gamma, H, L, \beta, \delta, s_P\}$. Differentiating equation (A1) with respect to a parameter k, we get

$$\frac{\partial b^*}{\partial k} \left[D(b^*,k) + b^* \frac{\partial D(b^*,k)}{\partial b^*} \right] = \frac{\partial (\delta s_A)}{\partial k} - b^* \frac{\partial D(b^*,k)}{\partial k}. \tag{A2}$$

Now, note that $D(b^*,k) > 0$ and $\frac{\partial D(b^*,k)}{\partial b^*} > 0$, where the latter is implied by $T'(b^*) < 0$. It follows that the sign of $\frac{\partial b^*}{\partial k}$ is equal to the sign of the right-hand side (RHS) of equation (A2).

γ, H, β : We have $\frac{\partial(\delta s_A)}{\partial k} = 0$ and $\frac{\partial D(b^*,k)}{\partial k} < 0$ when $k \in \{\gamma, H, \beta\}$, which implies $\frac{\partial b^*}{\partial \gamma} > 0$, $\frac{\partial b^*}{\partial H} > 0$, and $\frac{\partial b^*}{\partial \beta} > 0$.

L, s_P : $\frac{\partial(\delta s_A)}{\partial k} = 0$ and $\frac{\partial D(b^*,k)}{\partial k} > 0$ when $k \in \{L, s_P\}$, which implies $\frac{\partial b^*}{\partial L} < 0$ and $\frac{\partial b^*}{\partial s_P} < 0$.

s_A : $\frac{\partial(\delta s_A)}{\partial s_A} = \delta > 0$ and $\frac{\partial D(b^*,k)}{\partial s_A} = 0$, which implies $\frac{\partial b^*}{\partial s_A} > 0$.

δ : $\frac{\partial(\delta s_A)}{\partial \delta} = s_A > 0$ and $\frac{\partial D(b^*,k)}{\partial \delta} < 0$, which implies $\frac{\partial b^*}{\partial \delta} > 0$. □

Proof of Proposition 2. Since b^* is independent of c and α, equations (3) and (4) imply that q_L^* and q_H^* fall in c and α. Next, equation (3), Proposition 1, and $F'(b^*) > 0$ yield that q_L^* falls in s_P and increases in all the parameters that raise b^*, that is, in H, γ, s_A, δ, and β. Finally, L directly increases the left-hand side (LHS) of equation (3) but decreases b^*. It is straightforward to verify that either of these effects can prevail, depending on the parameter values, so that the effect of L on q_L^* is ambiguous.

The comparative statics on q_H^* work in a similar way. The parameters H, γ, s_A, δ, and β increase the LHS of equation (4) directly or indirectly through b^*, or both. Hence, q_H^* increases in these parameters. On the other hand, s_P and L decrease the LHS of equation (4) indirectly through b^*, and s_P also decreases it directly, which means that q_H^* falls in s_P and in L. □

Proof of Proposition 3. The claim follows in a straightforward way from the definition of R_i^* and from Propositions 1 and 2. □

Proof of Proposition 4. If disobedient agents are retained ((IC_P') does not hold), the principal's expected profit $E\pi(w_1, q)$ is independent of s_A and s_P. This implies that q^{**}, w_1^{**}, and R^{**} are also independent of s_A and s_P in this case.

Now suppose that (IC_P') holds. It is convenient to treat the principal's problem as a choice of $(q, \hat{b})$ rather than of (q, w_1). Using $w_1 = \frac{(1-\delta)\hat{b}}{\delta} - s_A$ and restricting attention to the feasible cutoff levels $\hat{b} \in \left[\frac{\delta s_A}{1-\delta}, B\right]$, the respective first-order conditions for the choice of q and $\hat{b}$ are

$$\mathrm{FOC(q)} : \delta(1-\alpha)\left[F(\hat{b})\left(v - \frac{(1-\delta)\hat{b}}{\delta} + s_A\right) + (1-F(\hat{b}))(\beta v - s_P)\right] - cq = 0;$$

$$\mathrm{FOC}(\hat{b}) : -\alpha(1-\delta) - q(1-\delta)(1-\alpha)F(\hat{b}) + q(1-\alpha)f(\hat{b})[\delta(1-\beta)v + \delta s_A + \delta s_p - (1-\delta)\hat{b}] = 0.$$

Suppose first the problem yields a corner solution $b^{**} = \frac{\delta s_A}{1-\delta}$, that is, monetary incentives are not used in $t = 1$. Then $1 - F(b^{**}) > 0$ and $\beta v - s_P > 0$ yield $E\pi_q|_{q=0} > 0$, which implies an interior solution for q^{**} for all $\alpha < 1$. The

result that q^{**} increases in s_A then immediately follows from $E\pi_{qs_A} = \delta(1-\alpha)F(b^{**}) > 0$. Since b^{**} also increases in s_A, $R^{**} = q^{**}F(b^{**})$ increases in s_A. Similarly, $E\pi_{qs_P} = -\delta(1-\alpha)[1-F(b^{**})] < 0$ implies that both q^{**} and R^{**} decrease in s_P in this case.

Next assume the opposite corner solution $b^{**} = B$. In this case it must be $E\pi_{\hat{b}}|_{\hat{b}=B} \geqslant 0$, which is only possible if $q^{**} > 0$. Hence, we again get an interior solution for q^{**} and the same arguments as above yield that both q^{**} and R^{**} increase in s_A and decrease in s_P.

Finally, let $b^{**} \in \left(\frac{\delta s_A}{1-\delta}, B\right)$. Then b^{**} is given by $E\pi_{\hat{b}}|_{\hat{b}=b^{**}} = 0$, which again requires $q^{**} > 0$. We thus have

$$
\begin{aligned}
E\pi_{qs_A} &= \delta(1-\alpha)F(b^{**}) > 0;\\
E\pi_{\hat{b}s_A} &= E\pi_{\hat{b}s_P} = \delta q^{**}(1-\alpha)f(b^{**}) > 0; E\pi_{qq} = -c < 0,\\
E\pi_{qs_P} &= -\delta(1-\alpha)[1-F(b^{**})] < 0;\\
E\pi_{\hat{b}\hat{b}} &= -2(1-\delta)q^{**}(1-\alpha)f(b^{**}) < 0, \text{ and}\\
E\pi_{q\hat{b}} &= -(1-\delta)(1-\alpha)F(b^{**}) + (1-\alpha)f(b^{**})\\
&\quad \times[\delta(1-\beta)v + \delta s_A + \delta s_p - (1-\delta)b^{**}] = \frac{\alpha(1-\delta)}{q^{**}} > 0.
\end{aligned}
$$

The second-order conditions $E\pi_{qq}, E\pi_{\hat{b}\hat{b}} < 0$ are met and we assume that the remaining second-order condition is satisfied, $E\pi_{qq}E\pi_{\hat{b}\hat{b}} - (E\pi_{q\hat{b}})^2 = \frac{2cq^{**}(1-\delta)(1-\alpha)}{B} - \left(\frac{\alpha(1-\delta)}{q^{**}}\right)^2 > 0$. We then note that $E\pi_{qs_A}E\pi_{\hat{b}\hat{b}} - E\pi_{q\hat{b}}E\pi_{\hat{b}s_A} < 0$ and $E\pi_{\hat{b}s_A}E\pi_{qq} - E\pi_{q\hat{b}}E\pi_{qs_A} < 0$, which in turn imply $\frac{\partial q^{**}}{\partial s_A} > 0$ and $\frac{\partial b^{**}}{\partial s_A} > 0$. Hence, R^{**} also increases in s_A.

Turning attention to the effects of s_P, we have that $\frac{\partial q^{**}}{\partial s_P} > 0$ if and only if $E\pi_{qs_P}E\pi_{\hat{b}\hat{b}} - E\pi_{q\hat{b}}E\pi_{\hat{b}s_P} < 0$. After rearranging, this holds if and only if

$$2q^{**}[1-F(b^{**})] < \frac{\alpha}{(1-\alpha)}. \tag{A3}$$

Now, let $\delta \to \frac{1}{s_A+B}$. Then $b^{**} \to B$, so that $F(b^{**}) \to 1$. Thus, equation (A3) holds and $\frac{\partial q^{**}}{\partial s_P} > 0$ for δ sufficiently close to $\frac{1}{s_A+B}$. We will next show that $\frac{\partial q^{**}}{\partial s_P} < 0$ when δ is small and $s_A \to 0$ and $\beta v - s_P \to 0$ (which requires $v - B \to 0$, from (IC_P)). Switching for the moment back to optimizing over (q, w_1), and using $s_A \to 0$ and $\beta v - s_P \to 0$, the first-order conditions for q and w_1 yield $w_1^{**}(v-w_1^{**})(v-2w_1^{**}) = \frac{\alpha(1-\delta)^2B^2c}{\delta^3(1-\alpha)^2}$. This requires $v/2 > w_1^{**} > \frac{\alpha(1-\delta)^2B^2c}{v^2\delta^3(1-\alpha)^2}$, so that from the first-order condition for q we get

$$2q^{**} = \frac{2\delta^2(1-\alpha)w_1^{**}(v-w_1^{**})}{cB(1-\delta)} > \frac{\delta^2(1-\alpha)v}{cB(1-\delta)}\frac{\alpha(1-\delta)^2B^2c}{v^2\delta^3(1-\alpha)^2} = \frac{\alpha(1-\delta)B}{v\delta(1-\alpha)}. \tag{A4}$$

Also, $w_1^{**} < v/2$ and $s_A = 0$ implies $b^{**} = \frac{\delta w_1^{**}}{1-\delta} < \frac{\delta v}{2(1-\delta)}$. Then

$$1 - F(b^{**}) = \frac{B - b^{**}}{B} > \frac{2B(1-\delta) - \delta v}{B}, \tag{A5}$$

which is strictly positive for δ sufficiently small. Using equations (A4) and (A5), we get $2q^{**}[1 - F(b^{**})] = \frac{\alpha(1-\delta)[2B(1-\delta)-\delta v]}{v\delta(1-\alpha)} > \alpha/(1-\alpha)$ for δ sufficiently small. Hence, $\frac{\partial q^{**}}{\partial s_P} < 0$ when δ is small.

It remains to show that the effects of s_P on R^{**} are also ambiguous. We have already established that when we have the corner solution $b^{**} = B$ (which is true, e.g., if δ is sufficiently large), then R^{**} decreases in s_P. Thus, it remains to show that R^{**} can increase in s_P. We have $\frac{\partial b^{**}}{\partial s_P} > 0$ if and only if $E\pi_{\hat{b}s_P} E\pi_{qq} - E\pi_{q\hat{b}} E\pi_{qs_P} < 0$, that is, if

$$\alpha(1-\delta)(B - b^{**}) < cq^{**2}. \tag{A6}$$

As before, let $\delta \to \frac{1}{s_A+B}$, so that $b^{**} \to B$ and q^{**} is bounded away from zero. Hence, both equations (A3) and (A6) hold for δ close enough to $\frac{1}{s_A+B}$. We therefore have $\frac{\partial b^{**}}{\partial s_P} > 0$ and $\frac{\partial q^{**}}{\partial s_P} > 0$, which implies that R^{**} increases in s_P for these parameter values. □

Proof of Proposition 5.

(a) Assume first that (IC'_p) holds. Under Assumption 1 the principal finds it suboptimal to use monetary incentives in $t = 2$. Suppose first the problem yields a corner solution $w_1^{**} = 0$, that is, monetary incentives are not used in $t = 1$. Consequently, $q^{**} = q^*$ and $R^{**} = R^*$ in this case.
Next suppose $w_1^{**} > 0$. Because $E\pi_{q\hat{b}} = \frac{\alpha(1-\delta)}{q^{**}} > 0$ in an interior equilibrium, as we have shown in the proof of Proposition 4, it must be that q^{**} increases in w_1, that is, $q^{**} > q^*$. Since $w_1^{**} > 0$ implies $b^{**} > b^*$, it must also be that $R^{**} > R^*$ in this case.

(b) Suppose (IC'_p) does not hold and let $w_2^d \equiv w_2(\text{disobedient})$ and $w_2^o \equiv w_2$ (obedient). A disobedient agent is then retained and offered w_2^d in $t = 2$. Consequently, an incongruent agent obeys in the first period if and only if

$$\delta[w_1 + \max\{b, w_2^o\}] \geqslant b + \delta \max\{b, w_2^d\} \tag{A7}$$

whereas a congruent agent obeys if $b + \delta(b + w_1 + w_2^o) \geqslant \delta(b + w_2^d)$, or

$$b \geqslant \delta(w_2^d - w_2^o - w_1) \equiv \tilde{b}. \tag{A8}$$

Restricting attention to feasible values of b, the cutoff benefit above which congruent agents obey is given by

$$b^C = \begin{cases} 0, \text{ if } \tilde{b} < 0 \\ \tilde{b}, \text{ if } \tilde{b} \in (0, B] \\ B, \text{ if } \tilde{b} > B. \end{cases}$$

Now, observe that both the LHS of (A7) and the RHS of (A7) are increasing functions of b, but the slope of the LHS of (A7) is always less than the slope

of the RHS of (A7). Hence, LHS of (A7) and RHSof (A7) intersect at most once and if they intersect at some $\hat{b} > 0$, then LHS of (A7) $\geqslant$ RHS of (A7) if and only if $b \leqslant \hat{b}$. Moreover, $\hat{b} > 0$ if and only if LHS of (A7) $>$ RHS of (A7) when evaluated at $b = 0$, that is, if and only if $w_2^{\mathrm{d}} - w_2^{\mathrm{o}} - w_1 < 0$. This implies that $b^{\mathrm{C}} = 0$ if $\hat{b} > 0$ and $\hat{b} = 0$ if $b^{\mathrm{C}} \geqslant 0$. That is, if some incongruent agents obey then also all congruent agents obey and if some congruent agents disobey then it must be that all incongruent agents disobey.

Suppose that the wages are such that the congruent agents always obey in the first period ($b^C = 0$). The analysis in the text and Assumption 1 then imply that in the second period, the principal sets $w_2^{\mathrm{o}**} = 0$ and $w_2^{\mathrm{d}**} = B$. An incongruent agent therefore obeys in period one if and only if $\delta(b + w_1) \geqslant b + \delta B$. Hence, $\hat{b} = \max\left\{0, \frac{\delta(w_1 - B)}{1-\delta}\right\}$, which implies that to elicit at least some obedience from the incongruent agents in $t = 1$, the first-period wage must be greater than B. The principal's expected profit is then given by

$$E\pi(w_1, q) = \delta\alpha(2v - w_1) + \delta q(1-\alpha)[F(\hat{b})(v - w_1) + (1 - F(\hat{b}))(v - B)] - C(q),$$

which yields $E\pi_{w_1} = -\delta\alpha - \delta q(1-\alpha)F(\hat{b}) + \frac{\delta^2}{1-\delta} q(1-\alpha) f(\hat{b})(B - w_1)$. Evaluating this at $w_1 = B$, we get $E\pi_{w_1}|_{w_1 = B} = -\delta\alpha - \delta q(1-\alpha)F(\hat{b}) < 0$. Hence, $w_1^{**} = 0$, that is, monetary incentives are not used in $t = 1$. However, condition (A8) then yields $b^{\mathrm{C}} = \delta B > 0$, a contradiction. Thus, by the previous argument, the equilibrium must be such that all incongruent agents and some congruent agents disobey in the first period ($\hat{b} = 0$ and $b^{\mathrm{C}} > 0$). This means that $R^{**} = 0$ for incongruent agents, which is less than R^* if ($\mathrm{IC_P}$) holds. Moreover, because some congruent agents also disobey, real authority is further undermined in the first period.

Turning to q and using $\hat{b} = 0$, first-period obedience tells the principal that he is dealing with a congruent agent, who does not need second-period incentives, so that we again get $w_2^{\mathrm{o}**} = 0$. If the agent disobeyed in the first period, then the posterior probability that the agent is congruent is $\hat{\alpha} = \frac{\alpha F(b^{\mathrm{C}})}{\alpha F(b^{\mathrm{C}}) + 1 - \alpha}$. The principal's second-period expected profit is therefore

$$E\pi_2(w_2^{\mathrm{d}}) = [\hat{\alpha} + (1-\hat{\alpha})F(w_2^{\mathrm{d}})](v - w_2^{\mathrm{d}}) = \left[\hat{\alpha} + (1-\hat{\alpha})\frac{w_2^{\mathrm{d}}}{B}\right](v - w_2^{\mathrm{d}}),$$

which is maximized at $w_2^{\mathrm{d}**} = \frac{v}{2} - \frac{\hat{\alpha}B}{2(1-\hat{\alpha})} = \frac{v}{2} - \frac{\alpha b^{\mathrm{C}}}{2(1-\alpha)}$. In equilibrium, the agent's expectation about the second-period wages must be correct, so that equation (A8) can be written as $b^{\mathrm{C}} = \delta(w_2^{\mathrm{d}**} - w_1)$. Plugging into the above expression and solving for $w_2^{\mathrm{d}**}$, we get

$$w_2^{\mathrm{d}**} = \frac{v(1-\alpha) + \alpha\delta w_1}{2(1-\alpha) + \alpha\delta}.$$

The principal's total expected profit is then given by

$$E\pi(w_1, q) = \delta\alpha[(1 - F(b^{\mathrm{C}}))(v - w_1) + (v - w_2^{\mathrm{d}**})]$$
$$+\delta q(1-\alpha)F(w_2^{\mathrm{d}**})(v - w_2^{\mathrm{d}**}) - C(q),$$

from which the first-order condition for q yields

$$\delta(1-\alpha)F(w_2^{d**})(v-w_2^{d**}) = cq^{**}. \tag{A9}$$

In contrast, in the absence of monetary incentives, q^* was given by equations (3) and (4). Suppose s_p is such that (IC_P) holds. A comparison of equation (A9) with (4) reveals that $q^{**} < q^*$ if $F(w_2^{d**})(v-w_2^{d**}) < [F(b^*)v + (1-F(b^*))(\beta v - s_P)]$, which holds if s_A is sufficiently large, so that b^* is close to B and $F(b^*)$ is close to one. Similarly, $q^{**} > q^*$ if $F(w_2^{d**})(v-w_2^{d**}) > [F(b^*)v + (1-F(b^*))(\beta v - s_P)]$, which holds if s_A is small, so that $F(b^*)$ is close to zero, and if s_P is close to βv. □

Proof of Proposition 6. Suppose (IC'_P) does not hold. As shown in the proof of Proposition 5, in this case the firm's expected profit is

$$E\pi(w_1,q) = \delta\alpha[(1-F(b^C))(v-w_1) + (v-w_2^{d**})]$$
$$+\delta q(1-\alpha)F(w_2^{d**})(v-w_2^{d**}) - C(q). \tag{A10}$$

Contrast this with the case where monetary incentives are not available and $\beta v - s_P > 0$. In this case $b^* = \frac{\delta s_A}{1-\delta}$ and the expected profit is

$$E\pi(q) = 2\delta\alpha v + \delta q(1-\alpha)[F(b^*)v + (1-F(b^*))(\beta v - s_P)] - C(q). \tag{A11}$$

By the Envelope Theorem, the maximum of equation (A10) is less than the maximum of equation (A11) if $[F(b^*)v + (1-F(b^*))(\beta v - s_P)] > F(w_2^{d**})(v - w_2^{d**})$. As we have shown in the proof of Proposition 5, this condition holds for a range of parameter values. □

Proof of Proposition 7. In this case, q_i^*, $i = L,H$, are given by the first-order conditions

$$\delta(1-\alpha)F(b^*)L + \delta[\alpha + (1-\alpha)F(b^*)]o = cq_L^*; \tag{A12}$$

$$\delta(1-\alpha)[F(b^*)H + (1-F(b^*))(\beta H - s_P)]$$
$$+\delta[\alpha + (1-\alpha)F(b^*)]o = cq_H^*. \tag{A13}$$

Analogous to equation (A1) in the proof of Proposition 1, equations (1), (2), (A12), and (A13) yield

$$b^*D(b^*,o) = \delta s_A, \tag{A14}$$

where $D(b^*,o) \equiv 1-\delta+\left(\frac{1-\gamma}{\gamma}\right)\frac{(1-\alpha)L+[1+\alpha T(b^*)]o}{(1-\alpha)[H+T(b^*)(\beta H-s_P)]+[1+\alpha T(b^*)]o}$ and $T(b^*) \equiv \frac{1-F(b^*)}{F(b^*)}$. Differentiating equation (A14) with respect to o, we get $\frac{\partial b^*}{\partial o}\left[D(b^*,o) + b^*\frac{\partial D(b^*,o)}{\partial b^*}\right] = -b^*\frac{\partial D(b^*,o)}{\partial o}$. It is straightforward to verify that $\frac{\partial D(b^*,o)}{\partial o} > 0$. Consequently, $\frac{\partial b^*}{\partial o} < 0$ if

$$D(b^*,o) + b^*\frac{\partial D(b^*,o)}{\partial b^*} > 0. \tag{A15}$$

We have $b^* \frac{\partial D(b^*,o)}{\partial b^*} = -\frac{B}{b^*}\left(\frac{1-\gamma}{\gamma}\right)\frac{(1-\alpha)o[\alpha(H-L)-(\beta H-s_P)]-(1-\alpha)^2L(\beta H-s_P)}{[(1-\alpha)[H+T(b^*)(\beta H-s_P)]+[1+\alpha T(b^*)]o]^2}$, where we have used the fact that $F(\cdot)$ is uniform on $[0,B]$ to obtain $b^*T'(b^*) = -\frac{B}{b^*}$. The following condition is therefore sufficient for inequality (A15):

$$b^*[(1-\alpha)L+[1+\alpha T(b^*)]o]$$

$$> B\frac{(1-\alpha)o[\alpha(H-L)-(\beta H-s_P)]-(1-\alpha)^2L(\beta H-s_P)}{(1-\alpha)[H+T(b^*)(\beta H-s_P)]+[1+\alpha T(b^*)]o}.$$

Because the LHS increases in L and the RHS falls in L, this holds for all L if it holds for $L=0$. Plugging in $L=0$ and using $\frac{B}{b^*} = T(b^*)+1$ reduces the condition to $1+\alpha T(b^*) > \frac{[T(b^*)+1](1-\alpha)[\alpha H-(\beta H-s_P)]}{(1-\alpha)[H+T(b^*)(\beta H-s_P)]+[1+\alpha T(b^*)]o}$. This is least likely to hold when $o=0$, which implies that a sufficient condition for equation (A14) is $[1+\alpha T(b^*)][H+T(b^*)(\beta H-s_P)]-[T(b^*)+1][\alpha H-(\beta H-s_P)]>0$. Differentiating the LHS with respect to $T(b^*)$, we get $\frac{\partial \text{LHS}}{\partial T(b^*)} = 2[1+\alpha T(b^*)](\beta H-s_P)>0$. Thus, equation (A15) holds if it holds for $T(b^*)=0$, that is, if $H(1-\alpha)+(\beta H-s_P)]>0$. This always holds, which proves that $\frac{\partial b^*}{\partial o}<0$. □

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