Review of Economic Studies (2002) **69**, 811–838
0034-6527/02/00320811$02.00

Authority and Communication in Organizations

WOUTER DESSEIN
University of Chicago and CEPR

First version received October 1999; *final version accepted January* 2002 (*Eds.*)

This paper studies delegation as an alternative to communication. We show that a principal prefers to delegate control to a better informed agent rather than to communicate with this agent as long as the incentive conflict is not too large relative to the principal's uncertainty about the environment. We further identify cases in which the principal optimally delegates control to an "intermediary", and show that keeping a veto-right typically reduces the expected utility of the principal unless the incentive conflict is extreme.

1. INTRODUCTION

This paper is concerned with the old saying that *"knowledge is power"*. In organizations, much of the information used in decision making is dispersed in the hierarchy. Lower-level managers, for example, are often much better informed about consumer needs, competitive pressures, specialized technologies or market opportunities than their superiors. The financial press is full of stories about how companies have pushed decision rights lower in the hierarchy in order to profit from this local knowledge.[1] For the same reason, newly acquired subsidiaries are often left with substantial autonomy. The goal of this paper is to better understand why an uninformed principal (the company owners, senior management) may grant formal decision rights to an agent (senior or middle management) who is better informed but has different objectives. We argue that a principal often delegates authority in order to avoid the noisy communication, and hence the loss of information, which stems from these differences in objectives.

At first sight, it may seem a puzzle why keeping authority and letting the agent report would not always weakly dominate delegation. By keeping authority, the principal has always the option to rubberstamp the proposals of the agent, but she may also refrain him from implementing projects which are obviously not in the interest of the organization. By delegating authority, in contrast, the principal commits to never reverse the agent's decisions. We will nevertheless argue that delegation is typically a better instrument to use the local knowledge of the agent than communication. Key to our analysis is that differences in objectives between principal and agent are often systematic and predictable. It is, for example, well documented that managers may be short-term biased, status-quo biased, risk-averse, empire builders etc. Whenever the principal and the agent systematically disagree on a certain action dimension, the principal will not rubberstamp a naive recommendation by the agent of his preferred action, but try to correct for the "bias" in objectives. As the agent is not naive but anticipates this, *communication* is then inherently *strategic* and—in equilibrium—noisy. Hence, the central trade-off in our paper is one between a *loss of control* under delegation and a *loss of information* under communication.

1. Among firms decentralizing decision rights in the 1990's are AT&T, General Electric, Eastman Kodak, Fiat, Motorola, United Technologies, Xerox and, recently, Ford.

Model. In order to analyse this trade-off, we develop a stylized model in which the principal (she) must screen among a range of projects which differ from each other on one dimension. The agent (he) has superior information on which project is best for the principal, but his objectives differ in a systematic way. He could, for example, always prefer a larger project than the principal (size-bias). For simplicity, this bias is constant and positive. Section 3 provides a discussion of the kind of biases we have in mind. The private information of the agent is assumed to be soft, that is the agent cannot prove or certify his knowledge. Furthermore, following Grossman and Hart (1986) and Hart and Moore (1990), we posit that *projects* (*actions*) *cannot be contracted upon* and, hence, the principal cannot use a standard mechanism to elicit the private information of the agent. The principal, however, can contract on the authority over the project. Indeed, to engage in a project, some critical resources are needed which are controlled by the principal. This implies that the agent normally needs the fiat of the principal to implement a project, but the principal can also delegate decision rights to the agent by granting him the authority over the use of these critical resources.

In our organization, the principal thus faces the *choice* between *fully delegating a task* to a better informed agent or to *order the latter what to do after having consulted him*. If she keeps decision rights and consults the agent, a game of strategic communication takes place in which each equilibrium is characterized by a partition of all possible states of nature and where the agent introduces noise into his signal by only specifying to which partition element the realized state of nature belongs. Given the information provided by the agent, the principal then takes the action which maximizes her expected utility. Such a *strategic information transmission* has been first analysed by Crawford and Sobel (1982), hereafter referred to as CS. While communication always involves a loss of information as long a preferences are not perfectly congruent, a central result of their paper is that the closer the preferences of agent and principal, the better is communication. The loss of information even goes asymptotically to zero when differences in objectives disappear. Delegation, in contrast, results in a loss of control since the agent always takes a decision which is biased relative to the first best. Similarly, this loss of control becomes smaller when the agent's preferences are closer to those of the principal and disappears in the limit. At first sight, the optimal allocation of authority is thus not trivial.

Results. Our main finding is that the principal optimally delegates control as long as the divergence in preferences is not too large relative to the principal's uncertainty about the environment. Thus, if the state of nature is uniformly distributed—a standard assumption in almost any application of the Crawford–Sobel model—the *principal prefers delegation to communication whenever the agent's bias is such that informative communication is feasible.* The larger the uncertainty about the environment, the larger is the range of biases for which the principal delegates control. More generally, for any given information structure, *delegation dominates communication if the bias is sufficiently small.* Indeed, for any continuous and twice differentiable distribution, as the agent's bias tends to zero, a principal who keeps control and communicates, will take an action which is on average an infinite times further away from the first best than the action the agent would take.

The intuition behind these results lies in the nature of the "screening" mechanism at work. For the agent to be induced to tell the truth, it is typically necessary that his messages become increasingly noisy as they recommend actions which go further in the direction of his bias. Intuitively, if an empire-builder recommends a "large" project, this message is less informative than if he recommends a "small" project. In addition, to prevent the agent from exaggerating his information, the increase in noise in subsequent signals should also be proportional to his bias. As a result, the better is communication, and thus the more messages the agent is able to send, the larger must be the average noise in these messages *relative* to the bias. In terms of the

CS-equilibrium, the finer the equilibrium partition becomes in absolute terms, the more coarse it is relative to the bias. Hence, the more informative is communication, the better it is to delegate authority to the agent and *avoid* communication.

In contrast, if we keep the bias constant, but change the information structure, *communication dominates delegation if the uncertainty about the environment is sufficiently small.* Indeed, while changing the information structure does not affect the loss of control under delegation, a more precise prior allows the principal to select an action which is on average much closer to the first best, and thus substantially reduces the loss of information under communication. While informative communication may then dominate delegation (*e.g.* when the prior of the principal is very "steep" and b is not too large relative to the support), communication is then typically very noisy. Simulations with (truncated) normal distributions and quadratic loss functions show that delegation is optimal unless the bias is so large that communication is almost uninformative: regardless of the variance of the distribution, only if the bias is such that the agent recommends the same action in more than 98% of all states of nature, communication does better than delegation.

To conclude, we investigate whether the principal can improve upon the pure delegation outcome by some *limited forms of delegation*:

— In Section 6, we show that in the leading example of Crawford and Sobel,[2] for moderate biases, the principal optimally *delegates decision rights to an intermediary* with objectives in between hers and her agents'. Doing this, the principal may prevent the agent from implementing extreme projects, without jeopardizing too much the communication concerning small and intermediate projects. Delegation to the agent remains optimal for small biases.

— In Section 7, finally, we consider *delegation with veto-power* for the principal, a mechanism which is known as the "closed rule" in Political Science (see Section 2). Again, one might conjecture that delegating but retaining veto-power should at least weakly dominate complete delegation. For reasonable choices of the status quo and a uniform distribution, however, we show that keeping veto-power is only beneficial for large divergences of preferences. For small or moderate biases, keeping veto-power results in additional variance in the deviation from the first-best, and complete delegation is optimal.

Outline. The paper is organized as follows: Section 2 gives an overview of the related literature. Section 3 describes the model. Section 4 characterizes the equilibrium for given decision rights. Section 5 then analyses the optimal allocation of authority. We go on to investigate the value of delegating control to an intermediary (Section 6) and the value of keeping veto-power (Section 7). Section 8, finally, discusses various extensions of our model: profit-sharing arrangements, private information concerning the agent's bias, repeated interaction, and verifiable information. We conclude in Section 9.

2. RELATED LITERATURE

The incentive view on delegation. So far, the economic literature on organizations has emphasized an incentive based rationale for delegation. In particular, Aghion and Tirole (1997), show that a principal may delegate formal authority to an agent in order to give the latter better

2. In the leading example of CS, principal and agent have a quadratic loss function and the state of nature is assumed to be uniform on $[0,1]$. So far, it has been the working horse for almost any application of CS.

incentives to acquire information.[3] While the focus of Aghion and Tirole is on the impact of authority on the information structure, we take the information structure as given—the agent is assumed to be better informed—and we investigate how the allocation of authority affects the use of this private information, providing a purely informational rationale for delegation.

The informational theory of legislative rules. Both the incentive based rationale and our purely informational rationale for delegation have a counterpart in the "informational theory of legislative rules" in political science. In a very influential paper, Gilligan and Krehbiel (1987) adopt the leading example of CS[4] in order to provide a rationale for the use of restrictive amendment procedures employed in the U.S. House of Representatives. In particular, Gilligan and Krehbiel (GK) is concerned with the motivation of the "closed rule", under which an uninformed legislature can only veto but not amend a proposal of a committee. If a proposal is vetoed, the status quo (which is taken exogenous) prevails. As Aghion and Tirole, GK assumes that this committee must make an effort to become informed. For the leading example of Crawford and Sobel, GK finds that when the preference divergence between the legislator and the committee is small, the "closed rule" is to be preferred over the "open rule" under which the legislature can freely amend the proposal of the committee. While GK mainly emphasize the closed rule's impact on incentives to acquire information,[5] Krishna and Morgan (2000) have recently shown that even in the absence of an information acquisition problem, the closed rule dominates the open rule as long as informative communication is possible under this open rule, a result which is similar to ours. While delegation is related to the "closed rule",[6] Section 7 shows that in the model of GK, for reasonable choices of the status quo, *delegation strictly dominates the closed rule unless preferences divergences are extreme.* In this sense, our paper points to a missing element in the reasoning of GK, which should explain why the committee then does not receive full decision power.

Other related literatures. Finally, our paper differs from a number of literatures on "information revelation" in its assumptions on the commitment ability of the principal. By adopting an incomplete contracting approach, we clearly depart from the standard principal–agent model in which the principal elicits private information by designing a mechanism. While this approach may explain many institutions, we feel that the underlying premise that the principal can perfectly and without cost commit herself to any mechanism is too strong in many organizational contexts.

In sharp contrast with the mechanism design literature, the literature on strategic communication or "cheap talk", initiated by CS assumes that no commitment at all is possible. When we think about communication in organizations, this is also rather unrealistic. Indeed, it is an insight of the property rights literature that ownership or more generally the control over critical resources confers authority to its holder. Hence, the principal can commit to never overrule the decisions of the agent by delegating to him the control over these critical resources. We discuss some of the recent literature on cheap talk in Section 8.2.[7] Most closely related is

3. As argued by Szalay (2000), however, it may be optimal to limit the discretion of the agent, and force him to choose between extreme options in order to provide even stronger incentives for information acquisition.

4. See footnote 2.

5. On p. 325, for example, they state "The dominant focus of the paper has been on the informational role of committees, more specifically on a committee's incentive to acquire expertise which, in equilibrium, may be used beneficially."

6. If the status quo were sufficiently extreme, the closed rule would even be identical to delegation. In the mentioned papers, however, this is never the case, since they assume that the status quo policy may be optimal. As is clear from Proposition 4, the closed rule then results in a very different outcome than pure delegation.

7. Other recent papers are Banerjee and Somanathan (2001), Battaglini (2001), and Krishna and Morgan (2001). Unlike CS, these papers consider more than one agent.

de Garidel-Thoron and Ottaviani (2000), which also compares delegation with communication, and investigates what happens when the information is noisy, the direction of the agent's bias is uncertain and the strategic sophistication of the principal limited.

Finally, a few studies, such as Holmström (1984), Melumad and Shibano (1991), and Armstrong (1994), posit that the principal can commit to a decision rule but not to monetary transfers. As noted by Holmström, such a decision rule only limits the discretion of the agent to a subset of actions and thus boils down to a partial form of delegation. In contrast to our paper, which stresses the loss of information which occurs when a commitment to (full) delegation fails, Holmström and Armstrong derive some general properties of the optimal partial delegation while Melumad and Shibano emphasize that the sender (the agent) does not always benefit from communication and hence may try to avoid it. The main difference with our paper, however, is that these papers presume that the principal can reverse some actions (which she determines *ex ante*) and at the same time is able to commit never to reverse others.

3. THE MODEL

A (profit or non-profit) organization has the opportunity to engage in a valuable project. There are an infinity of potential projects, but only one project can be undertaken. While an agent (he) is hired to implement this project, a principal (she) initially controls the critical resources of the organization which are needed to initiate any of these projects. The principal can be the CEO or the owner of a firm, but in principle, any hierarchical relationship in an organization could fit our model.

Preferences. Projects differ from each other on one dimension and can be represented by a real number $y \in \mathcal{R}$. (Alternatively, projects may have different dimensions, but agent and principal agree on all but one dimension.) With each project y is associated a monetary gain and/or private benefit $U_P \equiv U_P(y, m)$ for the principal and a private benefit $U_A \equiv U_A(y, m, b)$ for the agent, where m is a random variable and b a parameter of dissonance between agent and principal. The utility of the principal reaches a unique maximum for $y = m$ and can be rewritten as

$$U_P(y, m) = U_P(m, m) - \ell(|y - m|)$$

where $\ell''(\cdot) > 0$ and $\ell'(0) = 0$. Similarly, the utility of the agent is maximized for $y = m + b$ and can be rewritten as

$$U_A(y, m) = U_A(m + b, m) - \ell_A(|y - (m + b)|)$$

where $\ell''_A(\cdot) > 0$ and $\ell'_A(0) = 0$. Wlog, we assume $b > 0$. We will often refer to b as the *bias* of the agent.

Systematic biases in agency relationships are well documented. It is well accepted, for instance, that managers have a propensity to cause their department, division or firm to grow beyond the optimal size, *i.e.* they are *empire builders* and undertake too many investments.[8] They further seldom take externalities on future managers into account and, hence, are excessively *oriented towards short-term profitability* and results. Employees, concerned with their career perspectives, will favour projects with a high visibility or a close contact with senior management; they may, for the same reason, prefer projects which allow the acquisition or improvement of important skills or avoid risky projects. Managers also often internalize too much the interests of their subordinates. Bertrand and Mullainathan (1999), *e.g.* provide evidence that managers have a *preference for paying high wages*. In the same vein, managers with close ties to

8. See, for example, Jensen (1986).

their personnel may fire too few employees during a restructuring. Anecdotal evidence of other biases abound: employees are claimed to be *effort-averse, status-quo biased,* etc.

It is worth noting that biases often arise endogenously as the product of inherently imperfect incentive schemes. Division managers' salaries depend in general on the performance of their division, which distorts incentives if projects involve externalities on other divisions. Similarly, shareholders may partially control managerial short-termism by the way remuneration depends on reported earnings and changes in stock-market value. In order to simplify the analysis, however, we will treat the bias as exogenous in the core of the paper. In Section 8.1, though, we briefly discuss the impact of different incentive-schemes, such as profit-sharing arrangements, which aim to reduce the agent's bias.

Information structure. Only the agent observes the random variable m whose twice differentiable distribution function $F(m)$, with density $f(m)$, is supported on $[-L, L]$. The other parameters of the utility functions are common knowledge. Though not made explicit in the model, the superior information from the agent can be seen as an externality from implementing actions in previous periods or from his "proximity" to the business environment (clients, suppliers, competitors). In the core of the paper, we assume that information is soft, that is the agent cannot certify or "prove" his information. No restriction is imposed on the set of messages which can be sent by the agent. In Section 8.3, we discuss how relaxing this assumption may affect our results.

Authority and contracts. We adopt an incomplete contracting approach by positing that *projects (actions) cannot be contracted upon* and that to engage in a project, some critical resources are needed, which are initially controlled by the principal. Resources which we have in mind, are (a) the *assets* of the organization, (b) the *name* of the organization and more generally *the right to contract* on behalf of the organization with third parties, and, (c) to some extent, the *human resources* of the organization.[9] While projects cannot be contracted upon, the principal may then grant subordinates authority over the use of the resources needed to initiate a project.[10] This can be done by contracts, job-descriptions, corporate charters, customs or, in the extreme case, by selling some of the assets of the organization to the agent.[11] If an agent has control over the critical resources, he can initiate a project without assistance of the principal: he has formal decision rights. If the principal keeps authority, on the other hand, the agent needs her fiat. This fiat can take the form of some "signatures", may require some concrete actions by the principal, or may imply that the principal (or her staff) takes full care of the initiation stage. In any case, the principal then fully controls the project choice. Once a project is initiated, it still needs to be implemented by the agent, but cannot be reversed any more.

The timing is as follows. (i) The principal decides whether or not to delegate the agent authority over the use of the critical resources. (ii) The agent learns m and initiates her preferred project if she has authority. If the principal has not delegated authority, she may ask the agent to make a recommendation, and then initiates a project. (iii) The agent implements the project.

9. This control stems from the fact that the principal can contract with employees, that is hire, promote, demote and fire them.

10. By arguing that authority not only stems from *ownership* of assets, we follow several recent articles. For example, Aghion and Tirole (1997) argue that "Authority may more generally result from an explicit or implicit contract allocating the right to decide on specified matters to a member or group of members of the organization" (p. 2). Rajan and Zingales (1998) stress *access,* defined as the ability to use, or work with, a critical resource, as an alternative mechanism to allocate power. Baker, Gibbons and Murphy (1999) investigate how decision rights may be delegated informally through self-enforcing relational contracts.

11. Furthermore, the owner may delegate the authority to delegate some of these decisions to employees at lower levels in the organization, and so forth.

We assume that control rights over resources can only be allocated to the agent at the initial date and, hence, are always unconditional.

4. DELEGATION VS. COMMUNICATION

In our model, the principal has two instruments to use the local information of the agent: delegation and communication. In this section, we study both instruments separately and compare their comparative statics.

4.1. *Delegation*

Suppose first that principal and agent cannot communicate with each other. The principal then delegates control or takes an uninformed action. If the agent has control, he implements $y = m + b$, yielding

$$U_P(m + b, m) = U_P(m, m) - \ell(b)$$

to the principal. Hence, the principal delegates authority if and only if b is smaller than a cut-off value b' given by

$$\ell(b') \equiv \min_y \int_{-L}^{L} \ell(|y - m|) dF(m) \cdot$$

Obviously, the principal's expected utility increases as the agent's bias decreases and reaches the first best as b tends to zero.

4.2. *Communication (Crawford–Sobel)*

Consider now the polar case where the principal cannot commit to let the agent decide, but communication between agent and principal is feasible. Since projects are non-contractible, the principal then always undertakes the project y which maximizes her expected utility conditional on her beliefs upon m. Hence, the only thing communication may achieve, is changing the beliefs of the principal. This form of communication is often referred to as "cheap talk" and was first studied by Crawford and Sobel (1982). In CS, a better-informed sender (the agent) may reveal some of his information by sending a possibly noisy signal to a receiver (the principal), who then takes an action (initiates a project) which determines the welfare of both. The only constraint on the information transmission is that the agent's message and the principal's subsequent decision form a Bayesian equilibrium. Formally, an equilibrium is characterized by (i) a family of *signalling rules* $q(n|m)$ for the agent, where for every $m \in [-L, L]$, $q(n|m)$ is the conditional probability of sending message n given state m, and (ii) a *decision rule* $y(n)$ for the principal, where $y(\cdot)$ is a mapping from the set of feasible signals N to the set of actions $\mathcal{R}$, such that

- for each $m \in [-L, L]$, if n^* is in the support of $q(\cdot|m)$, then n^* maximizes the expected utility of the agent given the principal's decision rule $y(\cdot)$,
- for each n, $y(n)$ maximizes the expected utility of the principal, taking into account the agent's signalling strategy and the signal she receives in order to update her prior of the distribution of m.

As shown by CS, all equilibria in this communication game are characterized by a *partition* of $[-L, L]$, where the sender (the agent) introduces noise into his signal by only specifying to which partition element the realized state of nature belongs. As their model encompasses ours, the following proposition, which is a variant of Theorem 1 in CS, can be shown to hold.

Let $a \equiv (a_0, \ldots, a_N)$ denote a partition of $[-L, L]$ with N steps and dividing points between steps $a_0, \ldots, a_N$, where $-L = a_0 < a_1 < \cdots < a_N = L$. Define, for all $\underline{a}, \bar{a} \in [-L, L]$, $\underline{a} < \bar{a}$,

$$\bar{y}(\underline{a}, \bar{a}) \equiv \arg\max \int_{\underline{a}}^{\bar{a}} U_P(y, m) f(m) dm \cdot$$

Proposition 1 (Crawford and Sobel: Communication Equilibrium). *If $b > 0$, then there exists a positive integer $N(b)$ such that, for every N with $1 \leq N \leq N(b)$, there exists at least one equilibrium $(y(n), q(n|m))$, where*

$$q(\bar{y}(a_{i-1}, a_i) \,|\, m) = 1 \quad \textit{if} \quad m \in (a_{i-1}, a_i), \tag{1}$$

$$U_A(\bar{y}(a_i, a_{i+1}), a_i) - U_A(\bar{y}(a_{i-1}, a_i), a_i) = 0, \tag{A}$$

$$(i = 1, \ldots, N-1),$$

$$y(n) = \bar{y}(a_{i-1}, a_i) \quad \textit{if} \quad n \in (a_{i-1}, a_i) \tag{2}$$

$$a_0 = -L, \quad \textit{and} \quad a_N = L. \tag{3}$$

Further, all other equilibria have relationships between m and the principal's induced choice of y that are the same as those in this class for some value of N with $1 \leq N \leq N(b)$; they are therefore economically equivalent.[12]

Proof. The proof follows directly from CS, Theorem 1. ||

In equilibrium, only a finite number $N \leq N(b)$ of actions are thus implemented with positive probability, and the states of nature for which each of these actions is best for the agent form an interval, and these intervals form a partition of $[-L, L]$. The partition a is determined by (A), a well-defined second-order linear difference equation in the a_i's, and (3), its initial and terminal conditions. Equation (A) is an "arbitrage" condition which says that for states of natures that fall on the boundaries between steps, the agent is indifferent between the associated values of y. Given our assumptions about U_A, this condition is necessary and sufficient for the agent's signalling rule to be a best response to $y(n)$. Similarly, (2) gives a best response of the principal to the signalling rule (1).

Equilibrium selection. Although there is, in general, a multiplicity of economically different equilibria, CS provide some sufficient conditions under which the expected utility of both the principal and the agent are *ex ante* (that is, before the agent knows the state of nature) maximized by the same equilibrium.[13] Under these conditions, this is the equilibrium with the largest number, $N(b)$, of partition elements. As CS, we think that it is reasonable for the players to coordinate on this *(ex ante) Pareto-superior* equilibrium. Doing this, *we allow communication to be as powerful as possible.*

Comparative statics. Under the same conditions as above, CS establish a sense in which communication improves when the receiver (the principal) and the sender (the agent) have more similar preferences. They show that for a given b, the principal always strictly prefers equilibrium partitions with more elements and that the largest possible number of partition elements $N(b)$ weakly decreases with b. In the limit, as preferences of sender and receiver tend

12. CS Theorem 1, for instance, proposes that $q(n \mid m)$ is uniform, supported on $[a_{i-1}, a_i]$ if $m \in (a_{i-1}, a_i)$.

13. While these conditions are quite stringent, they are always satisfied when $F(m)$ is uniform and U^P and U^A depend on y and m only through $y - m$, as in our model.

to coincide, communication even becomes perfect: in the leading example of CS, the noise in the sender's message then tends to zero in the most informative equilibrium, a result which holds for any distribution $F(m)$, as shown by Spector (2000). In contrast, once preferences diverge by more than a given finite amount, only uninformative communication is consistent with rational behaviour.

A first comparison. From the previous analysis, the comparative statics of delegation and communication are very similar. When the agent's bias is very large, no informative communication is possible, but also delegation is suboptimal: the principal then optimally takes an uninformed decision. When the agent's bias decreases, communication improves, from which CS conclude *"direct communication is more likely to play an important role, the more closely related are agent's goals"*. However, also the expected utility under delegation increases as b decreases and both implement the first best as b tends to zero. At first glance, it is thus not clear how the optimal allocation of authority will vary with b.

5. THE OPTIMAL ALLOCATION OF AUTHORITY

We are now ready to endogenize the allocation of formal decision rights. As there exists in general no tractable solution to the second-order linear difference equation (A) of Proposition 1, unless $F(m)$ is uniformly distributed, we first focus on that simple case. We subsequently discuss to what extent our results carry over to more general distributions.

5.1. *Uniform distribution*

From CS, we know that all communication equilibria are fully characterized by a partition of $[-L, L]$, where the agent tells the principal to which partition element the state of nature m belongs. As a measure for the minimum *loss of information* under communication, it will be useful to define the *minimal average size of the partition elements*, denoted by $\bar{A}(b)$:

$$\bar{A}(b) \equiv 2L/N(b)$$

where $N(b)$ is the maximum number of partition elements in equilibrium given b. Note that this measure underestimates the real loss of information if partition elements are unequal in size. Similarly, a measure for the *loss of control* under delegation is given by the bias b.

Denoting by $y^* \equiv y(m)$ the *action undertaken by the principal under communication*, a sufficient condition for delegation to be strictly preferred over communication is that

$$E(|y^* - m|) \geq b. \tag{4}$$

Even when the equality holds, the principal strictly prefers to delegate because of the variance in $|y^* - m|$. Since $F(m)$ is uniform, we have that

$$E(|y^* - m|) \geq \bar{A}(b)/4 \tag{5}$$

where the inequality is strict if and only if partition elements are unequal in size.[14]

From (4) and (5), a sufficient condition for delegation is thus $\bar{A}(b)/b \geq 4$. In the remainder of this section, we show that $\bar{A}(b)/b \geq 4$ holds whenever $N(b) \geq 3$. In addition, while $\bar{A}(b)$ goes to zero as b tends to zero, $\bar{A}(b)/b$ then tends to infinity. We conclude by showing that also for $N(b) = 2$, we necessarily must have that $E(|y^* - m|) \geq b$, and thus whenever informative communication is possible, the principal prefers to delegate authority and avoid communication.

14. If partition elements differ in size, m is more likely to belong to larger partition elements for which $E(|y^* - m|)$ is larger.

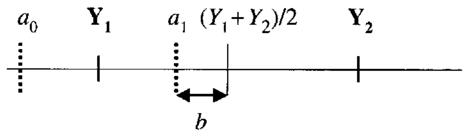

FIGURE 1
$a_2 - a_1 = a_1 - a_0 + 4b$

Key to our results will be the observation that *partition elements are increasingly large* as we move up the interval, where this increase is proportional to the bias. Suppose that y_1 and y_2 are two adjacent actions which are taken with a positive probability in equilibrium and denote by a_0, a_1 and a_2 the dividing points of the equilibrium partition respectively preceding y_1, following y_1 and following y_2.

Since the principal is not restricted in her project choice, she always initiates the project which is equal to the average state of nature of a partition element, that is $y_1 = (a_0 + a_1)/2$ and $y_2 = (a_1 + a_2)/2$. At the dividing point $m = a_1$, the agent must be indifferent between y_1 and y_2. As a result, we also have that $a_1 = (y_1 + y_2)/2 - b$. As can easily be seen on Figure 1, the latter two conditions imply that

$$a_2 - a_1 = a_1 - a_0 + 4b.$$

Lemma 1. *The size of a partition element is always* $4b$ *larger than the size of the preceding one:*

$$a_{i+1} - a_i = a_1 - a_0 + 4ib, \qquad i = 1, \ldots, N(b) - 1.$$

Lemma 1 explains us neatly how the "screening mechanism" of the communication equilibrium works: the agent is induced to tell the truth by the fact that "larger" messages are more noisy, which makes "exaggerating" his private information very costly. The larger the bias of the agent, the larger the incentive to exaggerate and, hence, the larger should be the increase in noise to keep the agent on his toes.

Note that the above result is in line with some straightforward intuitions on real world communication. Common sense tells us that if a person with a preference towards large projects recommends a "large" project, then his message is not very informative. If, on the other hand, the same person proposes a "small" project, this is much more revealing. Intuitively, one would thus expect that the more the agent's message pleads for an action which goes in the direction of his bias, the noisier this message will be, or in the terms of our model, the larger the size of the associated partition element. On the other hand, if the agent had no bias at all, there would be no reason for a "large" message to be more noisy than a "small" message. Hence, the increase in the noisiness should be somehow proportional to the bias.

Clearly, Lemma 1 seriously limits the effectiveness of communication as a means of information aggregation relative to delegation. Indeed, good communication requires a lot of messages or partition elements, where each partition element must be $4b$ larger than the preceding one. Hence, if communication is very good in absolute terms, the average size of a partition element, $\bar{A}(b)$, will be very large relative to the bias b. Concretely, from Lemma 1, it follows that

$$\bar{A}(b) = a_1 - a_0 + \frac{1}{N(b)} \sum_{i=1}^{N(b)-1} 4ib \geq 2[N(b) - 1]b. \tag{6}$$

As a result, the larger is $N(b)$ and thus *the better is communication, the worse communication performs relative to delegation.* When b tends to 0, $\bar{A}(b)/b$ even goes to infinity. More important for our purpose, from (6), whenever $N(b) \geq 3$, we have that $\bar{A}(b) \geq 4b$ and thus $E(|y^* - m|) \geq b$.

We conclude by showing that also for $N(b) = 2$, the principal prefers to delegate rather than to communicate. Denote $A_1 \equiv a_1 - a_0$ and $A_2 = a_2 - a_1$. From Lemma 1, then $A_2 = A_1 + 4b$ so that if the principal keeps authority, she implements $y = a_0 + A_1/2$ if $m \in (a_0, a_1)$ and $y = a_1 + A_1/2 + 2b$ if $m \in (a_1, a_2)$. Given that $F(m)$ is uniform, this implies again that $E(|y^* - m|) \geq b$, where the equality holds if and only if $A_1 = 0$. The next proposition states our first main result:

Proposition 2. *If $F(m)$ is uniformly distributed over $[-L, L]$, the principal prefers delegation to communication whenever b is such that informative communication is feasible.*

The following corollary is an immediate consequence of Proposition 2:

Corollary 1. *If $F(m)$ is uniformly distributed over $[-L, L]$, the principal delegates control rights to the agent if and only if $b \leq b'$, where b' is such that the principal is indifferent between an uninformed decision and a biased decision:*

$$\ell(b') = \frac{1}{L}\int_0^L \ell(m)dm. \tag{7}$$

Corollary 1 provides a first determinant for the allocation of authority: delegation is optimal when preferences between agent and principal are not too far apart. Two other determinants, which stem from (7), are that:

— *Delegation is more likely when the amount of private information of the agent is large.* A measure for the informational advantage of the agent is given by the variance of m, $\sigma_m^2 = L^2/3$. From (7), b' increases with σ_m^2 and goes to infinity as σ_m^2 goes to infinity. The principal thus delegates control as long as the bias of the agent is not too large relative to the amount of private information of the agent. Given that no communication occurs in equilibrium, this result is very intuitive: an increase in the variance decreases the pay-off of an uninformed decision while it has no impact on the pay-off of a delegated decision. Without the prior knowledge of Proposition 2, however, this would be less straightforward since more uncertainty also induces more communication: from Lemma 1, $N(b)$ increases weakly with L and also informative communication is possible for a larger range of values of b as L and thus increases.

— *Delegation is more likely when the principal is more risk-averse.* If the principal keeps authority, she takes on average an unbiased action, but the deviation from the optimal action has a large variance. Hence, the more concave her utility function, the more attractive is the constant bias which prevails under delegation.

The leading example of Crawford–Sobel. An interesting implication of the previous analysis is that $\lim_{b \to 0} E(|y^* - m|)/b = \infty$ or in the limit, the principal is an infinite number of times further away from the first best under communication than under delegation. This could stem from the fact that the principal's loss relative to the first best is only of *second-order* in *b with delegation*, while there is a *first-order utility loss with communication.* We verify this as well as our no communication result in case of the leading example of Crawford–Sobel which allows for a closed-form solution. Suppose $F(m)$ is uniformly distributed on [0, 1], $U_P(y, m) \equiv -(y-m)^2$ and $U_A(y, m) \equiv -(y-(m+b))^2$. As shown by CS, Section 4, the expected utility of the principal under communication is then given by

$$EU_P = -\frac{1}{12N^2} - \frac{b^2(N^2-1)}{3}$$

where N is the number of partition elements. As shown by CS, EU_P is maximized for $N = N(b)$ which is given by the smallest integer greater or equal to

$$N = -\frac{1}{2} + \frac{1}{2}\left(1 + \frac{2}{b}\right)^{1/2}.$$

One can verify immediately that for $N \geq 2$, $EU_P < -b^2$ and thus delegation is optimal whenever informative communication is possible. We now investigate what happens when b becomes small. In the limit, as b goes to zero, $N(b) \cong 1/\sqrt{2b}$. Hence

$$\lim_{b\to 0} EU_P = -\frac{b}{3} \quad \text{and} \quad \left.\frac{\partial EU_P}{\partial b}\right|_{b=0} = -1/3,$$

which implies that communication leads to a *first-order loss* in b. In contrast, delegation only results in a *second-order loss:* the principal's utility is then given by $-b^2$ and hence $\frac{\partial EU_P}{\partial b}|_{b=0} = 2b = 0$.

5.2. *General distributions*

We now discuss to what extent the results and intuitions obtained for a uniform distribution can be generalized to other distributions. When the agent's bias is *small,* we show that for any distribution $F(m)$, communication performs very badly compared to delegation, just as with a uniform distribution. For *large* biases, in contrast, we give a sufficient condition on the "informativeness" or "steepness" of $F(m)$ such that very noisy but informative communication does better than delegation. Obviously, this raises the question how large is then the parameter range for which delegation is optimal. To give an idea on this, we finally report simulation results for (truncated) *normal distributions* and a quadratic loss function, which show that only for biases for which communication is extremely noisy, the principal keeps control. For small or moderate biases, the principal delegates authority to the agent.

Small biases. For b small, the principal always delegates control to the agent. Indeed, when the agent's bias is small, communication must be very informative in order to dominate delegation. When communication is very informative, however, there must be a large number of partition elements, whose size—just as with a uniform distribution—must be increasingly large as we move up the interval in order to refrain the agent from exaggerating his private information. As a result, the average size of the partition elements will be huge relative to the bias, which yields our second main result:

Proposition 3. *Consider the most informative communication equilibrium given b. For any $F(m)$, in the limit as b tends to zero, a principal who keeps control and communicates, is on average an infinite times farther away from m than a principal who has delegated control:*

$$\lim_{b\to 0} \frac{E(|y^* - m|)}{b} = \infty. \tag{8}$$

We provide a sketch of the argument, a formal proof is given in the Appendix:

If $F(m)$ is not uniform, condition (A) of Proposition 1 implies that the increase in size of adjacent partition elements will be larger (smaller) than $4b$ if the density of m is downwards (upwards) sloping, as $\bar{y}(a_{i-1}, a_i)$ is then smaller (larger) than $(a_i + a_{i-1})/2$.

For communication to have any chance against delegation when b is small, however, the size of the partition elements must tend to zero as b tends to zero.[15] But in the latter case, the increase in size will be approximately $4b$, *regardless* of the distribution $F(m)$. Intuitively, when a partition element becomes small, for any distribution $F(m)$, the difference in density $f(m)$ along the partition element becomes negligible relative to the average density of the partition element, just as with a uniform distribution. Condition (A) of Proposition 1 then implies that partition elements increase at a rate of $4b$ as long as b is of the same order of magnitude as the partition elements.

Indeed, let (a_{i-1}, a_i) and (a_i, a_{i+1}) be two adjacent partition elements, then it is shown in the Appendix that if (a_{i-1}, a_i) and (a_i, a_{i+1}) are small

$$a_{i+1} - a_i \cong (a_i - a_{i-1}) + 4b - \left[(a_i - a_{i-1})^2 + (a_{i+1} - a_i)^2\right]\left(\frac{f'(a_i)}{6f(a_i)}\right)$$

where we have neglected all terms (and only those) that are in the third or higher order of $(a_i - a_{i-1})$ and $(a_{i+1} - a_i)$. As a result, as long as b is of the same order of magnitude as the partition elements, these partition elements increase dramatically as we move up the interval, which can be used to show (8). Partition elements may stop to increase when $b \sim (a_i - a_{i-1})^2$, but then $(a_i - a_{i-1})/b \sim 1/\sqrt{b}$, which also implies (8).

Large biases. For a sufficiently large bias, it is obvious that delegation is inferior to communication, as the principal's pay-off with the latter is bounded by what she can achieve if she took the decision in ignorance. If we only consider biases b for which informative communication is feasible ($N(b) \geq 2$), though, then with a uniform distribution, delegation always dominates communication. The uniform distribution, however, is the limit case of how agnostic the principal can be concerning which action she optimally should take. If we fix the bias and the support $[-L, L]$, and let $F(m)$ become more informative, then *communication will dominate delegation when the uncertainty about the environment is sufficiently small.* Indeed, while changing the distribution of m does not affect the loss of control under delegation, a more precise prior allows the principal to select an action which is on average much closer to the first best, and thus substantially reduces the loss of information under communication.

In order to formalize the above intuition, we only consider symmetric single-peaked distributions, which has the advantage that the range of biases for which informative communication is feasible is independent of $F(m)$.[16]

Lemma 2. *If $F(m)$ is symmetric, then communication is informative ($N(b) \geq 2$) if and only if $b < L/2$.*

Proof. See the Appendix. ||

Proposition 4. *Assume $F(m)$ is symmetric and $b < L/2$, then informative communication dominates delegation if $F(m)$ is such that*

$$\int_{-L}^{L} \ell(|m|)dF(m) \leq \ell(b). \tag{9}$$

15. If this is not the case, it is shown straightforwardly (see the Appendix) that (8) holds.
16. In a previous version we also considered asymmetric distributions. The results are not qualitatively different.

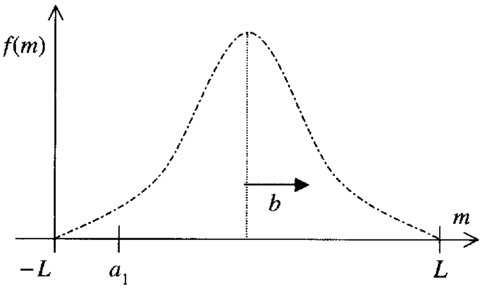

FIGURE 2
Given b and $F(m)$, communication is informative and dominates delegation

Proof. If (9) holds, the principal obtains a higher utility by taking an uninformed decision ($y^* = 0$) than by delegating control to the agent. Since communication cannot make her worse off, she then optimally keeps controls. Moreover, as $b < L/2$, informative communication is then feasible. ||

Corollary 2. *Assume $F(m)$ symmetric and $b < L/2$. If the principal has a quadratic loss function, then informative communication dominates delegation if $\sigma(m) < b$.*

Proposition 4 and its corollary tell us that, for a given bias b, keeping control is optimal if $F(m)$ is sufficiently informative. If $b < L/2$, informative communication then occurs in equilibrium. This contrasts with Proposition 2 which states that, for a given distribution $F(m)$, delegating control is optimal if b is sufficiently small. Taken together, this suggests that *delegation dominates communication if the bias of the agent is small relative to his informational advantage*, just as we found for a uniform distribution.

Figure 2 gives an example of a bias b and a steep single-peaked distribution $F(m)$ for which informative communication is feasible (the best partition equilibrium is $(-L, a_1, L)$) and keeping control is optimal.

Note that in the above example, communication is not very informative and if the bias were smaller (*e.g.* equal to $b/2$), delegation would again be optimal. The following simulation results suggest that typically only very noisy communication may dominate delegation.

Normal distributions. How large is the parameter range for which delegation is optimal? To have a quantitative idea on this, we have performed numerical simulations for a class of truncated normal distributions,[17] and a quadratic loss function, $\ell(|y - m|) \equiv (y - m)^2$. We find that the principal delegates authority if and only if $b < b'\sigma$, where $b' \cong 0{\cdot}955$, and this independently of the variance (we checked for $\sigma = 0{\cdot}5$, $\sigma = 1$ and $\sigma = 2$). For biases larger or equal to $b'\sigma$, communication occurs in equilibrium, but the agent recommends the same "high" action in at least 98·6% of all states of nature. The outcome is thus very close to the "no communication result" of the Uniform distribution: *only if communication is very noisy, it beats delegation.*

17. Concretely, we have assumed that $m \sim \mathcal{N}(0, \sigma)/c^{te}$, supported on $[-4\sigma, 4\sigma]$ where $c^{te} = \int_{-4\sigma}^{4\sigma} d\mathcal{N}(0, \sigma) \approx 0{\cdot}99994$. The results, however, are insensitive to the truncation points as long as $L \geq 4\sigma$, with $[-L, L]$ the support.

6. THE VALUE OF AN INTERMEDIARY

In practice, one often observes that top management delegates control to *intermediaries*—supervisors, managers, external consultants—with objectives between the principal's and the agent's. We investigate therefore whether, in our setting, the principal may have an incentive to delegate control to a middleman with a bias $b_I \in (0, b)$, rather than to the agent. In the latter scenario, the middleman—which is assumed to be equally uninformed as the principal—takes a decision after having consulted the agent. Obviously, such an allocation of control fosters communication compared to the case where the principal is in charge, and limits the loss of control compared to full delegation to the agent.[18]

Given that the only role of the intermediary is to *communicate* with the agent and *take a decision*, it seems reasonable that the principal disposes of a pool of candidate intermediaries, who all differ in their biases. An obvious candidate is the intermediary management. Product-line managers, for example, typically have interests in between those of top management and the individual product managers (say, due to the presence of implicit incentive schemes or relation-specific investments).[19] Secondly, entities which are external to the organization, such as consultants, may act as intermediaries in matters where both agent and principal have vested interests. Finally, intermediaries may also be created in the marketplace. In the software industry, for example, open source companies, such a Collab.net, act as intermediaries between independent open source programmers and commercial corporations, who release the source code of new technologies to these intermediaries.[20] To simplify the exposition, we will make the extreme assumption that for any $k \in (0, 1)$, the principal can find an intermediary with bias $b_I = (1-k)b$. This stands in contrast with the agent, who is unique in being informed and hence cannot be replaced. We further assume that the intermediary is not allowed to delegate on his turn the authority to the agent. Since the intermediary will have an incentive to do this, the principal then must clearly define the decision rights.[21]

The question we want to answer is thus: *"given the agent's bias, if the principal could freely choose an intermediary's level of bias, would she choose a biased intermediary?"*. To keep the problem tractable, we only characterize the optimal delegation scheme for the leading example of Crawford and Sobel. We subsequently discuss in a more general way the logic behind the value of an intermediary.

Proposition 5. *If $F(m)$ is uniformly distributed on $[0, 1]$ and the principal has quadratic preferences, that is $\ell(y-m) = (y-m)^2$, then*

- *For $b \leq 1/6$, the principal delegates authority to the agent.*
- *For $b \in]1/6, \sqrt{2}/4[$, the principal delegates authority to an intermediary with bias $b_I^* \in (0, b)$.*
- *For $b > \sqrt{2}/4$, there is neither delegation nor communication.*

18. A related explanation for the role of intermediaries in organizations is given by Mitusch and Strausz (1999), which show how an intermediary can improve things in a communication game where the principal cannot commit to a decision rule. In their model, the intermediary does not receive control, but is simply a "mediator" which is more congruent with the agent than the principal. Several papers have further shown (see, for example, Vickers (1985)) that firms which are engaged in competitive interactions often have an incentive to strategically delegate control to a manager who is not a profit-maximizer.

19. Note that top management could potentially increase (decrease) the congruence between middle and lower management by reducing (increasing) the span of control of middle management.

20. See Lerner and Tirole (2000).

21. This is realistic: it is common practice in organizations that the signature of a certain person (of a certain rank) is obligatory to have access to critical resources of the firm. Hence, authority cannot be passed on without the approval of top management.

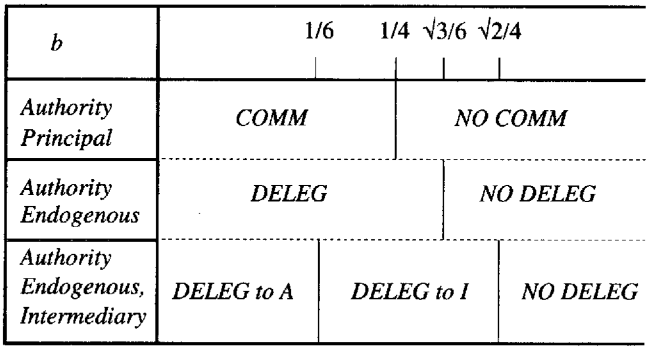

FIGURE 3

Delegation decision in leading example Crawford and Sobel (1982)

Proof. See the Appendix. ||

Figure 3 summarizes the optimal allocation of authority with and without an intermediary:

If the choice of intermediaries is limited, one may want to know for what values of b and k the principal would use an intermediary. Proposition 5 gives a partial answer to this by providing a necessary condition: only if the "optimal" bias b_I^* belongs to $(0, b)$, an intermediary with $b_I \neq b_I^*$ may be useful. As an example, suppose that $b_I = b/2$ exogenously. One can verify that the principal delegates control to this intermediary whenever $\frac{1}{2\sqrt{6}} < b < \frac{\sqrt{2}}{4}$.

Why is delegating control to an intermediary valuable for intermediate biases? Basically, delegation to an intermediary is a *commitment device*. From Proposition 1, communication between agent and principal is a noisy signalling game in which a finite number of actions $\{y_1, \ldots, y_N\}$ are implemented with positive probability. Since in this signalling equilibrium, the optimal response of the principal is always a pure strategy, the agent knows exactly which action will be implemented for which signal. The agent thus possesses a *limited form of discretion:* he is able to implement any action $y \in Y \equiv \{y_1, \ldots, y_N\}$. By delegating authority to the intermediary, the principal changes the set of actions Y and thus the discretion of the agent. For example, if $b = L/2$ and $F(m)$ is uniform on $[-L, L]$, then $Y = \{0\}$ if the principal keeps control, since no informative communication is then possible. In contrast, if the principal delegates control to an intermediary with bias $b_I = b/2 = L/4$, we have that $Y = \{-L/2, L/2\}$.[22] In this sense, it is interesting to investigate what is the "optimal amount of discretion" to be given to the agent, where the set of actions Y does not have to satisfy the conditions of Proposition 1. Previous work has already studied this question and the following result holds:[23]

Lemma 3. *If $F(m)$ is uniformly distributed on $[-L, L]$ the optimal amount of discretion to be given to the agent, consists of putting an upper bound y' on the actions which the agent may implement, where $y' = L - b$ if $b < L$ and $y' = 0$ if $b > L$.*

Proof. See Holmström (1977, Section 2.3.2). ||

22. Indeed, if the intermediary communicates with the agent, then at most two partition elements are possible, where the size of the second partition element equals the size of the first plus $4b_I = 2b$. Hence, the agent sends a low message if $m \in (-L, -b)$ and a high message if $m \in (-b, L)$. The intermediary then implements respectively $y_1 = -\frac{L+b}{2} + \frac{b}{2}$ and $y_2 = \frac{L-b}{2} + \frac{b}{2}$.

23. See Holmström (1977, 1984), Melumad and Shibano (1991), and Armstrong (1994).

Intuitively, the principal may reduce the average deviation from the optimal project by putting an upper bound on the projects which the agent is allowed to undertake. Further limiting the discretion of the agent, however, only harms the principal if her prior is uniformly distributed. While she may reduce the bias in some states of nature, this will always lead to an increase in the bias for other states of nature, generating a mean-preserving spread of the deviation which is better avoided given her concave preferences. In our example where $b = L/2$, optimally, the principal would allow the agent to choose any action $y \leq L/2$. Note that this upperbound would be binding with a probability $1/2$.

In practice, however, it may be difficult to commit to such a policy, since the principal will also be tempted to intervene when the agent wants to implement small or medium-sized projects. Here, an intermediary may play an important role. By delegating decision rights to an intermediary, the principal may prevent these very large projects from being initiated without jeopardizing the communication concerning small or medium-sized projects. Indeed, for $b = L/2$, if an intermediary with bias $b_I = b/2 = L/4$ has control, the agent has discretion on $\{-L/2, L/2\}$. Hence, by delegating control to this intermediary, the principal effectively implements the optimal upperbound $L - b$, while the agent still has the option to communicate that a smaller project is optimal. The expected deviation from m, $E(|y^* - m|)$, is then $\frac{3}{4}b$. In contrast, if the principal keeps control or delegates to the agent, the expected deviation from m equals b. Unless the loss function of the principal is very convex, the principal thus prefers to delegate to the intermediary.

It is finally intuitive that an intermediary is only useful for *intermediate preference divergences*, as shown in Proposition 5. For intermediate biases, the benefits of constraining projects to be smaller than $L - b$, are substantial and communication performs not so bad relative to delegation. In contrast, when preferences of principal and agent are close, the probability that the optimal upper bound $L - b$ is binding, is very low. The benefits of limiting the agent's discretion are then small. At the same time, communication performs very badly relative to delegation.

7. DELEGATION WITH VETO-POWER OR "CLOSED RULE"

As another form of limited delegation, the principal may delegate a decision to the agent but keep the right to veto this decision *ex post*, in which case the status quo prevails. A CEO or a division manager, for example, may be delegated the task to come up with a plan to redesign a product-line or to restructure the firm or a division, but theses plans need a final "thumbs up" of the board of directors or top management. Importantly, delegation with veto-power is also a regular practice in some *political organizations*. In the U.S. House of Representatives, for example, under the *closed rule*, a parliamentary committee has the right to propose a bill which can only be vetoed, but not amended.

In this section, we compare the effectiveness of delegation with veto-power, or equivalently the "closed rule", with pure delegation. As we discussed in Section 2, the "closed rule" and its *raison d'être* has been the object of intense debate and study in Political Science. In a seminal paper, Gilligan and Krehbiel (1987) have used the leading example of CS to show that for small biases, the closed rule yields a higher expected utility to the House than the "open rule" under which the House can freely amend the proposals of the committee and which is equivalent to communication.[24] In this section, we show that unless preference divergences are very large, pure delegation does even better than this closed rule. In case of the leading example of CS and a

24. By focusing on a more efficient equilibrium, Krishna and Morgan (2000) even show that the closed rule does better than communication whenever the latter is informative, that is as long as $b < 1/4$.

status quo equal to the mean of the distribution, delegation beats the closed rule unless preference divergences are so extreme that no informative communication is possible.

For simplicity and following the tradition of the literature on legislative rules, we assume that $F(m)$ is uniformly distributed. In accordance with GK, we make the following assumptions. There is an exogenously given status quo $y_o \in [-L, L]$. The sequence of moves under veto-based delegation is the following. First, the agent learns m. Secondly, the agent proposes a project $y \in Y$ to the principal. Finally, the principal chooses between y and y_o. Similar to the CS communication game, the veto-delegation game has typically several equilibria. We will focus on the one proposed in Krishna and Morgan (2000, Proposition 8) which is thus far the most efficient equilibrium identified in the literature. The following proposition characterizes this Krishna–Morgan equilibrium:

Lemma 4. *Under delegation with veto-power (closed rule):*

(*i*) *If* $b < (L - y_o)/2$:

— *the agent proposes to implement:*

* $y = m + b$ *if* $m < y_o - b$ *or* $m > y_o + 3b$.
* $y = y_o$ *if* $m \in [y_o - b, y_o]$.
* $y = y_o + 2b$ *if* $m \in (y_o, y_o + 2b]$.
* $y = y_o + 4b$ *if* $m \in (y_o + 2b, y_o + 3b]$.

— *the principal vetoes all projects* $y \in (y_o, y_o + 4b) \backslash \{y_o + 2b\}$, *and rubberstamps all other projects.*

(*ii*) *If* $b > (L - y_o)/2$:

— *the agent proposes* $y = m + b$ *if* $m < y_o - b$ *and* $y = y_o$ *otherwise,*
— *the principal vetoes* y *if and only if* $y > y_o$.

Proof. See the Appendix. ||

We compare the outcome under pure delegation with the above equilibrium. Given that the leading example of CS is the traditional working horse in the literature on legislative rules, we first make the comparison under the specific assumptions of this leading example. For concreteness, we also assume that the status quo equals the expected optimal value of y, that is $y_o = E(m)$. We subsequently generalize our results to more general loss functions and supports, and to different status quos.

Proposition 6. *Consider the leading example of* CS, *in which* $F(m)$ *is uniformly distributed on* $[0, 1]$ *and the principal has a quadratic loss function. If* $y_o \equiv E(m) = \frac{1}{2}$, *then pure delegation strictly dominates delegation with veto-power (closed rule) if and only if* $b < 1/4$.

Proof. See the Appendix. ||

Thus, for the leading example of CS and $y_o = E(m)$, we obtain the result that pure delegation dominates the closed rule unless the bias of the agent is so large that no informative communication between agent and principal is possible (indeed for $b > 1/4$, $N(b) = 1$). In contrast, for $b > 1/4$, the closed rule is optimal. Given that the status quo equals the expected value of m, the closed rule then also weakly dominates keeping control.

What is the intuition behind these results? First consider the case where $b < (1 - y_o)/3 = 1/6$. From Lemma 4 *the closed rule (veto-power) then introduces a variance in bias of the implemented project, but does not reduce the average bias.*[25] Since deviations from the first best are increasingly costly, the principal then strictly prefers pure delegation. Secondly, consider the case where $b > 1/6$. From Lemma 4, the closed rule then still introduces a considerable variance in the bias, but on average, this bias is smaller than b.[26] *Thus, for $b > 1/6$, the principal must trade-off a smaller average deviation with a larger variance under the closed rule.* As long as $1/6 < b < 1/4$, the reduction in the average bias is not sufficient to compensate for the large variance, and the principal prefers pure delegation. In contrast, for $b > 1/4$, the reduction in the average bias is sufficiently large and veto-power becomes optimal. Interestingly, for $b > 1/4$, the agent is allowed to implement any project $y < y_o = 1/2$ under the closed rule. *Keeping veto-power is then a tool to refrain the agent from implementing large projects, while allowing him discretion concerning small projects.* Whereas for small biases, such an upperbound on y would be far too tough, for large biases, it approaches the optimal upperbound $L - b$.[27]

We now generalize the above result for any convex loss function, any support $[-L, L]$, and any status quo $y_o \in [-L, L]$. Define $\bar{b}(y_o) \equiv (L - y_o)/3$:

Proposition 7.

(*i*) *If $b \leq \bar{b}(y_o)$, pure delegation strictly dominates delegation with veto-power (closed rule).*

(*ii*) *If $b > \bar{b}(y_o)$, $\exists \hat{\ell}(x)$ such that delegation with veto-power (closed rule) dominates pure delegation if the loss function of the principal, $\ell(x)$, is less convex in the sense of Arrow–Pratt than $\hat{\ell}(x)$.*

Proof. See the Appendix. ||

The intuition for Proposition 7 is identical to the one of Proposition 6. For $b < (L - y_o)/3$, keeping veto-power only introduces variance in the bias, but does not reduce the average bias. In contrast, for $b > (L - y_o)/3$, the principal has to trade-off a larger variance with a smaller average bias. Whether or not the closed rule is optimal, depends then on the risk-aversion of the principal.

Note that $\bar{b}(y_o)$ is decreasing in y_o, suggesting that having veto-power is more useful when the status quo is larger (or more in the direction of the agent's bias). Intuitively, from Lemma 3, it is only optimal to refrain the agent from implementing large projects. If the status quo is large, veto-power gives the principal an effective tool to do this without jeopardizing the agent's flexibility to implement small and medium-sized projects.[28] For the leading example of CS, one can easily show that the cut-off value for b above which the closed rule is optimal, is decreasing in y_o. While for $y_o = 0$, the closed rule is never optimal,[29] for $y_o = 1$, the closed rule always dominates delegation.

25. Indeed, for $m \in [1/2, 1/2 + 2b]$, the expected deviation from m ranges from 0 to $2b$. Similarly, while for $m \in [1/2 - b, 1/2]$, the expected deviation is $b/2$, for $m \in [1/2 + 2b, 1/2 + 3b]$, it equals $3b/2$.

26. Reason is that m is then less likely to belong to the range $[1/2 + 2b, 1/2 + 3b]$ where the bias in the implemented project is larger than b.

27. See Lemma 3.

28. If the principal could commit *ex ante* to a status quo point, he would choose y_o^* such that the optimal upperbound characterized in Lemma 3 is implemented, that is $y_o^* = L - b$. From Lemma 4, the veto-delegation game is then equivalent to the optimal partial delegation scheme in which the agent can pick any action $y \leq L - b$.

29. For $b < \sqrt{3}/6$, pure delegation is then best while for $b > \sqrt{3}/6$, the principal optimally keeps full control and implements $y = 1/2$.

8. EXTENSIONS AND DISCUSSION

To conclude, we discuss some important extensions of our basic set-up and their likely implications.

8.1. *Extending the space of contracts*

The main result of our paper is a comparison of two institutions: communication (cheap talk) vs. delegation. While these are indeed the only instruments available to the principal given our assumptions on the non-contractibility of projects and profits, one may wonder whether we have not biased our results in favour of delegation by restricting the space of contracts in this way. In this section, we argue that delegation will typically be a *complement* rather than a *substitute* to other contractual arrangements, in particular those institutions, such as profits sharing, promotions, career concerns etc., whose aim it is to better align the incentives of the agent with those of the organization or principal. Indeed, the smaller the bias of the agent, the better delegation performs relative to communication. Therefore, by reducing the agent's bias, these mechanisms may make delegation optimal whereas initially the principal would have kept control. Suppose, for example, that pay-offs are in monetary terms and that the principal is free to offer simple *sharing contracts* that award to the agent a percentage of the monetary pay-offs deriving from the project. If we suppose that the agent derives a private benefit of a project y given by

$$B(y) \equiv K_A - k_A(m + b - y)^2$$

and the principal maximizes a contractible profit

$$\pi(y) \equiv K - k(m - y)^2,$$

then awarding the agent a share s of $\pi(y)$, induces the agent to maximize a function of the form

$$B'(y) \equiv K_A' - k_A'\left[m + \left(\frac{k_A}{k_A + sk}\right)b - y\right]^2.$$

Thus, giving the agent a share s in total profits, reduces its bias from b to $b' = \frac{k_A}{k_A+sk}b$. The optimal amount of profit sharing s for a given bias will depend on whether or not *ex ante* transfers from agent to principal are possible and on the wealth constraint of the agent. At least with a uniform distribution, however, the principal will always delegate control for a larger range of biases than if no sharing contracts were possible.

8.2. *Uncertainty over the bias and repeated interaction*

A convenient simplification of our model is that the bias of the agent is known to the principal. Intuitively, though, as long as there remains a *systematic* average bias in the agent's objectives, introducing uncertainty will not greatly affect our results. In a setting where the agent has a bias b only with a probability p, Stocken and Morgan (2000) provide a first analysis of the communication equilibrium which then prevails. One of their findings is that the informational efficiency of communication may be either smaller or larger than if the agent's bias were known to be $p*b$. In the examples they provide, however, the difference is limited.[30] Therefore, one may expect the trade-off between communication and delegation to be only quantitatively affected.

A different picture is obtained if the unknown tastes of the agent were *symmetrically* distributed about the principal's tastes, that is the agent is unbiased in expectations. As shown by

30. Of the order of 2% or less.

de Garidel-Thoron and Ottaviani (2000), if $F(m)$ is uniformly distributed and the bias takes either a positive or negative value, there exists a communication equilibrium in which the principal rubberstamps the proposals of the agent as long as these proposals are not too extreme.[31] This can be shown to improve upon pure delegation, which suggests that if divergences in objectives are random rather than systematic, the principal often optimally keeps control.

Finally, when the bias of the agent is uncertain, it is also very important to take into account the impact of *repeated interaction*, as has become clear from Avery and Meyer (2000). In a two-period, two-action model where agents have an uncertain but positive bias,[32] they show that the presence of a second period acts as a first-period discipline device: agents are then less biased and may even show a negative bias in order not to be perceived as a type with a large bias. In a typical equilibrium, the principal rubberstamps the recommendation of the agent in the first period, and follows the advice of the agent in the second period if and only if the latter has recommended the "small" project in the first period. Given the binary nature of the example, this outcome is identical to the one in which the principal always delegates authority in the first period, and lets her second period delegation decision depend on the first period action of the agent. Intuitively, one may expect similar results if there is a continuum of projects, where the agent refrains from implementing "large" projects in an initial period out of fear of being perceived as extremely biased and hence losing control in a later period. To the extent that this puts a reasonable upperbound on the projects which are implemented in initial periods, intertemporal incentives may then greatly improve the efficiency of delegation.[33] This reputational delegation, and its comparison with reputational cheap talk, are exciting topics for future research.[34]

8.3. *Hard vs. soft information*

A crucial assumption in our analysis is that the private information of the agent is soft. Our motivation for this is that the best thing to do typically depends on a wide range of factors, which the principal may find very hard to foresee, of whom she may not understand their relevance and significance, let alone verify their magnitude or nature. Therefore, almost any project can be claimed to be optimal. In some settings, however, it is realistic to assume that the agent can somehow "prove" or "certify" his local knowledge and that the principal has the time and the background to assert this information. This may radically change the trade-off in favour of communication. As shown by Seidmann and Winter (1997), in the extreme case where the agent, in any state of nature, can certify his information at no cost to him or the principal, *communication is even perfect*. Obviously, the principal then never delegates. This suggests some interesting predictions on differences in the hierarchical structure of firms across industries. Even when private information can be certified or verified, this is often a very time-consuming process. In fast changing industries, the benefits may then not outweigh the costs in terms of incurred delays in the decision making and the heavy burden this puts on managerial attention. Private information is then de facto soft and our model predicts rather flat organizations with a decentralized organization structure. In contrast, when the business environment is very stable or information-processing costs are negligible, one may expect more centralized decision making.

31. Concretely, there exists an equilibrium in which the principal rubberstamps all proposals $y \in [-L+b, L-b]$, where the bias of the agent is either b or $-b$.

32. Avery and Meyer are concerned with the application where a biased evaluator must recommend whether or not to hire a candidate. In our language, "hire" is the large project, "do not hire", the small project.

33. As pointed out by Avery and Meyer, however, the intertemporal incentives may also be too strong, making agents far too cautious.

34. Note, however, that this reputational cheap talk is different from the one studied by Ottaviani and Sorensen (1999), where the expert is concerned to appear well informed rather than congruent.

9. CONCLUDING REMARKS

This paper has stressed the limits of the use of soft information in organizations. To the extent that a senior manager cannot verify the claims of a better informed subordinate, she is in general better off delegating decision rights to this subordinate than relying on the information she can induce from his claims. Intuitively, while the subordinate may not tell her what she should do, he will use all his information when he himself takes the decision.

This simple result has potentially important implications for the design of organizations. It suggests that centralization of authority is only optimal if top management has the information which is important to the main decisions, or is able to check and verify the information provided by lower levels of the hierarchy. At first sight, this is in line with the tendency of firms to focus on core activities, *i.e.* activities on which they have a profound knowledge, and to outsource other activities. Similarly, the trend of the last two decades towards more decentralization and empowerment, highlighted by the business press, may find its origin in a rapidly changing business environment which causes the knowledge of top management to become quickly obsolete. In response to an increased foreign competition in the 1980's and 1990's, for instance, many large American cooperations (ITT, IBM, General Motors, Eastman Kodak, and Xerox, ...) have changed the organizational design of their organization and frequently pushed decision rights lower in the organization.[35] An incentive based theory of communication costs in hierarchies, where these costs arise endogenously from the necessity to check and understand reports provided by agents prone to distort their information, will be needed to throw further light on these issues.[36]

APPENDIX

A.1. *General distributions*

Small biases

Proof of Proposition 3. Let $(a_0, a_1, \dots, a_{N(b)})$ characterize the most informative partition equilibrium given b, let h_n be the length of the nth partition element, $h_n \equiv a_n - a_{n-1}$, and let $\bar{h}$ be the largest partition element. The proof of (8) follows directly from the following three lemmas.

Lemma A1. *As $\bar{h}$ tends to zero,*

$$h_{n+1} = h_n + 4b - \left[h_n^2 + h_{n+1}^2\right]\left[\frac{f'(a_n)}{6f(a_n)}\right] \tag{A.1}$$

where we have neglected all terms in the 3-rd or higher order of h_n and h_{n+1}.

Proof. Let us consider the $(n+1)$-th partition element and denote $y_{n+1} \equiv \bar{y}(a_{n+1}, a_n)$. We will now express y_{n+1} as a function of h_{n+1} and a_n using Taylor approximations in which we neglect all terms (and only these) which are in the third or higher order of h_{n+1}. For this purpose, $\forall m \in (a_n, a_{n+1})$, we approximate $\ell(|m - y_{n+1}|)$ and $f(m)$ by

$$\ell(|m - y_{n+1}|) = \tfrac{1}{2}\ell''(0)(m - y_{n+1})^2$$
$$f(m) = f(a_n) + f'(a_n)(m - a_n) + \tfrac{1}{2}f''(a_n)(m - a_n)^2$$

where both $|m - y_{n+1}|$ and $m - a_n$ are fractions of h_{n+1}.

35. A discussion of some case studies on this can be found, *e.g.* in Brickley, Smith and Zimmerman (1997).

36. The literature on communication and processing costs (Radner (1993), Bolton and Dewatripont (1994), van Zandt (1999) etc.) has assumed a team theoretical framework without incentive problems. Note that the existence of explicit time/resource costs of communication, central in these papers, would only reinforce the preference for delegation in our model.

Denoting $k_n \equiv y_{n+1} - a_n$, we have that

$$k_n = \arg\min_k \int_0^{h^{n+1}} \tfrac{1}{2}\ell''(0)(k-x)^2[f(a_n) + f'(a_n)x + \tfrac{1}{2}f''(a_n)x^2]dx.$$

Taking the FOC yields

$$\int_0^{h_{n+1}} (x-k_n)[f(a_n) + f'(a_n)x + \tfrac{1}{2}f''(a_n)x^2]dx = 0$$

or still

$$\frac{f(a_n)}{2}h_{n+1}^2 - k_n f(a_n)h_{n+1} + \frac{f'(a_n)}{3}h_{n+1}^3 - k_n\frac{f'(a_n)}{2}h_{n+1}^2 + \frac{f''(a_n)}{8}h_{n+1}^4 - k_n\frac{f''(a_n)}{6}h_{n+1}^3 = 0$$

from which

$$k_n = h_{n+1}\left[\frac{f(a_n)/2 + f'(a_n)h_{n+1}/3 + f''(a_n)h_{n+1}^2/8}{f(a_n) + f'(a_n)h_{n+1}/2 + f''(a_n)h_{n+1}^2/6}\right].$$

A first-order Taylor expansion in h_{n+1} of the term in brackets yields[37]

$$k_n = h_{n+1}\left[\frac{1}{2} + h_{n+1}\frac{(f'(a_n)/3)f(a_n) - (f'(a_n)/2)(f(a_n)/2)}{f(a_n)^2}\right]$$

from which

$$k_n = \frac{h_{n+1}}{2} + \frac{h_{n+1}^2}{12}\frac{f'(a_n)}{f(a_n)}.$$

Since $k_n \equiv y_{n+1} - a_n$ and $h_{n+1} = a_{n+1} - a_n$, it follows that

$$y_{n+1} = \frac{a_n + a_{n+1}}{2} + (a^{n+1} - a^n)^2\frac{1}{12}\frac{f'(a_n)}{f(a_n)} \tag{A.2}$$

where we have neglected all terms in the 3-rd or higher order of $(a^{n+1} - a^n)$.

In the same way, for $(a^n - a^{n-1})$ small, one can show that

$$y_n = \frac{a_{n-1} + a_n}{2} + (a^n - a^{n-1})^2\frac{1}{12}\frac{f'(a_n)}{f(a_n)} \tag{A.3}$$

where we have neglected all terms in the 3-rd or higher order of $(a^n - a^{n-1})$. At $m = a_n$, the agent must be indifferent between y_n and y_{n+1} from which

$$y_{n+1} - (a_n + b) = a_n + b - y_n.$$

Substituting (A.2) and (A.3) we find

$$a^{n+1} - a^n = a^n - a^{n-1} + 4b - [(a^{n+1} - a^n)^2 + (a^n - a^{n-1})^2]\left[\frac{1}{6}\frac{f'(a_n)}{f(a_n)}\right]$$

or, equivalently,

$$h_{n+1} = h_n + 4b + [h_n^2 + h_{n+1}^2]\left[\frac{1}{6}\frac{f'(a_n)}{f(a_n)}\right]$$

where we have neglected all terms in h_n^3, h_{n+1}^3 and higher orders of h_n and h_{n+1}. ||

Lemma A2. *If* $\lim_{b\to 0}\bar{h} = 0$, *then*

$$\lim_{b\to 0}\frac{E(|y^* - m|)}{b} = \infty. \tag{A.4}$$

Proof. Let us fix two points x_1 and x_2 of the support of $F(m)$, where $-L < x_1 < x_2 < L$. Since $[F(x_2) - F(x_1)] > 0$, to prove that (A.4) holds, it is sufficient to show that

$$\lim_{b\to 0}\left(\frac{E(|y^* - m||m \in (x_1, x_2))}{b}\right) = \infty. \tag{A.5}$$

37. As this expansion is multiplied by h_{n+1}, a second-order Taylor expansion would only add additional terms in h_{n+1}^3, which subsequently would be neglected.

Abusing notation, let us denote from now on by $N(b)$ the number of partition elements fully contained in $[x_1, x_2]$, and by h_n the size of the n-th partition element that is fully included in (x_1, x_2). Defining further

$$\mu \equiv \max_{m\in(x_1,x_2)} \frac{f'(m)}{f(m)},$$

we have from Lemma A1 that $h_{n+1} \geq h_n + 4b - \mu[h_n^2 + h_{n+1}^2]$. We now first show that

$$\lim_{b\to 0} E(h_i)/b = \infty \tag{A.6}$$

holds (Part A and B) and then that the latter implies (A.5) (Part C):

Let us denote by $q(b)$ the number of partition elements fully included in $[x_1, x_2]$ for which $\mu h_i^2 \leq b$ and by $Q(b)$ the number of partition elements for which $\mu h_i^2 > b$. We have $q(b) + Q(b) = N(b)$. By assumption, if b goes to zero, $q(b) + Q(b)$ goes to infinity. We consider two cases.

(A) First, assume that

$$\lim_{b\to 0} \frac{Q(b)}{N} > 0.$$

Denoting $\lim_{b\to 0} \frac{Q(b)}{N} \equiv \Phi > 0$, we have

$$\lim_{b\to 0} \frac{E(h_i)}{b} \geq \lim_{b\to 0} \frac{1}{b} \frac{Q(b)E(h_i \mid \mu h_i^2 > b)}{N} \geq \Phi * \lim_{b\to 0} \frac{1}{b}\sqrt{\frac{b}{\mu}} = \infty.$$

(B) Secondly, assume that

$$\lim_{b\to 0} \frac{Q(b)}{N} = 0. \tag{A.7}$$

Let us denote by $\bar{n}(b)$ the average length (number of partition elements) of a series of adjacent partition elements for which $\mu h_i^2 \leq b$. For any two adjacent partition elements h_i and h_{i+1} which both belong to such a series, it follows from (A.1), that

$$h_{i+1} \geq h_i + 2b$$

and thus

$$E(h_i \mid \mu h_i^2 \leq b) \geq \frac{1}{\bar{n}(b)} \sum_{i=1}^{\bar{n}(b)-1} 2ib = [\bar{n}(b) - 1]b. \tag{A.8}$$

If $\lim_{b\to 0} \frac{Q(b)}{N} = 0$ holds, then $\lim_{b\to 0} E(h_i) = \lim_{b\to 0} E(h_i \mid \mu h_i^2 \leq b)$. Moreover, it also follows that $\lim_{b\to 0} \bar{n}(b) = \infty$.[38] From (A.8) it then follows that

$$\lim_{b\to 0} \frac{E(h_i)}{b} \geq \lim_{b\to 0}[\bar{n}(b) - 1] = \infty.$$

(C) We now show that (A.6) implies (A.5). Denoting by $f^{\min} \equiv \min_{m\in(x_1,x_2)} f(m)$ and by (a_{i-1}, a_i) the ith partition element included in (x_1, x_2), then

$$\int_{a_{i-1}}^{a_i} |\bar{y}(a_{i-1}, a_i) - m| f(m)dm \geq \int_{a_{i-1}}^{a_i} \left|\frac{a_{i-1} + a_i}{2} - m\right| f^{\min} dm$$
$$\geq \int_0^{h_i} \left|\frac{h_i}{2} - m\right| f^{\min} dm = \frac{f^{\min}}{4} h_i^2$$

and thus $E(|y^* - m| \mid m \in (x_1, x_2))$

$$\geq \frac{1}{F(x_1) - F(x_2)} \int_{a_0}^{a_N} |\bar{y}(a_{i-1}, a_i) - m| f(m)dm$$
$$\geq \frac{F(a_N) - F(a_0)}{F(x_1) - F(x_2)} \sum_{i=1}^{N} \frac{f^{\min}}{4} \frac{h_i^2}{F(a_N) - F(a_0)}$$
$$\geq \frac{f^{\min}}{4} \frac{F(a_N) - F(a_0)}{F(x_1) - F(x_2)} \frac{1}{N} \sum_{i=1}^{N} h_i = \frac{f^{\min}}{4} \frac{F(a_N) - F(a_0)}{F(x_1) - F(x_2)} E(h_i)$$

38. Indeed, suppose that $\lim_{b\to 0} \bar{n}(b) = n^*$ with n^* a finite number, then

$$\lim_{b\to 0} \frac{Q(b)}{N} \geq \lim_{b\to 0} \frac{Q(b)}{Q(b) + \bar{n}(b)Q(b)} = \frac{1}{1 + n^*},$$

a contradiction.

where $\frac{F(a_N)-F(a_0)}{F(x_1)-F(x_2)}$ tends to 1 as $\bar{h}$ tends to zero. From (A.6) then (A.5) and thus also (A.4). ||

Lemma A3. *If* $\lim_{b\to 0}\bar{h} > 0$, *then* $\lim_{b\to 0}\frac{E(|y^*-m|)}{b} = \infty$.

Proof. Let us denote by $\bar{a}$ the largest partition element of the most informative equilibrium and by ϕ the probability that $m \in \bar{a}$. Given the finite support of $F(m)$, if $\lim_{b\to 0}\bar{h} > 0$, also $\lim_{b\to 0}\phi > 0$ and $\lim_{b\to 0}\{\min_y E(|y - m||m \in \bar{a})\} > 0$. Hence $\lim_{b\to 0} E(|y^* - m|) > 0$ and $\lim_{b\to 0} E(|y^* - m|)/b = \infty$. ||

Large biases

Proof of Lemma 2. From Proposition 1, whenever a communication equilibrium exists with more than one partition element, there always exists a communication equilibrium with two partition elements. Hence, it is sufficient to show that a partition equilibrium with two partition elements exists if and only if $b < L/2$. A partition equilibrium with two partition elements exists if and only if $\exists a \in (-L, L)$ such that

$$a + b - \bar{y}(-L, a) = \bar{y}(a, L) - a - b \Leftrightarrow$$
$$2b = \bar{y}(a, L) + \bar{y}(-L, a) - 2a.$$

The R.H.S. of this equality is a continuous decreasing function of a since both $\partial\bar{y}(a, L)/\partial a < 1$ and $\partial\bar{y}(-L, a)/\partial a < 1$. Moreover, the R.H.S. equals L if $a = -L$ and $-L$ if $a = L$. Hence, if and only if $b < L/2$, $\exists a \in (-L, L)$ such that the equality holds, and a communication equilibrium with two partition elements exists. ||

A.2. *Delegation to an intermediary*

Proof of Proposition 5. Suppose the principal delegates control to an intermediary with bias $b_I = (1 - k)b$. Denoting by $\sigma_m^2(kb)$ the residual variance of m the intermediary expects to have after hearing the equilibrium signal of the agent, it is easy to verify that delegation to the intermediary yields

$$EU_P = U_P(m, m) - \sigma_m^2(kb) - (1 - k)^2 b^2. \tag{A.9}$$

This expression reflects the fact that quadratic loss equals variance plus the square of the bias and that the rational expectations character of the Bayesian Nash equilibrium eliminates all unconditional bias from the middleman's interpretation of the agent's signal. Solving for the communication equilibrium between agent and intermediary, we find[39]

$$\sigma_m^2(kb) = \frac{1}{12N^2} + \frac{(kb)^2(N^2 - 1)}{3} \tag{A.10}$$

where $N = N(kb)$ is the largest number of partition elements given their dissonance $b - b_I = kb$. Substituting (A.10) in (A.9), we can rewrite the expected utility of the principal as

$$EU_P(k, b) = U_P(m, m) - \frac{1}{12N^2} - \frac{k^2b^2(N^2 - 1)}{3} - (1 - k)^2 b^2 \tag{A.11}$$

where N is the number of partition elements in the most informative communication equilibrium between agent and intermediary. From Lemma 1, N is given by

$$N = N(kb) \equiv \left\langle -\frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{2}{kb}} \right\rangle, \tag{A.12}$$

where $\langle z \rangle$ denotes the smallest integer greater than or equal to z. Let us denote by $b_I^* \equiv [1 - k^*(b)]b$ the bias of the intermediary which maximizes (A.11), and by $N^* \equiv N(k^*b)$ the number of partition elements in the corresponding communication equilibrium. Define further $k(q)$ as

$$k(q) \equiv \frac{3}{q^2 + 2}.$$

39. See CS, Section 4, for computations.

(A) We first show that for $b \in]\frac{1}{6}, \frac{\sqrt{2}}{4}[$, $k^* = k(q)$, where

$$q = \left\langle -\frac{1}{2} + \frac{1}{2}\sqrt{\left(\frac{36b^2 + 7 + 4\sqrt{6}\sqrt{36b^2 - 1/3}}{36b^2 - 1}\right)}\right\rangle$$

and q is also the number of partitions in the corresponding communication equilibrium between intermediary and agent:

Suppose that $N^* = q$ and that given $k = k(q)$, an equilibrium with q partition elements exists, *i.e.* $N(k(q)b) \geq q$. From (A.11), then $k^* = k(q)$, which yields an expected utility of

$$eu_P(q, b) \equiv U_P(m, m) - \frac{1}{12q^2} - \frac{q^2 - 1}{q^2 + 2}b^2. \tag{A.13}$$

Moreover, even if $N(k(q)b) < q$, we always have that

$$\forall b : EU_P(k^*(b), b) \leq eu_P(N^*(k^*(b)b), b). \tag{A.14}$$

Define now the correspondence $\hat{b}(q)$:

$$b \in \hat{b}(q) \Leftrightarrow eu_P(q, b) = eu_P(q - 1, b). \tag{A.15}$$

Thus $b \in \hat{b}(q)$ is a bias for which the principal is indifferent between delegating authority to an intermediary with bias $[1 - k(q)]b$ and bias $[1 - k(q - 1)]b$, hereby assuming that a communication equilibrium with q, respectively $q - 1$ partition elements then effectively exists. Substituting (A.13) in (A.15) and imposing $b \geq 0$, we find that $\hat{b}(q)$ is a singleton; abusing notation, we have

$$\hat{b}(q) = \frac{1}{6}\frac{\sqrt{(q^2 + 2)(q^2 - 2q + 3)}}{(q - 1)q}.$$

Moreover, from (A.13), if $b = \hat{b}(q)$, then for $b > \hat{b}(q)$, $eu_P(q - 1, b) > eu_P(q, b)$, while for $b < \hat{b}(q)$, $eu_P(q - 1, b) < eu_P(q, b)$. Since $\hat{b}(q)$ is strictly decreasing in q, the following lemma thus holds:

Lemma A4. *If $b \in]\hat{b}(q + 1), \hat{b}(q)[$, then $\forall n \in \mathcal{N}, n \neq q : eu_P(q, b) > eu_P(n, b)$.*

If for $b \in [\hat{b}(q + 1), \hat{b}(q)]$, a communication equilibrium with q partition elements exists, that is if

$$\forall b \in [\hat{b}(q + 1), \hat{b}(q)] : q \leq N\left(\frac{3}{q^2 + 2}b\right) \tag{A.16}$$

then from Lemma A4 and inequality (A.14), $k^* = k(q) = \frac{3}{q^2+2}$.

From (A.12) and given that q is an integer, (A.16) holds if and only if

$$q < \frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{2(q^2 + 2)}{3\hat{b}(q)}}. \tag{A.17}$$

Substituting the value of $\hat{b}(q)$, which tends to $1/6$ if q becomes very large, one can verify that inequality (A.17) is satisfied for any $q \in \mathcal{N}$.

Lemma A5. $\forall q \in \mathcal{N}, q > 1 : b \in]\hat{b}(q + 1), \hat{b}(q)[\Longrightarrow k^* = k(q)$.

The function $\hat{b}(q)$ is decreasing in q, where $\hat{b}(2) = \frac{\sqrt{2}}{4}$ and $\lim_{q\to\infty} \hat{b}(q) = \frac{1}{6}$. Inverting $\hat{b}(q)$ on $]\frac{1}{6}, \frac{\sqrt{2}}{4}]$ and taking into account that q must be an integer, it follows from Lemma A5 that for $b \in]\frac{1}{6}, \frac{\sqrt{2}}{4}[$, $k^* = k(q)$ where q is given by

$$\left\langle -\frac{1}{2} + \frac{1}{2}\sqrt{\left(\frac{36b^2 + 7 + 4\sqrt{6}\sqrt{36b^2 - 1/3}}{36b^2 - 1}\right)}\right\rangle.$$

Note finally that we necessarily have that the number of partition elements in the resulting communication game cannot be larger than this q. Indeed, suppose $N^*(k^*b) > q$. Since for a given b and b_I, the principal is always better off by more informative communication between agent and intermediary, $EU_P(k^*, b) > eu_P(q, b)$. However, from (A.14) also $eu_P(N^*(k^*b), b) \geq EU_P(k^*, b)$. Since, by construction, $b \in [\hat{b}(q + 1), \hat{b}(q)]$, this in contradiction with Lemma A4. Hence, $N(k^*b) = q$.

(B) To conclude the proof, we show that (i) for $b \leq 1/6$, $k^* = 0$ and (ii) for $b > \frac{\sqrt{2}}{4}$, $k^* = 1$:

(i) One can easily verify that for $b \leq 1/6$, $\frac{1}{12q^2} + \frac{q^2-1}{q^2+2}b^2 > b^2$ as long as q is a finite number. Hence, from (A.13) and (A.14), the principal optimally delegates to full authority to the agent (or $k^* = 0$) for $b < 1/6$ in which case she obtains a utility $-b^2$.

(ii) One can easily verify that for $b > \sqrt{2}/4$, $\frac{1}{12q^2} + \frac{q^2-1}{q^2+2}b^2 > 1/12$ for any $q \in \mathcal{N}$. Hence, from (A.13) and (A.14), the principal optimally keeps authority (or $k^* = 1$) for $b > \sqrt{2}/4$, in which case she obtains an expected utility of $-1/12$.

A.3. *Delegation with veto-power or "closed rule"*

Proof of Lemma 4. The proof for $y_o \leq L - 3b$ follows directly from the proof of proposition 8 in Krishna and Morgan (2000).[40] While Krishna and Morgan do not consider the case where $y_o \geq L - 3b$, one can easily verify that as long as $y_o < L - 2b$, their equilibrium still exists and is Pareto-dominant. In contrast, for $y_o > L - 2b$, the principal would veto a proposal of $y = y_o + 2b$ if, as in Krishna and Morgan, the agent were to propose this whenever $m \in [y_o, L]$. The Pareto-dominant equilibrium is then economically equivalent to the one described in Lemma 4, (ii).

Proof of Proposition 6. As argued in the text, for $b < 1/6$, the average deviation from m under the closed rule equals b. Due to the variance in this deviation, the principal then strictly prefers pure delegation. If $1/6 < b \leq 1/4$, we know from Lemma 4, that the expected utility under the closed rule is given by

$$\int_0^{1/2-b} b^2 dx + \int_0^b x^2 dx + \int_0^{2b} x^2 dx + \int_{\frac{1}{2}+2b}^{1} \left(\tfrac{1}{2} + 4b - x\right)^2 dx = \tfrac{17}{2}b^2 - \tfrac{50}{3}b^3 - b + \tfrac{1}{24}.$$

If $1/4 \leq b < 1/2$, it is given by

$$\int_0^{1/2-b} b^2 dx + \int_0^b x^2 dx + \int_0^{\frac{1}{2}} x^2 dx = \frac{1}{2}b^2 - \frac{2}{3}b^3 + \frac{1}{24}.$$

The principal's utility under pure delegation is given by $-b^2$. It follows that pure delegation is strictly preferred over delegation with veto-power if and only if $b < 1/4$.

Proof of Proposition 7. From Lemma 4, following the same reasoning as for Proposition 6, the average deviation from m under the closed rule equals b as long as $b \leq (L - y_o)/3$. The principal then strictly prefers pure delegation since in the latter case the deviation is constant. In contrast, for $b > (L - y_o)/3$, the average deviation from m under the closed rule is smaller than b. Hence, if the principal were risk-neutral, she would strictly prefer the closed rule over delegation. It follows that $\exists \hat{\ell}(x)$ such that the closed rule dominates pure delegation if the loss function of the principal, $\ell(x)$, is less convex in the sense of Arrow–Pratt than $\hat{\ell}(x)$.

Acknowledgements. This paper is based on chapter three of my Ph.D. dissertation submitted to the Université Libre de Bruxelles and the Université de Toulouse. The author is very grateful to Mathias Dewatripont, Patrick Rey and Jean Tirole for their guidance. I further thank Philippe Aghion, Abhijit Banerjee, Rob Gertner, Oliver Hart, Patrick Legros, Meg Meyer and Marco Ottaviani for very helpful discussions and remarks, as well as seminar participants at MIT, LSE, Leuven, Chicago, Stanford, LBS, University College London, Toulouse, Tel Aviv, Tilburg, Helsinki, Wisconsin, the CEPR Conference on Information Processing Organizations in Brussels and the SITE conference on contract theory in Stanford. He also thanks Mark Armstrong (the editor) and three anonymous referees for several comments which greatly improved the paper. Financial support from the Foundation for Scientific Research Flanders is gratefully acknowledged.

REFERENCES

AGHION, P. and TIROLE, J. (1997), "Formal and Real Authority in Organizations", *Journal of Political Economy*, **105**, 1–29.

ARMSTRONG, M. (1994), "Delegation and Discretion"(Mimeo).

AVERY, C. and MEYER, M. (2000), "Designing Hiring and Evaluation Procedures when Evaluators are Biased" (Mimeo).

40. As argued by Krishna and Morgan, this equilibrium Pareto-dominates the one proposed in Gilligan and Krehbiel (1987).

BAKER, G., GIBBONS, R. and MURPHY, K. (1999), "Informal Authority in Organizations", *Journal of Law, Economics and Organizations*, **15**, 56–73.

BANERJEE, A. and SOMANATHAN, R. (2001), "A Simple Model of Voice", *Quarterly Journal of Economics*, **116**, 189–228.

BATTAGLINI, M. (2001), "Multiple Referrals and Multidimensional Cheap Talk", *Econometrica* (forthcoming).

BERTRAND, M. and MULLAINATHAN, S. (1999), "Is There a Discretion in Wage Setting? A Test Using Takeover Legislation", *Rand Journal of Economics*, **30**, 535–554.

BRICKLEY, J., SMITH, C. and ZIMMERMAN, J. (1997) *Managerial Economics and Organizational Architecture* (Chicago: Irwin).

BOLTON, P. and DEWATRIPONT, M. (1994), "The Firm as a Communication Network", *Quarterly Journal of Economics*, **109**, 809–839.

CRAWFORD, V. and SOBEL, J. (1982), "Strategic Information Transmission", *Econometrica*, **50**, 1431–1452.

DE GARIDEL-THORON, T. and OTTAVIANI, M. (2000), "The Economics of Advice"(Mimeo).

GILLIGAN, T. and KREHBIEL, K. (1987), "Collective Decision-Making and Standing Committees: An Informationale Rationale for Restrictive Amendment Procedures", *Journal of Law, Economics, and Organization*, **3**, 287–335.

GROSSMAN, S. and HART, O. (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration", *Journal of Political Economy*, **94**, 691–719.

HART, O. and MOORE, J. (1990), "Property Rights and the Nature of the Firm", *Journal of Political Economy*, **98**, 1119–1158.

HOLMSTROM, B. (1977), "On Incentives and Control in Organizations" (Ph.D. Dissertation, Stanford University).

HOLMSTROM, B. (1984), "On the Theory of Delegation", in M. Boyer and R. Kihlstrom (eds.) *Bayesian Models in Economic Theory* (New York: North-Holland).

JENSEN, M. (1986), "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers", *American Economic Review*, **76**, 323–329.

KRISHNA, V. and MORGAN, J. (2000), "Asymmetric Information and Legislative Rules: Some Amendments", *American Political Science Review* (forthcoming).

KRISHNA, V. and MORGAN, J. (2001), "A Model of Expertise", *Quarterly Journal of Economics*, **116**, 747–775.

LERNER, J. and TIROLE, J. (2000), "The Simple Economics of Open Source", *Journal of Industrial Economics* (forthcoming).

LEGROS, P. and NEWMAN, A. (2000), "Competing for Ownership"(Mimeo).

MITUSCH, K. and STRAUSZ, R. (1999), "Mediators and Mechanism Design: Why Firms Hire Consultants"(Mimeo, Free University of Berlin).

MELUMAD, N. and SHIBANO, T. (1991), "Communication in Settings with No Transfers", *Rand Journal of Economics*, **22**, 173–198.

OTTAVIANI, M. and SORENSEN, P. (1999), "Professional Advice"(Mimeo).

RADNER, R. (1993), "The Organization of Decentralized Information Processing", *Econometrica*, **61**, 1109–1146.

RAJAN, R. and ZINGALES, L. (1998), "Power in a Theory of the Firm", *Quarterly Journal of Economics*, **113**, 387–432.

SEIDMANN, D. and WINTER, E. (1997), "Strategic Information Transmission with Verifiable Messages", *Econometrica*, **65**, 163–169.

SPECTOR, D. (2000), "Pure Communication Between Agents with Close Preferences", *Economic Letters*, **66**, 171–178.

STOCKEN, P. and MORGAN, J. (2000), "An Analysis of Stock Recommendations"(Mimeo).

SZALAY, D. (2000), "Optimal Delegation"(Mimeo).

TIROLE, J. (1999), "Incomplete Contracts: Where Do We Stand", *Econometrica*, **67**, 741–782.

VAN ZANDT, T. (1999), "Real-Time Decentralized Information Processing as a Model of Organizations with Boundedly Rational Agents", *Review of Economic Studies*, **66**, 633–658.

VICKERS, J. (1985), "Delegation and the Theory of the Firm", *Economic Journal (Conference Papers)*, **95**, 138–147.