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Management Style in Decision Making: Top Down or Bottom Up?

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Abstract

This paper analyses management style as a governance mechanism in agency relationships when the lack of verifiable information restricts the contracting possibilities. Specifically, it investigates which tasks a decision making process should comprise and how these should be organized, i.e. whether the evaluation of alternatives and/or the selection among them should be delegated to an informed expert or not. The optimal organization design is shown to depend nonmonotonically on the divergence of objectives and the efficiency of available information technologies. Moreover, this paper demonstrates how the nature of the expert's technological advantage influences the underlying tradeoffs.

Keywords: governance structure, centralization, delegation.

JEL Classification Numbers: D23, D8.

1 Introduction

The design of appropriate incentives to ensure that an appointed specialist serves the objectives of an organization constitutes a fundamental question for practitioners and theorists alike. In fact, it represents the key issue that has been extensively addressed by the moral-hazard strand of literature. The challenge of incentive design is aggravated by the lack of verifiable information about the choice variable and the realized outcome. In these situations the allocation of decision rights as proposed by the incomplete-contracts approach may become relevant. The extent to which these rights can be exercised, however, relies on the holder's access to information, which in turn guides the practised management style.

This paper explores ways to minimize the agency problem in complex decision making processes in which efficient choices crucially depend on expert information but contracting possibilities are severely restricted by the nonverifiability of this information. More specifically, it investigates the usefulness of management style as a governance mechanism: which tasks should decision making comprise and how should these be organized? How much autonomy should effectively be granted to an expert who may pursue a hidden agenda?

An example of this is the political decision making process where the formulation of new legislation frequently relies on the suggestions of an expert committee before being passed by parliament. The question arises as to why this committee of experts can have significant influence even if its members clearly pursue vested interests? Similarly, policy units often have considerable impact on the direction in which a corporation develops, sometimes with disastrous consequences for the organization. Nevertheless it is not unusual that management decisions rely on the information presented by subordinate experts. Should executives not evaluate the alternatives themselves to ensure that a chosen project indeed serves the objectives of the firm?

In both examples the principal (parliament or the executive board) retains the right to decide whether a proposal should be adopted or not. The dilemma faced by the principal arises from the dependence on the experts' competence coupled with the risk of deception in case private interests are aspired to. Can valuable information be credibly elicited from the specialists? If so, how and at what cost? Which structures should be instituted as safeguards of the principal's objectives?

This paper aims to answer these questions by investigating whether decision making, i.e. the *selection* of an alternative, should be supplemented with prior *verification* of the alternatives. For this purpose I distinguish between two corresponding levels of informativeness: either the principal is ignorant or she is informed and hence able to identify that alternative which primarily promotes her own interest. In the latter case, selection becomes trivial but assessment is prerequisite to obtain this information. If, however, she is ignorant and thus incapable of making intelligent choices, the organization of decision making - top down (centralization) or bottom up (delegation) - clearly affects the outcome. Instead of delegating the selection in a situation of limited information, the principal may press for additional information which may be provided by investing in own research or in formal communication channels where the expert is required to substantiate his findings. Hence the way in which this verification is organized determines the chances and/or the costs of becoming fully informed. Since I do not assume that the organization of the complementary tasks of selection and appraisal is binding it is subsumed under the notion of management style.

This paper analyses how the optimal management style is determined by the estimated conflict potential (or the level of trust) and the ease of generating observable information. Moreover, it illustrates that this relationship is not monotonous, and that the underlying tradeoffs are affected by the nature of the expert's technological advantage, i.e. whether his efforts are more efficient or less costly than the principal's in providing her with an informative and observable signal.

The use of alternative instruments to complement incentive pay in agency relationships features in both, the comprehensive- and incomplete-contracting strands of literature. Within the former category, organization design has been studied in various contexts. The articles by Milgrom (1988), Holmström and Milgrom (1991), and Itoh (1994), for instance, address the distribution of effort among various activities. In the model by Milgrom the allocation of effort between productive and influence activities emerges as a consequence of the organization of decision processes[1], whereas Holmström and Milgrom, and Itoh explicitly design the allocation of multiple tasks as to provide optimal incentives. Apart from modelling differences, the latter differ from my analysis in their focus: the tasks to be allocated are *a priori* considered to be essential. My model, by contrast, applies to a class of problems where the necessity of one task (the supplementary task of generating informative signals) is determined endogenously and arises exclusively from the agency problem involved in performing the primary task of selecting an alternative. That is, the assessment or verification of potential alternatives would be superfluous if the expert were not only *able* but also *willing* to act in the principal's interest. Appraisal and the organization thereof thus serves to provide the principal with

[1] The idea of influencing the decision outcome features passively in my analysis in that the expertise of an agent may empower him to do so. This empowerment affects the scope of and hence also the maximal investment in influence activities.

a second dimension to control the specialist's behaviour in addition to generating observable information. The main contribution of Holmström and Milgrom that agency problems must be analysed in totality to avoid obscure inferences (which may be obtained from studying the attributes of an activity in isolation) remains, of course, valid in my approach since the organization of one task affects the incentives to perform another.

A number of articles, also within the comprehensive-contracting framework, have focussed on the comparative advantage of centralized versus decentralized decision making, e.g. Demski, Patell and Wolfson (1984), Melumad and Reichelstein (1987), and more recently in the context of hierarchies Melumad, Mookherjee and Reichelstein (1995) and Villadsen (1995). In particular, they identify conditions under which a direct revelation mechanism (which facilitates informed centralized decision making) can be replicated by a delegation mechanism without communication. The common tradeoff driving the optimal organization design is that delegation of decision authority to a better informed party reduces the communication requirements while possibly introducing additional incentive problems that manifest themselves as potential loss of control[2]. The 'placement' of moral hazard - on the agent's discretion or communication? - to minimize the principal's exposure thus dictates the ideal organization of decision making. For the results to hold, it is essential that key variables such as communicated reports, chosen actions and/or outcome levels can be contracted upon. If these variables are not verifiable to outsiders (courts), the agency problem intensifies: communication becomes less credible and delegation involves a greater loss of control. In which way the above mentioned tradeoff is affected by the nonverifiability of information has not received sufficient attention.

This is not to say that nonverifiability of crucial information is unfamiliar. On the contrary, the difficulty of unambiguously verifying certain information to outsiders has been accommodated by the incomplete-contracting literature. Building on the pioneering work of Grossman and Hart (1986) and Hart and Moore (1988), who describe the notion of property rights as the discretionary power obtained by the ownership of an asset, contributions to this strand of literature have primarily been concerned with the formal, or explicit, allocation of decision rights. Far less attention has been placed on the importance of information in exercising decision rights. This shortcoming has been identified by Aghion and Tirole (1997) who, in response, clearly distinguish between formal and real allocation of authority within

[2]Compare also with Jensen and Meckling (1992), who analyse the organizational problem of collocating knowledge and decision authority in terms of costs owing to poor information *vis-à-vis* agency costs.

organizations[3]. They argue that delegation of both types of authority promotes initiative from the agent but diminishes the principal's control. Although the payoff structure presented in this paper takes its lead from their paradigm of project selection, this model differs from their set-up in important aspects. In particular, I assume an extreme informational asymmetry between the two parties involved in decision making to highlight a clear distinction between various functions of information generation. In the model by Aghion and Tirole project evaluation, if successful, enables the agent to make an informed proposal. In my model, by contrast, the agent is considered a specialist who is already capable of an intelligent choice. In this scenario his fact-finding fulfills solely the purpose of adding credibility to communicating his accumulated information, any signals (evidence) he produces serve to convince the principal of the appropriate decision. In reality, appraisal presumably serves both these functions. Acknowledging that lobbyists and strategists are likely to acquire specialist information in their pursuit of own interests, the focus on their incentives or apprehension to communicate their private information appears plausible. As a consequence of these alterations, the formal delegation of authority can in this setting be replicated by effective delegation and thus becomes redundant. Moreover, they affect the emerging tradeoff between initiative and control and thereby highlight its responsiveness to the assumed informational structure.

Another related article is by Strausz (1997) who studies whether monitoring of an agent's hidden action should be delegated in a three-tier hierarchy. The established profitability of delegation relies on a different set of effects, compared to my model, as delegation extends the contracting possibilities and thereby provides the principal with additional means to control incentives and to offer commitments.

This paper proceeds as follows. Section 2 introduces the basic model and investigates possible governance mechanisms, in particular also the scope of delegating the project selection. In Section 3 the decision making process is extended by the supplementary task of project appraisal which, if successful, generates observable information and hence mitigates the agency problem. This section specifically investigates how the management of decision making affects the agent's participation and his incentives to search for informative signals. In Section 4 the factors determining the feasible and optimal combination of top-down and bottom-up structures are identified. It exhibits how the nature of the agent's superior technology determines the impact of mutual distrust and the principal's access to information on the underlying tradeoff between the costs of asymmetric information and loss of

[3] 'Formal' authority refers to the right to decide, whereas 'real' authority concerns the effective control over decisions.

control. An extension is considered in Section 5 in which the cost of communicating private signals is analysed. In the subsequent section, the intention to endogenously align dissonant objectives is discussed. Section 7 concludes. Appendix A presents a foundation for the payoff structure, followed by Appendix B which contains the proofs of propositions.

2 The Basic Model

The organization is characterized by a principal-agent relationship, where the principal P is to take an important non-routine decision, for whose implementation agent A is indispensible[4]. Efficient decision making requires specialized knowledge, for instance, to identify the set of various alternatives and their corresponding consequences. Apart from postulating that the rational decision maker selects the option that maximizes own returns, this selection process is not explicitly modelled. Instead, this model emphasizes two aspects that influence the kind of decision taken: organizational form, i.e. who is to select an alternative, and the principal's informational status. The participants' expected returns are depicted below:

	P ignorant	P informed
Top down (centralization)	$U_P = 0$ $U_A = 0$	$U_P = B$ $U_A = \beta b - (1-\beta)\, c$
Bottom up (delegation)	$U_P = \alpha B - (1-\alpha)\, C$ $U_A = b$	$U_P = \alpha B - (1-\alpha)\, C$ $U_A = b$

where $B, C, b, c, > 0$ and $\alpha, \beta \in [0,1]$.

This payoff structure can be motivated as follows, with a detailed interpretation presented in Appendix A. If the ignorant principal retains centralized (top down) decision making power, she could either take an arbitrary or no decision at all. Since the former is considered too risky to be worthwhile (by assumption), the principal will maintain the status quo; the corresponding expected payoffs have been normalized to zero for both participants.

In all remaining situations a non-trivial decision is adopted and the expected returns are expressed as linear combinations of a 'beneficial', or 'preferred', project (of value B or b) and a 'costly' project which yields -C or -c for the principal and agent, respectively[5].

[4]Note that the emphasis is on decision making, i.e. selection of an alternative. Any frictions that may arise in the implementation phase are disregarded by this model.

[5]The magnitudes B, C, b, c can themselves be interpreted as expected values.

The highest payoff can be attained by the party that is both informed and in control of decision making. This principle reflects not only that information is a prerequisite for sensible decisions, but also that the pursuit of own interests is likely to influence the decision outcome. Consequently, the principal's loss of control, caused by delegating responsibility (bottom up) to a specialized agent who is capable of intelligent decision making, rests largely on the extent to which this expert pursues the objectives of the organization. The more aligned the interests are, the higher will be the probability α (the 'congruence' parameter) that the principal's preferred action will be adopted. A high degree of divergence (distrust), by contrast, implies a high probability that the agent's preference is harmful for the principal. The congruence parameter β can be interpreted similarly if an authoritarian decision structure is prevalent. Apart from Section 6, both α and β are exogenous parameters.

It is necessary to clarify the presumed informational structure. At the outset (stage 0) the principal and the agent are ignorant and thus unable to take a non-trivial decision. Moreover, neither participant knows whether their objectives coincide. Their subjective beliefs of congruence are indicated by the probabilities α and β. Once a move by nature unravels this uncertainty (stage 1), only the agent learns the information required for decision making. This captures the idea that the agent is some specialist who - due to his position and experience as a strategist, for example - has private information about the payoffs of potential alternatives, or projects[6]. This perfect, though soft, information enables him to evaluate various alternatives and identify the 'appropriate' course of action, where the proposal is, of course, biased by his own interests. In stage 2 a decision is taken and the returns are realized.

The question of governing this relationship to the principal's best advantage constitutes the prime concern of this chapter. The available options, however, hinge crucially on the observability of the realized returns. In particular it is assumed that these payoffs, though observable to the participants, are not verifiable to third parties. This can be justified, for instance, if the projects resemble long-term investments, mergers, downsizing operations, or some other restructuring processes within the firm. Or, in the context of political decision making, projects may refer to new laws or policies. In fact, they can be thought of any activities which are difficult to describe precisely and hence impossible to objectively and verifiably distinguish from any alternative actions. Moreover, their implied consequences cannot unambiguously be identified: apart from the fact that incremental profits accrue

[6]These concepts are used interchangeably, where a 'project' should be understood in its most general sense.

over time, their existence cannot be exclusively attributed to one specific cause. In addition, many consequences about which individuals care are private, such as a change in the perceived image or on-the-job leisure. It is therefore plausible that neither the alternatives nor their payoffs are contractible.

The specified payoff structure implicitly conveys that both parties are risk-neutral. Finally, assume that the agent is liquidity-constrained, and that the implementation of a project affects the principal more intensely than the agent[7], i.e.

$$B + C > b + c. \tag{1}$$

2.1 Possible governance structures

Given the above informational specifications, let us briefly investigate possible governance structures available to the principal, who ideally wishes to acquire the information necessary for judicious decision making. Can the principal induce the agent to truthfully communicate his expert knowledge to her in case their aspirations are dissonant?

2.1.1 Direct Revelation Mechanism

Recall that both the principal and agent observe the realized payoffs which, however, are not directly verifiable to outside parties such as courts or arbitrators. Then, unless an *ex post* revelation mechanism can be designed to verify the realized returns to which compensatory payments can then be tied, the principal cannot elicit *ex ante* the information crucial for efficient decision making[8]. The reasoning is straightforward: a transfer that does not distinguish amongst various outcomes is by implication a lump-sum payment. Irrespective of its size, this lump sum is incapable of inducing the agent to act in the principal's interest. If the principal cannot prove when the expert acts opportunistically to cater for his own rather than the organization's needs, she is unable to punish such behaviour. Consequently, it is rational for the agent to always suggest that his preferred project be adopted. Only if it can unambiguously be verified when the agent indeed bears the burden inflicted by the costly project, is the principal able to compensate him sufficiently and thereby align his returns according to her own objectives, i.e. induce A to honestly identify her favourite project.

[7]The consequences of this assumption will be discussed in due course.

[8]In the sequel, *ex ante* and *ex post* are relative to the time of decision making and the associated realization of returns.

Is it possible to construct an *ex post*, renegotiation proof, revelation mechanism that truthfully reveals whether the adopted decision is beneficial (b) or costly (c) for the agent? To illustrate, suppose that the principal and agent each report the nature of the agent's realized outcome to an arbitrator who, conditional on these reports, determines the compensation t to be paid. With reference to the simplified payoff matrix

		A: b	A: c
P	b	$-t_b$, t_b	$-t_{bc}$, t_{bc}
	c	$-t_{cb}$, t_{cb}	$-t_c$, t_c

the participant's rational behaviour in this zero-sum game can be predicted, given any realization of returns (which have been subtracted because they are not affected by the reports). Using the Nash equilibrium concept, it becomes apparent that both players will report the beneficial return b if and only if

$$t_{bc} < t_b < t_{cb}.$$

Analogously, cost c is announced by both players if and only if

$$t_{cb} < t_c < t_{bc}.$$

Since these two inequalities are incompatible, there exist no transfers such that identical reports (i.e. on the diagonal) are Nash equilibria, let alone that truthful revelation constitutes a unique equilibrium[9]. The principal can therefore not resort to this direct announcement mechanism to elicit crucial information such that it becomes verifiable. With reference to Tirole (1994), the reason for this failure lies in the fact that information about realized returns is not payoff-relevant since the implementation of projects is irreversible[10].

[9] If the mechanism is not required to be balanced, truthful revelation is implementable though not unique.

[10] Tirole (1994, p19) argues that 'the nonverifiability of information by a court is in general no obstacle to the implementation of contracts contingent on this information as long as this information is commonly observed by several parties.' He qualifies this assertion by stating that 'information that is no longer "payoff-relevant" - meaning that it does not alter the agent's von Neumann-Morgenstern (VNM) utility functions in the continuation game - cannot be elicited as a unique outcome.'

2.1.2 Delegation

An alternative instrument for governing agency relationships, as analysed by the incomplete-contract literature, constitutes the optimal allocation of decision rights. Unless the principal can elicit information about the decision alternatives *ex ante*, she faces the question whether to retain the right to select a project or to delegate it to her subordinate.

As argued above, the expert's proposed decision is biased by his own ambitions. Nevertheless, the principal may invite him to suggest a project. Acceptance of his suggestion is tantamount to delegating the decision to the specialist, a rejection corresponds to a centralized decision structure, because the principal lacks the knowledge to judge whether the proposal implies beneficial or costly consequences for her. Both of these options entail risks. Delegation, though facilitating the principal to capture return B with probability α, implies the risk of implementing a potentially costly project. Disregarding the expert's advice, by contrast, she forgoes the opportunity, however small, of adopting the beneficial project. Instead, the ignorant principal prefers to take no active decision rather than an arbitrary choice which she expects to yield a negative return. Consequently, a top-down selection procedure coincides with the status quo which yields zero impact for both.

The principal delegates the decision if and only if her agent's interests are sufficiently congruent, $\alpha \geq \tilde{\alpha} := \frac{C}{B+C}$.

This lemma follows directly from the left-hand-side of the payoff matrix, i.e. the comparison of P's respective payoffs

$$U_P = \begin{cases} \alpha B - (1-\alpha)\, C & if delegation \\ 0 & if centralization. \end{cases} \tag{2}$$

Since the agent's corresponding payoff as given by

$$U_A = \begin{cases} b & if delegation \\ 0 & if centralization \end{cases}$$

is nonnegative in either case, no transfers need to be paid.

So far I have not distinguished between the formal and effective allocation of decision making - a distinction that is central to Aghion and Tirole (1997) - because one exactly replicates the other in this basic model where commitment plays no role. From a practical point of view it may be imprudent to formally and irrevocably relinquish specific decision rights if nothing can be gained thereby, particularly since the optimality of delegation depends on the principal's subjective beliefs. Thus, upon any updating of these beliefs she might want to reverse the delegation. A delay of the delegation decision is also optimal from the theoretical perspective of this model if the decision making process is supplemented with an attempt to generate observable information (as analysed in subsequent sections) prior to the final decision stage. Since the formal delegation of project selection to the agent implies that the principal relinquishes her power to veto or override the agent's choice, there is no scope to improve efficiency - from the principal's perspective - of decision making. Consequently formal delegation can be disregarded in the sequel.

3 Observable Signals

The principal may not be content with informal communication as the recommendation obtained from her subordinate is inherently biased. Instead she will explore further possibilities to become informed, that is, to verify whether the expert's advice contributes to her objectives. In general, two ways appear plausible: either the principal can do her own research or she can initiate more formal communication by requiring the specialist to substantiate his proposal with evidence. The relative performance of these verification procedures depends only partly on the technologies that are accessible to the participants. Specifically, the principal must trade off her non-professionalism in these matters with additional incentive problems that may arise if appraisal is delegated to the agent.

Suppose that either the principal or the agent can by investing into their respective information technology generate a perfect, but infrequent, signal that unambiguously reveals the principal's preferred project. This signal constitutes common knowledge and, once obtained, it can neither be forged nor concealed. Hence appraisal enables the principal to implement her favourite project with a higher probability. The question thus becomes whether she should engage in fact-finding herself (P-appraisal) or induce the agent to do so (A-appraisal). To reiterate, the latter entails a search for evidence that serves the purpose of making communication of the expert's knowledge credible.

Notice that in either case, appraisal does not create 'new' information for the relationship, since the agent is perfectly informed about potential payoffs as soon as the state uncertainty (in/congruence) is resolved. This implies that appraisal is, from a first-best point of view, socially wasteful. Nevertheless it may alleviate the agency problem because it enhances the observability of information and hence the efficiency of the decision making process.

Based on the agent's postulated expertise, he is likely to have access to a more effective verification technology than the principal. His search effort of g produces the correct signal with probability μ, no signal otherwise. The principal's required search investment is $G \geq g$, her signal frequency is $\lambda = \delta\mu$, where $\delta \leq 1$. Further assume that evaluation costs are sufficiently small,

$$G < B. \tag{3}$$

The timing of events is delineated below. Initially, both parties are symmetrically uninformed. Provided the principal requires appraisal, she offers a take-it-or-leave-it contract to the agent. The stipulated transfer $t = (t^0, t^1)$ can only condition on the presence or absence of a signal, not on the type of project implemented nor on the internal organization regarding the project choice[11]. Its magnitude is obviously tailored to the intended purpose. In case the principal undertakes the appraisal herself, the reimbursement only needs to cover the agent's reservation utility to ensure his participation. To induce delegated appraisal, however, the contract must also be incentive compatible. The contract offer at stage 0 thus presupposes the internal organization of appraisal. Provided the agent accepts the offer, hidden effort is invested[12], followed by a draw by nature which determines whether the payoffs are congruent or not, and whether a signal is produced. Once the uncertainty is resolved, the agent privately learns various alternatives and their associated payoffs. If a signal is produced, the principal also becomes informed about her relevant payoffs. Finally, a decision is made. In case the appraisal is successful, the principal adopts her preferred action. Without any signal she either delegates the choice or not[13]. The assumption that the organization of project selection is only determined in the final period reflects that the principal can unilaterally reallocate this right[14].

[11]To clarify, the signal enables the principal to select her favourite project. This does not affect the nonverifiability of the implemented project, its payoffs, and the adopted management style.

[12]This sequence where the investment decision precedes the draw by nature suggests that investment serves to *prepare* the research or formal communication, respectively. Formally, it implies that the agent's incentive constraints need to be satisfied only on average.

[13]In what follows, given the projects are evaluated, the delegation or centralization of decision making refers to the case in which no evidence is found, i.e. whenever P remains uninformed.

[14]The point that the principal does not *ex ante* commit herself to delegate or centralize the project choice implies that, in terms of the Aghion-Tirole model, I remain in the realm of P-formal authority in which the real allocation of the decision power is deferred until all uncertainty has been resolved. This disregard of formally delegating in period 0 the task of selection is itself a consequence of the assumed set-up: under no circumstances is the formal delegation strictly superior to formal centralization (with the option of effective delegation.) Anticipating somewhat, this claim is confirmed by Lemma 3.2.

$\|0$	$\|\frac{1}{4}$	$\|\frac{1}{2}$	$\|1$	$\|2$
appraisal?	A accepts	invest	nature:	decision
contract	or rejects t	(g or G)	in/congruence	
$t = (t^0, t^1)$			$(no)signal$	

$if\, signal:$	no signal:
implement B	delegate or
	centralize ?

Before investigating whether appraisal should be delegated or not, let us analyse some important considerations of P- and A-appraisal in turn.

3.1 Non-Professional Research (P-Appraisal)

Suppose the principal invests G to obtain a signal with probability λ. If obtained, this signal enables efficient decision making. Depending on the management style the expected payoff for the principal is

$$U_P = \begin{cases} \lambda B + (1-\lambda)\left[\alpha B - (1-\alpha)\, C\right] - G - t & if\, delegation \\ \lambda B - G - t & if\, centralization. \end{cases} \tag{4}$$

It is straightforward to verify that, whenever no signal (or evidence) is obtained, the principal remains uninformed; hence Lemma 2.1.2 applies for any transfer t. Moreover, the optimal contract offer must satisfy the agent's individual-rationality constraints

$$\begin{array}{rll} \lambda\left[\beta b - (1-\beta)\, c + t^1\right] + (1-\lambda)\left(b + t^0\right) & \geq 0 & if\, delegation \\ \lambda\left[\beta b - (1-\beta)\, c + t^1\right] + (1-\lambda)\, t^0 & \geq 0 & if\, centralization \end{array}$$

to ensure the agent's participation[15]. Without loss of generality it can be assumed that $t^0 = t^1 = t$, i.e. that the agent receives a lump-sum payment. These constraints can thus be rewritten as

$$t_d + \lambda\left[\beta b - (1-\beta)\, c\right] + (1-\lambda)\, b \geq 0$$

[15]Alternatively, if A were dispensible for the project or locked in the employment relation already (assuming substantial mobility costs), these participation constraints could be disregarded. By implication, P-appraisal becomes relatively more attractive for small β.

under delegated project choice, and

$$t_c + \lambda [\beta b - (1 - \beta) c] \geq 0$$

otherwise. Recalling that the transfers cannot condition on the adopted management style, the indeces d and c refer to the *anticipated* internal organization of decision making.

Agent participation is more costly to induce under a centralized decision structure.

For any β, $t_c \geq t_d$ because

$$\begin{aligned} t_d &= \max\{0; \lambda (1 - \beta)(b + c) - b\} \\ &> 0 \Leftrightarrow \beta < \beta_d^0 := \tfrac{\lambda(b+c)-b}{\lambda(b+c)} \end{aligned} \tag{5}$$

and

$$\begin{aligned} t_c &= \max\{0; \lambda (1 - \beta)(b + c) - \lambda b\} \\ &> 0 \Leftrightarrow \beta < \tilde{\beta} := \tfrac{c}{b+c} \end{aligned} \tag{6}$$

with $\beta_d^0 \leq \tilde{\beta} \quad \forall \lambda$.

This result relies crucially on the fact that appraisal introduces the possibility of implementing a project which adversely affects the agent. Provided his payoffs are relatively incongruent (β small), he needs to be compensated for this expected loss. Potential delegation of decision making partly serves this purpose; this management style thus reduces the required transfer payment. Whether the agent needs to be compensated at all depends on his payoff congruency. If it falls short of β_d^0 or $\tilde{\beta}$ under the two respective management styles, the implied transfers are positive and add to the appraisal costs. With this effect in mind, I introduce congruence symmetry

$$\alpha \equiv \beta \tag{7}$$

when investigating the profitability of own appraisal compared with no appraisal and the principal's associated ignorance[16].

The principal prefers P-appraisal to no appraisal if the signal frequency is sufficiently high, that is

i) $\lambda \geq \lambda_d = \max\left\{\underline{\lambda}_d; \bar{\lambda}_d\right\}$ in case decision making without evidence is bottom up, or

[16] Congruence symmetry is assumed for all subsequent results. Only if it facilitates the interpretation, I distinguish between α and β in the proofs and text.

ii) $\lambda \geq \max\{\underline{\lambda}; \lambda_c\}$ provided $\alpha \geq \frac{c-B}{b+c}$ and selection is organized top down where

$$\underline{\lambda}_d := \frac{G}{(1-\alpha)(B+C)} \quad and \quad \bar{\lambda}_d := \frac{G-b}{(1-\alpha)[B+C-(b+c)]}$$

$$\underline{\lambda} := \frac{G}{B} \quad and \quad \lambda_c := \frac{G}{B+\alpha(b+c)-c} .$$

The proof is deferred to Appendix B. The observation that appraisal becomes more profitable as the signal frequency (i.e. the success rate of screening) rises is hardly surprising. But Proposition 3.1 also reveals the tradeoffs underlying the threshold frequencies of appraisal. Particularly interesting is that the level of congruency, or trust, does not monotonically reduce the need to evaluate the alternatives. More precisely, provided that the selection is organized bottom up, trust diminishes the need of appraisal. Top-down selection, by contrast, implies that trust raises the profitability of appraisal, because pronounced divergence makes appraisal extremely costly since project implementation is likely to harm the agent and hence require huge compensation payments.

Consider first the case of $\alpha > \tilde{\alpha}$ where the uninformed principal sufficiently trusts the agent and therefore delegates decision making. Within this range appraisal lowers the probability of implementing the costly project $(1-\alpha)$ by proportion λ. Simultaneously, a high degree of trust makes appraisal increasingly superfluous, because the opportunity cost of delegation without evaluation shrinks. Consequently, the impact of appraisal and hence its attractiveness diminishes with a closer alignment of interests - as reflected by the positive relationship between λ_d and α [17].

If, by contrast, the decison is imposed centrally because of insufficient congruence, appraisal is a prerequisite for non-trivial decisions. The associated expected gain of λB compared to the status-quo zero utility is clearly independent of α, as mirrored in the constancy of $\underline{\lambda}$. Notice that $\lambda_c \leq \underline{\lambda} \Leftrightarrow \alpha \geq \tilde{\beta}$ and recall from (6) that the expert requires positive transfers if his congruency falls short of $\tilde{\beta}$. Thus, under this regime congruence only plays a role if it is low and refers to the agent's returns in which case compensational issues add to the expected appraisal costs. The fact, that these incremental appraisal costs rise as the incongruency becomes more pronounced clearly establishes the inverse relationship between λ_c and α. In particular, if the agent's costly project causes substantial disutility, $c > B - G$, the

[17] Notice that the absolute magnitude of the threshold frequency is determined by the agency rent *vis-à-vis* the appraisal effort: $\overline{\lambda}_d \leq \underline{\lambda}_d \leq \lambda_d^0 \Leftrightarrow \frac{G}{B+C} \leq \frac{b}{b+c} \Leftrightarrow$ (23) where λ_d^0 is the inverse of β_d^0, i.e. those congruence-frequency pairs at which the agent voluntarily participates in the relationship without earning any rent. In view of (1), violation of condition (23) is only possible if $b < G$.

principal might abstain from appraisal even if she had access to a perfectly reliable signal technology.

Having explained why aligned interests contribute to the profitability of P-appraisal if selection is practised top down but not if it is pursued bottom up, let us now consider $\tilde{\alpha}$. In this special case of zero expected congruence the principal is indifferent about the organization of project selection. The threshold frequency of appraisal is discontinuous with $\lambda_d(\tilde{\alpha}) < \lambda_c(\tilde{\alpha})$. Whenever the costly project constitutes a relatively larger stake for the agent than the principal (that is, if $\frac{c}{b+c} > \frac{C}{B+C}$ or equivalently $\tilde{\beta} > \tilde{\alpha}$), By Lemma 3.1, this peculiarity is attributed to more costly agent participation whenever the decision making is pursued top down[18].

3.2 Formal Communication (A-Appraisal)

Alternatively the principal could place more emphasis on improved communication by inducing the agent to invest g in order to obtain an observable signal with probability μ. Recall that this signal is common knowledge, that is, once obtained the agent can neither conceal nor forge it[19]. As before, compensation for the agent can only condition on the presence or absence of the signal. Since the agent is liquidity constrained and the principal only benefits from his screening effort if successful, no compensation will be paid if she remains ignorant, i.e. the optimal contract stipulates $t^0 = 0$and $t^1 = t$. The corresponding expected payoff is thus

$$U_P = \begin{cases} \mu(B-t) + (1-\mu)[\alpha B - (1-\alpha)C] & if delegation \\ \mu(B-t) & if centralization. \end{cases} \tag{8}$$

Notice that Lemma 2.1.2 again indicates the optimal organization of decision making in case no signal is obtained. Though the principal may choose her management style as she likes, her credibility is effectively dictated by the extent to which the decision consequences are congruent. The trust parameter α thus determines which constraints are relevant. Since appraisal is a hidden action, the optimal transfer in return for producing a signal must satisfy the agent's incentive compatibility constraints

$$\mu[t_d + \beta b - (1-\beta)c] + (1-\mu)b - g \geq b \tag{9}$$

[18]The fact that the participation constraint plays no role in the alternative regime of bottom-up choice is due to assumption (1). Violation thereof creates a frequency cap $\bar{\lambda}_d$ beyond which P-appraisal becomes too costly relative to no appraisal: with reference to the proof of Proposition 3.1 $\left(\tilde{\alpha} \leq \alpha \leq \beta_d^0\right)$, appraisal is viable if $\lambda(1-\alpha)[B+C-(b+c)] \geq G-b$, i.e. $\lambda \leq \bar{\lambda}_d$ and $\neg(1)$.

[19]This assumption will be relaxed in Section 5.

or

$$\mu\left[t_c+\beta b-(1-\beta)\,c\right]-g\geq 0 \tag{10}$$

if A believes P to endorse or override, respectively, his unsubstantiated suggestion. The corresponding participation constraints may be disregarded here since they are implied once the incentive constraints are satisfied[20].

Centralization of decision making strengthens the agent's incentives to establish informative signals that formally communicate his knowledge.

For any $\beta\in[0,1]\,,t_c<t_d$ because

$$t_d=\frac{g}{\mu}+(1-\beta)\,(b+c)>0 \tag{11}$$

and

$$\begin{aligned} t_c &= \max\left\{0;\frac{g}{\mu}+(1-\beta)\,(b+c)-b\right\} \\ &> 0\Leftrightarrow\beta<\beta_c^0:=\tfrac{g+\mu c}{\mu(b+c)}\ . \end{aligned} \tag{12}$$

Despite diverging from the conventional understanding that more rather than less delegation intensifies an agent's incentives[21], the intuition of this result can be readily explained. If the agent believes that his suggestion will be endorsed, his situation can only deteriorate in case he produces a (potentially incongruent) signal. Investing in search effort thus disagrees with his own interests since it causes his favourite project to be implemented with less than certainty. Consequently, he needs not only to be compensated for his appraisal effort but also for this reduction in his expected private benefits. Unless he is granted his agency rent b, he will not invest any appraisal effort.

By contrast, if the principal maintains the status quo unless evidence is produced, the agent clearly gains from monitoring the payoffs provided he expects a net expected congruence, i.e. beyond $\frac{c}{b+c}$. For sufficiently high congruence (above β_c^0) and frequency he will even search voluntarily for an observable signal.

By implication of this lemma, the principal has no incentive to commit herself to delegate project selection as this would destroy the agent's incentives to credibly

[20]By substituting the reservation utility of zero into the above constraints, it can easily be verified that Lemma 3.1 carries over to A-appraisal, but is of no consequence.

[21]Refer, for example, to Aghion and Tirole (1997) who argue that delegation promotes initiative from the agent. Itoh (1994) also argues that delegation of tasks to a subordinate provides additional incentives.

communicate his information. The neglect of formal delegation of authority in this context is accordingly justified.

Let us suppose symmetric congruence (7) again to characterize the minimum required signal frequency at which A-appraisal becomes worthwhile.

The principal prefers A-appraisal to no appraisal if the signal frequency exceeds μ_d or μ_c whenever decision making without evidence is delegated or centralized, respectively, and provided trust exceeds $\frac{c-B}{b+c}$; where

$$\mu_d := \frac{g}{(1-\alpha)[B+C-(b+c)]}$$

$$\mu_c := \frac{g}{B-c+\alpha(b+c)} \, .$$

The direction of the tradeoffs is similar to P-appraisal in the sense that the threshold frequency μ_d is positively, μ_c inversely related to α. In this sense the agent's incentive constraints play only a 'subordinate' role. Under centralized selection, the incentive and participation constraints are identical. The similarity of μ_c with λ_c is therefore intuitive.

If the principal approves an unverified recommendation, however, agent incentives are indeed important. Nevertheless they do not interfere with the positive slope of $\mu_d(\alpha)$ for the following reason: A-appraisal raises the principal's payoff by reducing the risk of implementing a costly project. Simultaneously, the agency rent makes it costly. The net impact (ignoring g) of $\mu(1-\alpha)[B+C-(b+c)]$ is positive if and only if (1) holds. That is, bottom-up appraisal can only be viable if the principal's stakes exceed those of the agent. Assumption (1), being responsible for the dominance of the positive effect of appraisal, thus also determines the shape of $\mu_d(\alpha)$. If, by contrast, (1) were violated, the principal would consider A-appraisal under no circumstances. That is, formal bottom-up communication and decision making can only be optimal if the principal cares more about the outcome than the agent[22].

As a consequence of Lemma 3.2, the threshold frequency of appraisal is discontinuous at $\tilde{\alpha}$. Since the principal finds it easier to induce appraisal if she boycotts rather than endorses her subordinate's suggestions, a less effective signal technology is required to warrant the search effort, i.e. $\mu_c(\tilde{\alpha}) < \mu_d(\tilde{\alpha})$.

[22]This observation contrasts with Milgrom's (1988) result that the discretion of the central decision authority should be restricted if the decision is important for the organization.

4 Optimal Task Allocation

Having shown that more delegation does not necessarily increase payoffs, let me now turn to my main intention and identify the optimal combination of top-down and bottom-up structures. With reference to Lemma 2.1.2 to 3.2, I investigate how the interest alignment and the signal frequency determine the optimal task allocation of decision making and appraisal. Recall that Lemma 3.1 points to an organizational complementarity between centralized appraisal and participatory decision making, whereas by Lemma 3.2 delegated assessment tends to be supported by authoritarian selection. Since, by Lemma 2.1.2, the management of the decision making process (in case the principal is uninformed because of failed assessment) is anticipated, let us investigate how the above tendencies interact to determine the optimal organization of appraisal in case delegated, and in turn centralized, choice is credible.

In this section the focus is on the *relative* performance of the two appraisal methods. Recall that the principal's signal frequency constitutes a fraction of the agent's. Substituting $\lambda = \delta\mu$ with $\delta \in [0,1]$ therefore facilitates the direct comparison between P- and A-appraisal.

4.1 Bottom-Up Decision Making

Given the principal endorses her subordinate's unverified suggestions ($\alpha \geq \tilde{\alpha}$), let us assess their relative efficiency in generating signals. For clarity define the agent's technological advantage to be *complete* if either his frequency or his cost advantage is sufficiently large, i.e.,

$$1 - \delta > \frac{b+c}{B+C} \tag{13}$$

or

$$G - g > b. \tag{14}$$

The agent's technological advantage is necessary for the optimal delegation of both, appraisal and decision making. If it is complete, then both tasks should be delegated $\forall \alpha \geq \tilde{\alpha}$.

Else, provided $\delta > \delta_1$ and $b > G - g$, P-appraisal dominates A-appraisal for $\underline{\mu}_d \leq \mu \leq \bar{\mu}_d$; where

$$\delta_1 := \frac{b[B+C-(b+c)]}{b(B+C)-(G-g)(b+c)} \tag{15}$$

$$\underline{\mu}_d := \frac{G-g}{(1-\alpha)[b+c-(1-\delta)(B+C)]} \quad and \quad \bar{\mu}_d := \frac{b-(G-g)}{(1-\alpha)(1-\delta)[B+C-(b+c)]}.$$

fhFO3.0692in2.1793in0ptOptimal mix of top-down and bottom-up structuresmixmix.wmf

The first part of this result is intuitive. It establishes the intensity of the agency problem and characterizes the minimal frequency or cost advantage required for the delegation of both tasks. If the agent's technological advantage is incomplete, the principal might well decide to investigate potential alternatives herself and, in case of failed research effort, to delegate the final choice. This strategy is optimal particularly in the vicinity of μ_d^0 (the inverse of β_d^0 as defined in (5), i.e. those pairs in the $\alpha - \mu$ space at which the agent voluntarily participates while earning no rent when the principal appraises the projects.) As shown in Figure **??** this area corresponds to 'intermediate' levels of congruence or signal frequency. But how can these lower and upper bounds be explained?

For this purpose it is important to distinguish among three effects, the *agency*, *savings*, and *frequency* effects, of A-appraisal relative to P-appraisal. First, A-appraisal is costly due to the agent's ability to capture rent payments if appraisal is delegated. These hidden action costs rise if the signal frequency increases and if trust diminishes[23]. Second, the agent's lower screening costs compensate the aforementioned agency costs, at least to some extent. Notice that the direct cost savings of $G - g$ are independent of the frequency and congruence level. The third effect involves the higher signal frequency of the agent. Like the agency costs, the associated impact of $\mu(1-\alpha)(1-\delta)(B+C)$ is more pronounced for a high frequency and a low congruence. Consequently, the relative importance of this effect compared to the agency costs determines whether A-appraisal becomes more or less attractive the higher the rate of signal reception and the lower the congruence.

Consider the case where, under P-appraisal, the agent's participation is costless, i.e. $\alpha \geq \beta_d^0 \Leftrightarrow \mu \leq \mu_d^0$. In view of the condition stipulated for the relative advantage of A-appraisal

$$\mu(1-\alpha)\left[(1-\delta)(B+C)-(b+c)\right]+G-g \geq 0 \qquad (16)$$

(derived in the proof), the positive frequency effect dominates the agency-cost effect if and only if the term in square brackets is positive, which is the case whenever the agent's frequency advantage is complete with (13) satisfied. Thus, P-appraisal becomes viable for high μ and low α only if the hidden-action costs dominate the (incomplete) technology advantage. For low μ and high α the agent requires little compensation for screening, because the probability of obtaining an incongruent signal is particularly low. Moreover, this transfer is only paid occasionally if the signal is difficult to obtain. Given that the agent is more competent in appraisal, the principal will delegate this task as long as the transfer remains sufficiently small.

[23]Compare (5) and (11).

Consequently, the complementarity of delegating both tasks is enhanced by higher α and lower μ, provided (13) is violated.

The direction of this organizational complementarity is reversed when agent participation under P-appraisal becomes costly, i.e. if $\alpha < \beta_d^0 \Leftrightarrow \mu > \mu_d^0$. Observe that bottom-up appraisal is superior whenever

$$\mu (1-\alpha)(1-\delta)[B+C-(b+c)] - b + G - g \geq 0. \tag{17}$$

(again as derived in the proof) is satisfied. In this case, the additional costs $(b+c)$ and benefits $(B+C)$ of A-appraisal over and above those of P-appraisal carry the same weight. Their net magnitude thus dictates the direction of the tradeoff. By assumption (1) the agency-cost effect is outweighed by the benefits of the frequency differential. Simultaneously A-appraisal is no viable option unless more is at stake for the principal than the agent. Thus, provided the competence asymmetry is incomplete such that (14) is not fulfilled, P-appraisal becomes more attractive the lower the impact of the frequency advantage, i.e. if μ is low, α high to violate (17).

The reversal of the underlying tradeoffs is clearly exposed by isolating the effects of a cost or frequency differential, respectively. For this purpose suppose that the expert enjoys either a cost or frequency advantage but not both. Depending on the nature of the agent's technology advantage, either the floor $\underline{\mu}_d$ or the cap $\bar{\mu}_d$ becomes relevant for the optimal task allocation as summarized in

In case of a cost advantage the delegation of both tasks tends to be complementary for high project congruence and a low signal frequency. Given a frequency advantage, by contrast, this complementarity is enhanced by low congruence (as long as it exceeds $\tilde{\alpha}$) and a high signal frequency.

Suppose first that the agent enjoys only a cost advantage. By implication, the non-existent frequency advantage is dominated by the impact of the hidden-action costs. A-appraisal thus becomes more attractive when the latter is negligible compared to the direct cost saving, i.e. as we move away from μ_d^0 toward the top left corner in Figure **??**. Note also, that the upper bound $\bar{\mu}_d$ approaches infinity if the cost advantage is incomplete.

Consider now the opposite extreme where the agent only enjoys a frequency advantage. In the absence of direct cost savings, A-appraisal can only be superior to P-appraisal if its benefits from the higher reception rate exceed the agency costs. From the previous discussion it is clear that, as soon as the agency-cost effect is dominated, the relative advantage of A-appraisal rises along the diagonal toward the bottom right corner in the α-μ space of Figure **??**. Moreover, the lower bound $\underline{\mu}_d$ recedes to zero whenever the frequency advantage is incomplete.

These two polar types of technology asymmetries thus clarify the opposing forces that the signal frequency and the payoff congruence may exert on the suitability of organizing appraisal top down or bottom up. If the technological advantage comprises both components while remaining incomplete, there exists a tension between the frequency and the agency-cost effects. Consequently, the relative advantage of delegating appraisal is not monotonous in α and μ, as illustrated in the figure.

4.2 Top-Down Decision Making

How is the question of organizing appraisal affected by a low congruence ($\alpha < \tilde{\alpha}$) that causes the principal to insist on authoritarian decision making unless supplementary information is generated?

Centralized decision making should ideally be accompanied by A-appraisal $\forall \alpha \geq \underline{\alpha}_c$, in particular also if the same technology is shared; and by P-appraisal if $\alpha < \underline{\alpha}_c$, where

$$\underline{\alpha}_c := \frac{\mu(1-\delta)(c-B)-(G-g)}{\mu(1-\delta)(b+c)} \ .$$

One implication of this result is the dominance of A-appraisal even if the principal and the agent were equally adept at evaluating the alternatives, i.e. $\delta = 1$ or $g = G$. Provided the agent's payoffs are fairly congruent (above $\tilde{\beta}$) its dominance is indeed strict - not only if the agent voluntarily evaluates the projects (i.e. beyond $\beta_c^0 > \tilde{\beta}$.)

Below $\tilde{\beta}$, however, the principal is indifferent to the internal organization of appraisal unless the agent is more competent. In particular, a mere cost advantage, no matter how small, is sufficient to ensure the optimality of A-appraisal for any level of congruence below $\tilde{\alpha}$ or any signal reception rate, provided $\delta = 1$. If accompanied by a frequency advantage, this statement needs to be qualified if the agent's costly project outweighs the principal's maximal benefit: unless $c > B$ the threshold congruency $\underline{\alpha}_c$ is negative, hence irrelevant. This parameter constellation paves the way for

The complementarity of centralizing both tasks tends to be enhanced by low α, high μ, provided the agent enjoys a frequency advantage and $c > B$.

The underlying tradeoff between the comparative costs and benefits of A-appraisal as described in the preceding subsection applies here as well: $c > B$ implies that the agency-cost effect dominates the frequency advantage, hence A-appraisal is more attractive the lower this agency cost (i.e. if α high, μ low). Hence cost savings and a low signal frequency are necessary for the preference of A-appraisal. In the polar case of a frequency advantage without cost differences, the delegation of appraisal is optimal for any congruence level above $\underline{\alpha}_c = \frac{c-B}{b+c}$.

To reiterate the main results of this section, notice that formal communication (A-appraisal) requires a technological advantage if decision making is bottom up but not if it is top down. On the contrary, no harm is done by delegating appraisal if both parties are equally competent in doing so, provided the principal retains effective control over decision making. The fact that the optimality of A-appraisal is more pronounced under a centralized rather than delegated decision structure, can be attributed to the agent's strengthened incentives as expressed in Lemma 3.2. Consequently, the top-down organization of decision making tends to complement the bottom-up organization of appraisal.

5 Private Signals

In this section the common knowledge assumption regarding the signals is relaxed. Specifically, the agent has private information over any obtained signal and may potentially conceal it, but he is incapable of forgery. Only if he decides to reveal its contents, can the principal observe the signal and select her favourite project accordingly. In order to induce the revelation of the obtained signal, the principal must take the following constraints into account in addition to the incentive compatibility constraints (9) and (10) of effort investment: the agent will communicate an incongruent signal if

$$t_d - c \geq b \tag{18}$$

provided he anticipates endorsement of his unverified proposal; alternatively, if he expects the status quo to prevail,

$$t_c - c \geq 0 \tag{19}$$

will induce him to announce an incongruent signal[24]. Since the compensation cannot condition on the type of signal (i.e. its congruence) it is always paid upon revelation of evidence. This makes consistent revelation extremely expensive, because the agent can capture additional rents whenever he reports a congruent signal - which he would reveal voluntarily.

Signal revelation becomes more costly than effort inducement for $\mu\beta > \frac{g}{b+c}$ irrespective of the chosen management style. The privacy of signals thus makes A-appraisal more costly for high levels of congruence and signal frequency. In view of

[24]It is always in the agent's interest to report congruent signals, therefore only the constraints in case of incongruent signals are relevant.

these costs the necessity or appropriability of signal revelation becomes questionable. It is therefore imperative to analyse the alternative of *biased* reports in which case (18) and (19) are violated and the agent only reveals congruent signals.

Given that the signals communicated by the agent are biased by his objectives, the principal requires a higher congruence level $\hat{\alpha} := \frac{C}{(1-\mu)B+C} > \tilde{\alpha}$ in order to warrant delegated decision making.

This lemma is a direct consequence of the principal's expected payoffs

$$U_P = \begin{cases} B - \mu\alpha t_d - (1-\alpha)(B+C) & \text{if delegation} \\ \mu\alpha(B - t_c) & \text{if centralization} \end{cases} \tag{20}$$

with congruence symmetry (7) imposed[25]. It effectively states that a high signal frequency inhibits the principal's credibility of endorsing the agent's proposals. To illustrate, note that the principal receives no evidence if the agent's search is either futile or produces an incongruent, hence concealed, signal. If the latter is the case, delegation leads to the implementation of the principal's costly project with conditional certainty. For a very reliable information technology, the lack of evidence can less conceivably be attributed to unsuccessful screening than withheld information. Consequently, it raises the cost of delegation. Notice that the incentive compatibility constraints

$$\begin{array}{ll} \mu\beta t_d + b - g \geq b & \text{if delegation} \\ \mu\beta(t_c + b) - g \geq 0 & \text{if centralization} \end{array} \tag{21}$$

are compatible with hidden incongruent signals (i.e. violation of (18) and (19), respectively) whenever $\mu\beta \geq \frac{g}{b+c}$. This observation confirms the intuition that biased reports are only relevant if complete signal revelation is costly.

Private signals, by raising the costs of bottom-up appraisal, make it a less attractive strategy compared with P-appraisal. It may, nevertheless, be relevant if the agent's technology is sufficiently superior. For simplicity assume for the remainder of this section that his effort costs are negligible, that is

$$g = 0.$$

Consequently, the incentive constraints become lax in comparison to the revelation constraints, which become binding for any combination of α and μ.

[25]With asymmetric payoff congruence, delegation is preferred to centralization

$$\Leftrightarrow \alpha \geq \hat{\alpha}' := \frac{(1-\mu\beta)C}{(1-\mu)(B+C)} .$$

The principal induces complete revelation rather than biased reports if any of the following cases apply:

i) $\hat{\alpha} \leq \alpha \leq \alpha_D$

ii) $\tilde{\alpha} \leq \alpha < \hat{\alpha}$ and $\mu >< \mu_H$ for $\alpha <> \alpha_{den}$

iii) $\alpha \leq \min\{\tilde{\alpha}; \alpha_C\}$

where

$$\alpha_D := \frac{B+C-(b+c)}{B+C}$$

$$\mu_H := \frac{\alpha(B+C)-C}{\alpha(2B+C)-[B+C-(b+c)]} \qquad \alpha_{den} := \frac{B+C-(b+c)}{2B+C}$$

$$\alpha_C := \frac{B-c}{B} .$$

Biased reports reduce the agency rent but also the probability of implementing the principal's preferred project. The latter effect is exclusively driven by the agent's payoff congruence β which essentially indicates the cost of hidden information: a high degree of congruence implies a low probability of concealment. Biased reporting becomes relatively desirable, because the incidence of withheld information is low and the agency rent involved in the revelation of a congruent signal (in case of complete revelation) would be commanded frequently. This phenomenon explains the upper bounds α_D and α_C in Proposition 5 which are relevant in case the organization of decision making is not affected by the extent of signal revelation[26]. In these areas the principal's payoff congruence plays no role apart from determining her credibility of managing style.

Part (ii) of the proposition refers to the case where the principal will delegate decision making only if she induces complete signal revelation. If she tolerates biased reports, she will retain authority. Here the degree of congruency has an opposing effect in addition to the high level of β favouring biased reports (as described above): high congruency of the principal's payoffs supports the delegation of decision making. The tradeoff between the costs of hidden information and centralization thus determines the optimal strategy. Since these costs fall in μ, biased reports coupled with the status quo become preferable if the signal reception is sufficiently high, $\mu \geq \mu_H > 0$.[27]

[26]Notice that the management style of A-appraisal combined with delegated decision making and biased reports is dominated by unappraised delegation.

[27]In case $\alpha_{den} > \tilde{\alpha}$, or equivalently, $B^2 > (B+C)(b+c)$, μ_H is inversely related to α and biased reports are only viable for very high congruency: true reports are preferred $\forall \alpha < \alpha_{den}$ (note that $\alpha_C > \tilde{\alpha}$ is implied).

6 Endogenous Congruence

So far the principal's credibility of organizing the decision making process in a certain way was restricted by the exogenous level of payoff congruence. Suppose that she can influence it, for example, by engaging in confidence building measures, would she be prepared to invest in such operations? Let us focus on the more interesting case of A-appraisal by assuming that the agent's technological advantage is complete[28].

The principal's payoffs are not monotonous in the congruency, in particular, they are discontinuously decreasing at $\tilde{\alpha}$.

For any given management style her payoffs are nondecreasing in α. She would thus benefit from intensifying the payoff congruence provided she can align their mutual interests at sufficiently small costs. Simultaneously, however, the adjustment of the congruence level may affect the optimal decision making style. If the incremental congruence prompts a switch from centralized to delegated selection, this benefit must be weighed up against the agent's weakened incentives for appraisal. An infinitessimal upward alignment around $\tilde{\alpha}$ is therefore not viable. For congruence levels just above $\tilde{\alpha}$, the principal will, in fact, prefer a net expected conflict of interest $(\alpha < \tilde{\alpha})$, since this allows her to commit to centralization and thereby strengthen her subordinate's incentives.

7 Conclusion

This paper investigates the scope of management style to govern complex decision making in agency relationships. Specifically, it explores which tasks the decision making process should comprise - i.e. whether choice should be supplemented by prior verification - and how these should be organized in a situation in which an efficient decision outcome crucially depends on the expertise of a self-interested specialist. This question is particularly relevant when the nonverifiability of critical information prohibits output-contingent compensation or direct revelation mechanisms. The main findings summarized below should be viewed against this background.

The intuition is confirmed that, unless the principal becomes informed, a delegated decision structure becomes increasingly profitable the closer the objectives are aligned. The level of trust is thus the sole determinant of unsubstantiated decision making (provided that generated signals are common knowledge within the

[28]Under P-appraisal, U_P is in general monotonously increasing in α. The only exception is a possible discontinuity at $\tilde{\alpha}$ if $\beta_d^0 < \tilde{\alpha} < \tilde{\beta}$ and $\frac{b}{c} > \frac{B}{C}$.

relationship). Delegation, i.e. informal, bottom-up communication based on trust is efficient in the presence of closely aligned objectives.

Furthermore, I demonstrate that an authoritarian decision style tends to inhibit agent participation but enhances his initiative to invest in formal communication. In case verification is delegated, incentive considerations become more important than participation requirements. This fact suggests two organizational complementarities: P-appraisal tends to be fostered by participatory decision making while A-appraisal tends to be enhanced by a top-down decision structure. The observation that bottom-up signal generation requires a technological advantage from the agent if decision making is participatory but not if it is centralized reinforces this organizational complementarity. Moreover, it suggests that whenever informal bottom-up communication becomes unreliable, for instance if a lack of trust prohibits participatory decision making, it should be complemented with formal bottom-up communication rather than self-reliant research by a non-professional autocrat.

For both decision making styles, the optimal manner of managing the supplementary task of appraisal emerges from the interaction of the above tendencies. The resulting tradeoff between the technological benefits derived from and the agency costs inflicted by delegation is shown to be driven by the nature of the agent's technological advantage, as it specifies the relative significance of the components (cost savings and higher frequency). Consequently, the optimality of formal bottom-up communication is neither monotonous in the congruence of objectives nor the principal's informativeness. Depending on the nature of the expert's superiority, the mutual impact of the parameters may jeopardize the complementarity identified above. For example, the agent's cost advantage promotes the delegation of both tasks if he can be trusted to act in the firm's interest despite a relatively inefficient verification technology. His frequency advantage, however, reverses this relationship because the signal reception becomes the overriding criterion. Hence, both tasks should be delegated if appraisal tends to be successful and interests diverse, as long as the dissonance of objectives tolerates bottom-up decision making.

This paper has shown that informational constraints, such as the distribution of private information and the presence of communication hazards, may significantly influence the organization of decision making processes. The endogenous derivation of the optimal management style may provide us with a clearer understanding of certain hierarchical structures if the direction of authority lines and information flows can be linked causally to the number of hierarchical layers. It seems plausible that top-down decision making tends to involve more middle management whereas the delegation of authority allows flatter hierarchies because more decision making occurs at lower levels. This connection is also suggested by Aoki (1986), who compares the efficiency between vertical and horizontal information structures: the latter attains its efficiency by taking advantage of the subordinates' grass-roots knowledge and can therefore be likened to bottom-up decision making whereas a vertical information structure corresponds to top-down control. In addition, a vertical structure implies more hierarchical layers compared to a horizontal one. In the light of this interpretation, this paper may serve as a stepping stone to explain the conditions under which one would expect certain hierarchical structures.

A Interpretation of the Payoff Structure

This appendix offers an interpretation of, or foundation for, the expected returns specified in Section 2. The assumed payoff structure can be viewed as an implicit simplification of a very complex underlying environment with little information. For example, suppose there exist $\theta = 1, ..., n$ states of nature, each of which occurs with probability q_θ. A project ρ can be chosen from the set $\{0, 1, ..., k\}$ where $\rho = 0$ denotes the status quo which yields zero returns in all states. All other projects imply consequences R_θ^ρ for the principal, r_θ^ρ for the agent. For each state of nature, there exists one project that is ideal for the principal and one (possibly the same) project that is favoured by the agent. Thus, by choosing their ideal project, both the principal and the agent can - although not necessarily simultaneously - attain their maximal return. Denote $B_\theta = \rho \max R_\theta^\rho$ and $b_\theta = \rho \max r_\theta^\rho$. The resulting payoff matrix for the 3×4 case can for instance be represented by:

ρ \ θ	1	2	3	4
0	0,0	0,0	0,0	0,0
1	B_1, b_1	B_2, r_2^1	R_3^1, b_3	R_4^1, r_4^1
2	R_1^2, r_1^2	R_2^2, b_2	B_3, r_3^2	B_4, b_4

Then payoffs are congruent with probability $\alpha = q_1 + q_4$. Consequently, if A selects his preferred project, P expects a return of $\alpha B - (1 - \alpha) C$ where

$$B = \frac{q_1 B_1 + q_4 B_4}{q_1 + q_4}$$

reflects the expected benefit conditional on A selecting a congruent project and

$$-C = \frac{q_2 R_2^2 + q_3 R_3^1}{q_2 + q_3}$$

represents the expected burden conditional on an incongruent project choice by A. The agent, in this scenario, expects $d = \sum_\theta q_\theta b_\theta$. Similarly, if the principal were able (informed) to select her favourite project, she would expect $D = \sum_\theta q_\theta B_\theta$; the agent's expected payoff conditional on P's choice could be expressed as $\beta b - (1 - \beta) c$ where

$$b = \frac{q_1 b_1 + q_4 b_4}{q_1 + q_4} \quad and \quad -c = \frac{q_2 r_2^1 + q_3 r_3^2}{q_2 + q_3}.$$

Thus, conditional on A choosing a project, B and d capture the expected benefit in case mutual interests are shared while C is the expected burden in case of dissonant objectives. The magnitudes D, b and c can be interpreted analogously if P selects her preferred project.

For expositional simplicity I assume payoff symmetry with $B = D$ and $b = d$. This simplification affects the relative efficiency of possible strategies, but not the nature of the underlying tradeoffs. Hence, no important insight is lost. (The same effect is obtained by the stronger assumption that the maximal payoffs are invariant across the states of nature, i.e. $B_\theta = B$ and $b_\theta = b \; \forall\theta$. The scenario where $-C = R_2^2 = R_3^1$ and $-c = r_2^1 = r_3^2$ is likewise a special case, in which an incongruent project inflicts the same burden irrespective of the underlying state.)

The assumption $C > 0$ requires that at least one of R_2^2 and R_3^1 be negative. Moreover, the ignorant principal will not choose any arbitrary project as long as $E\left[R^\rho\right] = \sum_\theta q_\theta R_\theta^\rho < 0 \quad \forall\rho$; that is, if $-R_\theta^\rho \neq B_\theta$ are 'sufficiently' large relative to B_θ. In addition, it is assumed that the principal maintains the status quo irrespective of a project recommendation made by A. This specification requires that the non-trivial projects are not uniquely identifiable in the sense that P is unable to update the state probabilities conditional on the agent's suggestion, because A and P use different project labels. Using above example, if A suggests a project he calls 'x', P does not know whether he means $\rho = 1$ or 2. Consequently, she can neither implement the 'opposite' project nor update her information partition to $\theta \in \{1, 3\}$

or $\{2,4\}$ [29].

Provided that the states of nature cannot be clearly distinguished, they only serve motivational purposes and are therefore suppressed in the text. The aggregation of their probabilities in terms of α is hence innocuous while greatly simplifying the analysis by allowing us to focus on the relevant payoff combinations of B or $-C$ with b or $-c$.

[29] Alternatively, if the projects were identifiable, the expected payoffs depend on the agent's project recommendation $\hat{\rho}$ because it reveals information about the underlying state of nature. For instance, if A suggests $\hat{\rho}=1$, P concludes that $\theta \in \Theta_1 = \{1,3\}$. By implication

$$\begin{array}{c} E\left[R^1 \mid \hat{\rho}=1\right] = \frac{q_1 B_1 + q_3 R_3^1}{q_1+q_3} = \alpha^1 B_1 + \left(1-\alpha^1\right) R_3^1 \\ and \quad E\left[R^2 \mid \hat{\rho}=1\right] = \frac{q_1 R_1^2 + q_3 B_3}{q_1+q_3} = \alpha^1 R_1^2 + \left(1-\alpha^1\right) B_3 \end{array}$$

where $\alpha^1 = \frac{q_1}{q_1+q_3}$. More generally,

$$E\left[R^\rho \mid \hat{\rho}\right] = \frac{\sum_{\theta\in\Theta_{\hat{\rho}}} q_\theta R_\theta^\rho}{\sum_{\theta\in\Theta_{\hat{\rho}}} q_\theta} \qquad where \quad \Theta_{\hat{\rho}} = \left\{\theta \mid \hat{\rho} = \rho \arg\max r_\theta^\rho\right\}.$$

Symmetry in this case presupposes a very specific payoff structure. To fix notation, denote all payoff pairs as one of the following: (B_θ, b_θ), $(B_\theta, -c_\theta)$, $(-C_\theta, b_\theta)$, or $(R_\theta^\rho, r_\theta^\rho)$. In terms of above example the payoff matrix would thus read

ρ \ θ	1	2	3	4
0	0,0	0,0	0,0	0,0
1	B_1, b_1	$B_2, -c_2$	$-C_3, b_3$	R_4^1, r_4^1
2	R_1^2, r_1^2	$-C_2, b_2$	$B_3, -c_3$	B_4, b_4

Then expected payoffs $E\left[R^\rho \mid \hat{\rho}\right]$ can be rewritten as $\alpha^{\hat{\rho}} B_\theta - \left(1-\alpha^{\hat{\rho}}\right) C_\theta$ with

$$\alpha^{\hat{\rho}} = \frac{q_{\theta_B}}{\sum_{\theta\in\Theta_{\hat{\rho}}} q_\theta}$$

where $\theta_B \in \Theta_{\hat{\rho}} \cap \left\{\theta \mid R_\theta^\rho = B_\theta\right\}$. They are independent of the suggestion if B, b, C, and c are state-invariant and $\alpha^{\hat{\rho}} = \alpha \quad \forall \hat{\rho}$. The latter requires that all states for which there exists a congruent project with payoff combination (B, b) are equally distributed.

The principal will never implement a non-trivial project that is not recommended if $-R_1^2 > \frac{q_3 B_3}{q_1}$ and $-R_4^1 > \frac{q_2 B_2}{q_4}$. The general condition is $-R_\theta^\rho > \frac{q_i B}{q_c}$ where q_c and q_i reflect the probabilities of states exhibiting congruent payoffs or not.

In the case of 'identifiable' projects, the principal could extract some information from the expert, using a suitable revelation mechanism; but this does not constitute an improvement for her compared to unconditional delegation (Subsection 2.1.2). Consequently, the main results are not affected.

B Proofs

Proof of Proposition (3.1): Upon substitution of (5) and (6) into (4)

$$U_P = \begin{cases} \left.\begin{array}{ll} B-(1-\alpha)(1-\lambda)(B+C)-G & \alpha \geq \beta_d^0 \\ B+b-(1-\alpha)\left[\lambda(b+c)+(1-\lambda)(B+C)\right]-G & \alpha < \beta_d^0 \end{array}\right\} & \textit{delegation} \\ \\ \left.\begin{array}{ll} \lambda B - G & \alpha \geq \tilde{\beta} \\ \lambda\left[B+b-(1-\alpha)(b+c)\right]-G & \alpha < \tilde{\beta} \end{array}\right\} & \textit{centralization} \end{cases} \tag{22}$$

reflects P's expected payoff given P-appraisal. This exceeds its no-appraisal counterpart (2) under delegation ($\alpha > \tilde{\alpha}$) if $\lambda \geq \lambda_d$ because

- if $\alpha \geq \beta_d^0$ $\left(\Leftrightarrow \lambda \leq \lambda_d^0 := \frac{b}{(1-\alpha)(b+c)}\right)$ appraisal is worthwhile if

$$B-(1-\alpha)(1-\lambda)(B+C)-G \geq \alpha B-(1-\alpha)C$$

$$\Leftrightarrow \lambda \geq \underline{\lambda}_d := \frac{G}{(1-\alpha)(B+C)} .$$

  Compatibility pervails if and only if $\underline{\lambda}_d \leq \lambda_d^0 \Leftrightarrow$

$$\frac{G}{B+C} \leq \frac{b}{b+c}. \tag{23}$$

- for $\alpha < \beta_d^0$ $(\Leftrightarrow \lambda > \lambda_d^0)$ appraise if

$$B+b-(1-\alpha)\left[\lambda(b+c)+(1-\lambda)(B+C)\right]-G \geq \alpha B-(1-\alpha)C$$

$$\Leftrightarrow \lambda(1-\alpha)\left[B+C-(b+c)\right] \geq G-b,$$

  by assumption (1)

$$\Leftrightarrow \lambda \geq \bar{\lambda}_d := \frac{G-b}{(1-\alpha)[B+C-(b+c)]} .$$

  Note that $\bar{\lambda}_d \leq \lambda_d^0 \Leftrightarrow$ (23).

- since assumption (1) implies that $\bar{\lambda}_d \leq \underline{\lambda}_d \Leftrightarrow$ (23), appraisal is optimal if (23) and $\lambda > \underline{\lambda}_d$, or $\neg$(23) and $\lambda > \bar{\lambda}_d$. Defining $\lambda_d := \max\left\{;\bar{\lambda}_d\right\}$ proves part (i).

Given centralization ($\alpha \leq \tilde{\alpha}$), inspection of the relevant payoffs show that appraisal is worthwhile whenever it yields positive returns, i.e.

- if $\alpha \geq \tilde{\beta}$ and $\lambda \geq \underline{\lambda} := \frac{G}{B}$; or
- if $\alpha < \tilde{\beta}$ and $\lambda [B + \alpha (b + c) - c] \geq G$, i.e. $\alpha \in \left[\frac{c-B}{b+c}, \tilde{\beta}\right]$ and $\lambda \geq \lambda_c := \frac{G}{B+\alpha(b+c)-c}$.

Provided that $\alpha \geq \frac{c-B}{b+c}$, $\lambda_c \leq \underline{\lambda} \Leftrightarrow \alpha \geq \tilde{\beta}$, completing the proof.

Proof of Proposition 3.2: Substitute (11) and (12) into (8), $\Rightarrow$

$$U_P = \begin{cases} B - (1-\alpha)[\mu (b+c) + (1-\mu)(B+C)] - g & \textit{delegation} \\ \left.\begin{array}{ll} \mu B & \alpha \geq \beta_c^0 \\ \mu [B + b - (1-\alpha)(b+c)] - g & \alpha < \beta_c^0 \end{array}\right\} & \textit{centralization} \end{cases} \tag{24}$$

can be attained with A-appraisal. This exceeds the no-appraisal payoff (2) whenever P authorizes A's suggestion ($\alpha \geq \tilde{\alpha}$) and

$$B - (1-\alpha)[\mu (b+c) + (1-\mu)(B+C)] - g \geq \alpha B - (1-\alpha) C$$

$$\Leftrightarrow \mu (1-\alpha)[B + C - (b+c)] \geq g.$$

In view of (1) this condition corresponds to $\mu \geq \mu_d := \frac{g}{(1-\alpha)[B+C-(b+c)]}$.

Under centralization $(\alpha < \tilde{\alpha})$, appraisal is voluntary, hence optimal, beyond β_c^0. For $\alpha < \beta_c^0$ this relative advantage is maintained if and only if

$$\mu [B + \alpha (b+c) - c] \geq g$$

$$\Leftrightarrow \mu \geq \mu_c := \frac{g}{B+\alpha(b+c)-c} \quad \textit{and} \quad \alpha \in \left[\frac{c-B}{b+c}; \beta_c^0\right].$$

Proof of Proposition 4.1: Recall from (22) and (24) the payoffs attainable with P- and A-appraisal, respectively.
For $\alpha \geq \beta_d^0$ (or equivalently $\mu \leq \mu_d^0 := \frac{b}{(1-\alpha)\delta(b+c)}$) A-appr $\succeq$ P-appr $\Leftrightarrow$

$$\begin{aligned} B - (1-\alpha)[\mu (b+c) + (1-\mu)(B+C)] - g \\ \geq B - (1-\alpha)(1-\delta\mu)(B+C) - G \end{aligned}$$

$\Leftrightarrow$ (16):

$$\mu (1-\alpha)[(1-\delta)(B+C) - (b+c)] + G - g \geq 0.$$

For $\alpha < \beta_d^0$ (or equivalently $\mu > \mu_d^0$) A-appr $\succeq$ P-appr $\Leftrightarrow$

$$\begin{aligned} & B - (1-\alpha)\left[\mu(b+c) + (1-\mu)(B+C)\right] - g \\ & \geq B + b - (1-\alpha)\left[\delta\mu(b+c) + (1-\delta\mu)(B+C)\right] - G \end{aligned}$$

$\Leftrightarrow$ (17)

$$\mu(1-\alpha)(1-\delta)\left[B + C - (b+c)\right] - b + G - g \geq 0.$$

Upon substituting $\delta = 1$ and $G = g$, both (16) and (17) are violated, supporting the first statement of the proposition.
Notice that (16) implies (17) $\Leftrightarrow \mu > \mu_d^0 \Leftrightarrow \alpha < \beta_d^0$. Consequently, (13) is sufficient to ensure that both, appraisal and choice should be delegated for all $\alpha \geq \tilde{\alpha}$.

Suppose (13) is violated, then $(1-\delta)(B+C) - (b+c) < 0$. Considering $\mu \leq \mu_d^0$, (16) $\Leftrightarrow \mu \leq \underline{\mu}_d := \frac{G-g}{(1-\alpha)[b+c-(1-\delta)(B+C)]}$.
$\underline{\mu}_d < \mu_d^0 \quad \Leftrightarrow \quad \delta > \delta_1 := \frac{b[B+C-(b+c)]}{b(B+C)-(G-g)(b+c)} \wedge$ (25) or $\delta < \delta_1 \wedge \neg$(25) where

$$\tfrac{G-g}{B+C} < \tfrac{b}{b+c} \ . \tag{25}$$

It follows that $\delta_1 \in [0,1] \Leftrightarrow b > G - g$ which because of (1) implies (25).
In case (14), then $\delta_1 > 1$ if (25) or $\delta_1 < 0$ if $\neg$(25). Hence $\mu_d^0 < \underline{\mu}_d$ for any $\delta \in [0,1]$.
Consequently (16) is satisfied $\forall \mu \leq \mu_d^0$.

Consider $\mu > \mu_d^0$. Then (17) $\Leftrightarrow \mu \geq \bar{\mu}_d := \frac{b-(G-g)}{(1-\alpha)(1-\delta)[B+C-(b+c)]}$.
If (14)$\Rightarrow \bar{\mu}_d < 0$, consequently (17) holds $\forall \mu \geq 0$.
Moreover, $\mu_d^0 < \bar{\mu}_d \Leftrightarrow \delta \geq \delta_1 \wedge b > G - g$.
Thus, if $\delta \geq \delta_1 \wedge b > G - g, \quad \exists \left(\underline{\mu}_d, \bar{\mu}_d\right)$ such that P-appr $\succeq$ A-appr.

Proof of Corollary 4.1: Cost advantage: substitute $\delta = 1$, hence (16)

$$G - g \geq \mu(1-\alpha)(b+c)$$

is satisfied $\Leftrightarrow \mu \leq \underline{\mu}_d = \frac{G-g}{(1-\alpha)(b+c)}$. Condition (17) simplifies to

$$G - g \geq b,$$

that is, $\bar{\mu}_d \to \infty$ and therefore becomes irrelevant. Provided $b > G - g$, $\underline{\mu}_d < \mu_d^0$ and A-appraisal becomes more dominant as α rises, μ falls.

Frequency advantage: substitute $G = g$. Consequently (16)

$$\mu(1-\alpha)\left[(1-\delta)(B+C) - (b+c)\right] \geq 0$$

is satisfied $\Leftrightarrow$ (13) holds; $\underline{\mu}_d = 0$. From (17)

$$\mu (1-\alpha)(1-\delta)[B + C - (b+c)] \geq b,$$

A-appraisal is optimal if $\mu \geq \bar{\mu}_d = \frac{b}{(1-\alpha)(1-\delta)[B+C-(b+c)]}$. Its preference is increased by high μ, low α, provided $\neg$(13) and of course, $\alpha \geq \tilde{\alpha}$.

Proof of Proposition 4.2: Recall (22), (24) and that $\tilde{\beta} < \beta_c^0$. A-appr $\succeq$ P-appr $\Leftrightarrow$

if $\alpha \geq \beta_c^0$:

$$\mu (1-\delta) B + G \geq 0 \tag{26}$$

if $\tilde{\beta} \leq \alpha < \beta_c^0$:

$$\mu [(1-\delta) B + \alpha (b+c) - c] + G - g \geq 0 \tag{27}$$

if $\alpha < \tilde{\beta}$:

$$\mu (1-\delta)[B + \alpha (b+c) - c] + G - g \geq 0. \tag{28}$$

Conditions (26) and (27) are satisfied $\forall \alpha \geq \tilde{\beta} = \frac{c}{b+c}$; (28) $\Leftrightarrow \alpha \geq \underline{\alpha}_c := \frac{\mu(1-\delta)(c-B)-(G-g)}{\mu(1-\delta)(b+c)}$. Notice that $\underline{\alpha}_c < \tilde{\beta}$, moreover $\underline{\alpha}_c > 0$ if only if $B < c$ and $\mu > \frac{G-g}{(1-\delta)(c-B)}$.

Proof of Proposition 5: Let (18) and (19) bind and substitute $t_d = b + c$ and $t_c = c$ into (8) to write the signal-revelation payoff as

$$U_P = \begin{cases} B - \mu (b+c) - (1-\mu)(1-\alpha)(B+C) & \text{if delegation} \\ \mu (B - c) & \text{if centralization.} \end{cases}$$

Note that the principal's payoff from biased reports, (20), with asymmetric congruence is given by

$$U_P = \begin{cases} \mu [\beta (B - t_d) - (1-\beta) C] + (1-\mu)[\alpha B - (1-\alpha) C] & \text{if delegation} \\ \mu\beta (B - t_c) & \text{if centralization.} \end{cases}$$

Substitute the compensation according to (21) with $g = 0$ to rewrite the biased-reports payoff

$$U_P = \begin{cases} B - [1 - \alpha + \mu (\alpha - \beta)](B + C) & \text{if delegation} \\ \mu\beta B & \text{if centralization.} \end{cases}$$

i) $\alpha \geq \hat{\alpha}$, i.e. delegated decision making: revelation $\succeq$ biased reports

$$\Leftrightarrow B - \mu (b+c) - (1-\mu)(1-\alpha)(B+C) \geq B - [1 - \alpha + \mu (\alpha - \beta)](B + C)$$

$$\Leftrightarrow \mu\left[(1-\beta)(B+C)-(b+c)\right] \geq 0 \Leftrightarrow \beta \leq \alpha_D = \frac{B+C-(b+c)}{B+C}.$$

Imposing symmetric congruency, compatibility with $\alpha \geq \hat{\alpha}$ requires that

$$\frac{C}{(1-\mu)B+C} \leq \frac{B+C-(b+c)}{B+C}$$

$$\Leftrightarrow \mu \leq \mu_D := \frac{(B+C)[B-(b+c)]}{B[B+C-(b+c)]}$$

ii) $\tilde{\alpha} \leq \alpha < \hat{\alpha}$: revelation (delegation) $\succeq$ biased reports (centralization)

$$\Leftrightarrow B-\mu(b+c)-(1-\mu)(1-\alpha)(B+C) \geq \mu\beta B$$

$$\Leftrightarrow H := \alpha(B+C)-C+\mu\left[B+C-(b+c)-\alpha(B+C)-\beta B\right] \geq 0$$

With congruence symmetry, $H \geq 0 \Leftrightarrow \mu < \mu_H := \frac{\alpha(B+C)-C}{\alpha(2B+C)-[B+C-(b+c)]}$ if its denominator is positive, i.e. $\alpha > \alpha_{den}$, or $\mu > \mu_H$ if it is negative. Note that

$$\frac{\partial}{\partial\alpha}\ \mu_H \geq 0 \Leftrightarrow B^2 \leq (B+C)(b+c)\,.$$

iii) $\alpha < \tilde{\alpha}$, i.e. centralized decision making: revelation $\succeq$ biased reports $\Leftrightarrow$ $\mu(B-c) \geq \mu\beta B \Leftrightarrow \beta \leq \alpha_C = \frac{B-c}{B}$. The result follows from symmetric congruency with

$$\alpha_C < \tilde{\alpha} \Leftrightarrow B^2 < c(B+C)\,.$$

Proof of Proposition 6: Recall (24). The first derivatives

$$\frac{\partial}{\partial\alpha}\ U_P = \begin{cases} \mu(b+c)+(1-\mu)(B+C) & \text{if delegation} \\ \left.\begin{array}{ll} 0 & \text{if } \alpha \geq \beta_c^0 \\ \mu(b+c) & \text{if } \alpha < \beta_c^0 \end{array}\right\} & \text{if centralization} \end{cases}$$

are nonnegative and U_P(delegation) $< U_P$(centralization) at $\tilde{\alpha} = \frac{C}{B+C}$ since

$$B - \frac{B}{B+C}\ \left[\mu(b+c)+(1-\mu)(B+C)\right]-g < \mu B$$

$$\Leftrightarrow -\mu B(b+c) < g(B+C)$$

and

$$B - \frac{B}{B+C}\ \left[\mu(b+c)+(1-\mu)(B+C)\right]-g < \mu\left[B+b-\frac{B}{B+C}\ (b+c)\right]-g$$

$$\frac{\mu B}{B+C}\ \left[B+C-(b+c)\right] < \frac{\mu}{B+C}\ \left[(B+b)(B+C)-B(b+c)\right] \Leftrightarrow 0 < B+C.$$

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