Delegation and Strategic Silence*

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March 27, 2023

Abstract

We consider an incomplete contracting model in which the decision process consists of advice, choice, and execution. Each party has an imperfectly informative private signal on the promising project, and the execution of the project is costly. The revelation of the principal's signal through her project choice may discourage the agent's costly execution by denting his confidence that the project is promising. Rubber-stamping the agent's advice about the project choice allows the principal to avoid discouragement. However, because of the agent's learning motive, he may be intentionally silent to prompt the principal to reveal her private signal through the project choice. The agent's *strategic silence* may prevent informal delegation even when the principal has no incentive to overturn the agent's advice.

Keywords: Delegation; Advice, Choice, and Execution; Confidence; Empowerment; Strategic Silence
JEL classification: D23, D83, D86, M12

1 Introduction

In organizations, delegating decision-making authority tends to be broadly viewed as a counterpart of traditional top-down organizations. It is often argued that bottom-up organizations outperform top-down ones because the former effectively utilizes subordinates' information and encourages subordinates' motivation (e.g., Dessein, 2002; Zábojník, 2002). Despite the

*We are grateful to Yu Awaya, Daisuke Hirata, Takakazu Honryo, Hideshi Itoh, Kohei Kawamura, Hongyi Li, Hodaka Morita, Kimiyuki Morita, Takeshi Murooka, Satoshi Nakada, Hiromasa Ogawa, Hideo Owan, Ali Palida, Takashi Shimizu, Roland Strausz, Michael Waldman, Ján Zábojník, and all the participants of CTW, the 2018 JEA Spring Meeting, SIOE 2018, the Michael Waldman Workshop on Internal Labor Markets, APIOC 2018, the 2nd Japan-German Workshop on Contracts and Incentives, the 2021 Organisational Economics Workshop, and the seminars at Waseda University, Tokyo University of Science, University of Tokyo, University of Talca, University of Colorado Boulder, and Hiroshima University for their valuable discussions and suggestions. The authors appreciate the financial support from JSPS Grant-in-Aid (16K17093, 17K13724, 18H03640, 19K13655). All remaining errors are our own.

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potential benefits of delegation, however, formally delegating authority is often infeasible due to institutional or legal constraints. For instance, in the United States, contracts specifying the allocation of authority written within a firm are not legally enforced (Bolton and Dewatripont, 2013).[1] Instead, authority is informally delegated through *empowerment*, by which bosses promise to rubber-stamp subordinates' opinions.

It is not necessarily easy for bosses to empower subordinates. A typical difficulty is that bosses are tempted to overturn subordinates' opinions because of conflicts among the parties (e.g., Baker et al., 1999). In addition, the story of HCL Technologies, a leading IT company in India, describes the impediment to empowerment on the subordinates' side, which has been rarely discussed in the literature on organizational economics. Vineet Nayar, the CEO of HCL Technologies from 2005 to 2013, introduced a management philosophy called "Employees First, Customers Second," which aimed to facilitate empowerment by inverting the organizational pyramid. In the early phase of the reform, Nayar received many messages from employees that "[w]ould describe a problem or an issue and then conclude with a question like, 'What do you recommend?' or 'What should we do?' or 'How should we handle this one?'" even though they might have a better understanding of the problems and the CEO had no intention of overturning their opinions (Nayar, 2010).[2] As Nayar admitted, subordinates' passive attitudes disturbed empowerment because of the failure to utilize employees' expertise.

This study investigates impediments to empowerment arising from subordinates' side. Specifically, as in the above example, we demonstrate that subordinates may prefer to be passive and argue that passiveness deters empowerment. To support our arguments, we consider an incomplete contracting model between a principal (boss, female) and an agent (subordinate,

[1] This perspective is widely shared within the literature. Foss (2003), for example, argues that "[b]ecause decision rights cannot be delegated in a court-enforceable manner inside firms (i.e., are not contractible), authority can only reside at the top."

[2] Nayar (2010) argues that one reason employees seemingly hesitated to insist on their own opinion was that they "[d]idn't want to take complete responsibility for the answer or for the outcome" and intended to clarify the order from the top to use it as an excuse for failure.

male), in which the decision process consists of advice from the agent, a project choice by the principal, and execution by the agent, as described by Mintzberg (1979).[3] Each party has an imperfectly informative private signal on which project is promising. The project succeeds if and only if the promising project is chosen and the agent executes the project costly. We investigate whether the principal can empower the agent by reflecting the agent's advice on the project choice.

To elucidate the underlying problem in the decision process, we first consider a benchmark scenario in which the parties make decisions without communication. The project choice reveals the principal's signal, which affects the agent's belief that the chosen project is promising, referred to as the agent's *confidence*. Specifically, if the agent recognizes that their signals are misaligned through the project choice, then he becomes less confident and, thus may hesitate to execute the chosen project. Such a motivational problem can be mitigated if the control right of the project choice can be delegated to the agent through formal contracting, by which the principal's signal transmission is shut down. Accordingly, the principal might be better off if the decision right is formally delegated to the agent.

When the formal transfer of authority is exogenously prohibited due to institutional constraints, the motivational problem may not be mitigated by the informal transfer of authority. Specifically, as our main result, we show that empowerment may be impeded by subordinates' attempts not to transmit information. If the agent conceals his signal, then the principal chooses the project solely based on her signal, and the agent, in turn, learns the principal's private signal through her project choice as in the benchmark. Therefore, the agent hinders empowerment by concealing his signal to learn the principal's signal for selectively executing the chosen project, even though the principal wants to choose the project based on his disclosed signal.

[3]Fama and Jensen (1983) present a similar view of the organizational decision process. See also Gibbons et al. (2013) for a discussion of decision processes.

Strategic silence, defined as the phenomenon that the agent has his learning motive and is willing to wait to be told what to do by the principal, explains passive subordinates, as in the example of HCL Technologies. Notably, strategic silence prevents informal delegation even though, as we assume, the parties do not disagree on the promising project. To the best of our knowledge, our mechanism is the first to demonstrate the non-credibility of informal delegation without the boss's turnover incentives.[4] Our model instead features a potential conflict over *ex post* execution decision between the parties, which prevents empowerment due to the failure of information transmission.

The key economic mechanism behind our result is based on the tension between information provision by one party (typically, a principal) and *ex post* effort or investment by another (typically, an agent).[5] Several studies, such as Blanes i Vidal and Möller (2007), Strausz (2009), and Van den Steen (2009), have examined both the positive and the negative aspects within the same framework to discuss the trade-offs caused by information provision.[6] Our model is most closely related to that of Zábojník (2002), who discusses the value of delegation in a setup where formal incentive contacts are available. His main question is the optimal allocation of contractible authority.[7] By contrast, we consider an incomplete contracting model where neither incentive contracts are available nor the allocation of authority is contractible. As in his model, our benchmark analysis demonstrates that formal delegation may be optimal even

[4]The literature on employee voice and silence, mainly discussed in organizational behavior, asks whether and why subordinates hesitate to engage in upward communication with their bosses (Morrison, 2014). In Section 3.4.3, we discuss how our result contributes to this strand of literature.

[5]The literature on information economics and organizational economics has investigated other kinds of effects of information provision. See, for instance, Hermalin (1998) on team production with leadership and Marino et al. (2010) in the context of employee discharge for positive aspects as well as Scharfstein and Stein (1990) on sequential investment with herding, Crémer (1995) on dynamic agency, Schmidt (1996a,b) on ownership rights and privatization, Bénabou and Tirole (2003) and Suzuki (2017) on the aggravation of intrinsic incentives, Blanes i Vidal and Möller (2016) on team production with information aggregation and execution motivation, Ishida and Shimizu (2016) on cheap-talk games, and de Battignies and Zábojník (2019) on *ex ante* investment for negative aspects.

[6]Landier et al. (2009) and Itoh and Morita (2023) point out the trade-off caused by organizational dissent. Adrian and Möller (2020) discuss the impact of pay dispersion on information provision and worker motivation.

[7]Hirsch (2016) considers a two-period version of the model presented by Zábojník (2002) and sheds light on motivating experimentation as a new benefit of delegation. Nevertheless, he assumes different priors as a crucial factor.

though the principal is more informative in the incomplete contracting environment. Our main contribution is to argue that strategic silence is a novel obstacle preventing the principal from informally delegating authority.

Since Holmström (1977, 1984), economic scholars have been interested in the allocation of authority within organizations. The major part of this literature focuses on environments where the allocation of authority is contractible. Similar to Prendergast (1995), Zábojník (2002), Bester and Krähmer (2008), Fabrizi and Lippert (2012), Lee (2014), Hirata (2017), Kräkel (2021), and Ishihara (2021), our model describes a scenario where the allocation of authority or tasks may influence *ex post* incentives such as costly execution.[8] Different from those in the contractible authority paradigm, our main purpose is to argue the impossibility of delegating authority in an informal manner, which is also discussed in Baker et al. (1999), Alonso and Matouschek (2007), Hart and Holmstrom (2010), Li et al. (2017). To the best of our knowledge, all the studies on informal delegation focus on the principal's incentive to overturn the agent's decision as obstacles to the informal delegation and discuss when and how the principal defers to or overturns the agent's proposal. In contrast to these studies, we assume that the principal has no incentive to overturn the agent's decision and demonstrate a novel mechanism that the agent's strategic silence could serve as another obstacle to informal delegation.

The remainder of this paper is organized as follows. Section 2 considers the benchmark analysis to clarify the fundamental problem and the value of contractible delegation in our setup. Next, Section 3 discusses the credibility of empowerment in the framework of communication. Section 4 examines the robustness of our results. Finally, Section 5 concludes this

[8]Other rationales for delegation argued in the literature include (i) enhancing *ex ante* incentives for searching projects (Aghion and Tirole, 1997; Newman and Novoselov, 2009; Rantakari, 2012), (ii) utilizing the agent's private information (Dessein, 2002; Harris and Raviv, 2005; Gautiel and Paolini, 2007; Alonso et al., 2008), and (iii) mitigating inefficiency generated by possibilities of contractual renegotiation (Beaudry and Poitevin, 1995; Poitevin, 2000). See Bolton and Dewatripont (2013), Gibbons et al. (2013), and Mookherjee (2013) for surveys on the economic analysis of authority in organizations.

paper. All omitted proofs and additional results are provided in the appendices.

2 Choice and Execution

We first consider a benchmark analysis where the parties make decisions without communication. The benchmark analysis highlights the fundamental problem in the decision process and the value of delegating the decision right in our setup. The main insight of this section is owed from Zábojník (2002).

2.1 Setup

The model of benchmark analysis (hereinafter also called *centralization*) is as follows. There are two risk-neutral parties in an organization, a principal (P) and an agent (A). The decision process in the organization consists of the project choice and the execution decision. We assume that the organization has two potential projects, and the parties know that only one of the projects is promising. Let $d \in D \equiv \{1, -1\}$ be the chosen project and $s \in S \equiv \{1, -1\}$ be the state variable of the promising project. Although s is never observable to the parties, they have a common prior such that $\text{Prob}(s = 1) = \text{Prob}(s = -1) = 1/2$. Furthermore, before the project choice, each party $i \in I \equiv \{P, A\}$ receives a private signal $\theta_i \in \Theta \equiv \{1, -1\}$, which is correlated with the state variable s. Specifically, given s, θ_i is the same as the state variable s with probability $q_i \in (1/2, 1)$ (i.e., $\text{Prob}(\theta_i = s \mid s) = q_i$ for any $s \in S$ and $i \in I$). We assume that θ_P and θ_A are independently drawn conditional on s and that both q_P and q_A are common knowledge. Hence, Bayes' rule implies $\text{Prob}(s = \theta_i \mid \theta_i) = q_i$ for any $s \in S$ and $i \in I$.

After the project choice, the agent makes the execution decision $e \in E \equiv \{1, 0\}$ (i.e., execute the project ($e = 1$) or not ($e = 0$)). The agent bears a cost $c > 0$ from execution. After the execution decision, the project succeeds if and only if the chosen project is promising (i.e., $d = s$) and the agent executes the project (i.e., $e = 1$). The principal and the agent earn private benefits, $B > 0$ and $b > 0$, respectively, from the project's success.[9] If the project fails, both parties earn zero benefits. Let $x \in \{1, 0\}$ be the outcome of the project, where $x = 1$ if and only if the project results in success. The *ex post* payoffs are then expressed as Bx for the principal and $bx - ce$ for the agent. Unless otherwise stated, the principal chooses a project, the agent executes it, and no incentive contract is available for the parties.

The timing of the game is then summarized as follows.

1. State $s \in S$ and private signals $\theta_P, \theta_A \in \Theta$ are chosen by nature.

2. Given private signal θ_P, the principal chooses project $d \in D$.

3. Given private signal θ_A and project d, the agent chooses execution decision $e \in E$.

The parties play a perfect Bayesian equilibrium (PBE, hereinafter), where their posteriors about the state are derived from their posteriors about the opponent's signal by using Bayes' rule whenever possible (Fudenberg and Tirole, 1991). We look at an optimal PBE, meaning no other equilibrium is strictly better for the principal.[10]

2.2 The Fundamental Problem

2.2.1 Project Choice

The parties have a common interest in the project choice: both parties are willing to choose the promising project if they know it. As the principal has no informational source other than her own private signal in the project choice stage, we obtain the intuitive result that the project is chosen according to θ_P.[11]

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[9] The interpretation of b includes, for example, shared revenue with an exogenously fixed ratio, benefit from future reputation, and psychological benefits from achieving success.

[10] The formal definitions of the strategies, beliefs, and equilibrium are provided in Appendixes A and B.

[11] There may exist another optimal equilibrium in which $d \neq \theta_P$ for some θ_P and the agent never executes the project. However, as the principal is indifferent to both equilibria, we focus on the equilibrium characterized in Lemma 1 without loss of generality. See the proof of Lemma 1 for details.

Lemma 1. *Under centralization, there exists an optimal PBE such that $d = \theta_P$ for any $\theta_P \in \Theta$.*

From the perspective of the project choice, choosing project $d = \theta_P$ is reasonable as $q_P > 1/2$. Nevertheless, as seen below, the principal's project choice might demotivate the agent's execution by changing his belief concerning the promising project.

2.2.2 Execution

Given θ_A and d, the agent chooses e to maximize his expected payoff $(\text{Prob}(s = d \mid \theta_A, d)b - c)\, e$. Then, the agent executes the project ($e = 1$) if and only if

$$\text{Prob}(s = d \mid \theta_A, d)b - c \geq 0 \iff v \geq \frac{1}{\text{Prob}(s = d \mid \theta_A, d)}, \tag{1}$$

where $v \equiv b/c$ is the benefit/cost ratio, referred to as the agent's *intrinsic incentive* hereinafter.[12] Condition (1) implies that the agent is inclined to execute the project as the intrinsic incentive v is larger. In addition, the agent's incentive to execute the project depends on the conditional probability $\text{Prob}(s = d \mid \theta_A, d)$, which is the agent's (posterior) belief regarding whether the chosen project is promising and interpreted as his *confidence* in the project. Therefore, to motivate the agent's execution, the principal should lead him to be more confident.

Execution depends on both parties' signals. As Lemma 1 implies that the agent knows that the principal chooses the project based on her private signal, he learns the principal's signal through her project choice. Then, by Bayes' rule, the agent updates his confidence as

$$\text{Prob}(s = d \mid \theta_A, d = \theta_P) = \begin{cases} \dfrac{q_P q_A}{q_P q_A + (1 - q_P)(1 - q_A)} & \text{if } \theta_A = d, \\[2ex] \dfrac{q_P(1 - q_A)}{q_P(1 - q_A) + (1 - q_P)q_A} & \text{if } \theta_A \neq d. \end{cases} \tag{2}$$

[12] Throughout the analysis, we assume that the agent executes the project if he is indifferent to shirking.

For easy exposition, we say that there is *consensus* (resp. *disagreement*) among the parties if $\theta_P = \theta_A$ (resp. $\theta_P \neq \theta_A$). By plugging the posterior belief (2) into (1), we characterize the agent's execution decision under centralization. Let $v_0^C \equiv 1 + (1 - q_P)(1 - q_A)/q_P q_A$ and $v_1^C \equiv 1 + (1 - q_P)q_A/q_P(1 - q_A)$ with $v_0^C < v_1^C$.

Lemma 2. *Under centralization, execution in the optimal PBE with $d = \theta_P$ is as follows:*

1. *$e = 1$ for any $\theta_A \in \Theta$ if and only if $v \geq v_1^C$;*

2. *$e = 1$ for and only for $\theta_A = d$ if and only if $v_0^C \leq v < v_1^C$;*

3. *$e = 0$ for any $\theta_A \in \Theta$ otherwise.*

As shown above, the lack of consensus may prevent the execution of the project. If there is disagreement among the parties, then the agent becomes suspicious that the promising project has been chosen. Consequently, when v is intermediate, the agent's execution decision depends on whether there is consensus. Such consensus-contingent execution is referred to as *partial execution.*

As a corollary of Lemmas 1 and 2, the principal's *ex ante* equilibrium payoff $U^C(v)$ is characterized as follows.

Proposition 1.

$$U^C(v) = \begin{cases} q_P B & \text{if } v \geq v_1^C, \\ q_P q_A B & \text{if } v_0^C \leq v < v_1^C, \\ 0 & \text{if } v < v_0^C, \end{cases} \tag{3}$$

2.3 The Value of Delegation

Following Holmström (1977, 1984) and Aghion and Tirole (1997), organizational economics has discussed the value of delegation by assuming that the party who initially holds control rights can commit to delegation through formal contracting. The assumption of contractible authority helps clarify the value of delegation in our model, too. For this purpose, consider a hypothetical scenario (hereinafter called *formal delegation*) where the agent chooses the project and decides to execute it.[13]

Under formal delegation, as the agent has no opportunity to learn the principal's signal, he chooses $d = \theta_A$ and his confidence is given by $\text{Prob}(s = d \mid d = \theta_A) = q_A$. Then, he executes the project if and only if

$$\text{Prob}(s = d \mid d = \theta_A)b - c \geq 0 \iff v \geq v^D \equiv \frac{1}{q_A}. \tag{4}$$

Let $U^D(v)$ represent the principal's *ex ante* expected payoff under formal delegation and $\hat{q}_P(q_A) \equiv q_A^2/[q_A^2 + (1 - q_A)^2]$.

Proposition 2. *1. If $v \geq v^D$, then under formal delegation, there exists an optimal PBE in which $d = \theta_A$ and $e = 1$ are chosen for any θ_A.*

2. $U^D(v) = q_A B$ if $v \geq v^D$.

3. $U^C(v) < U^D(v)$ if and only if one of the following holds:

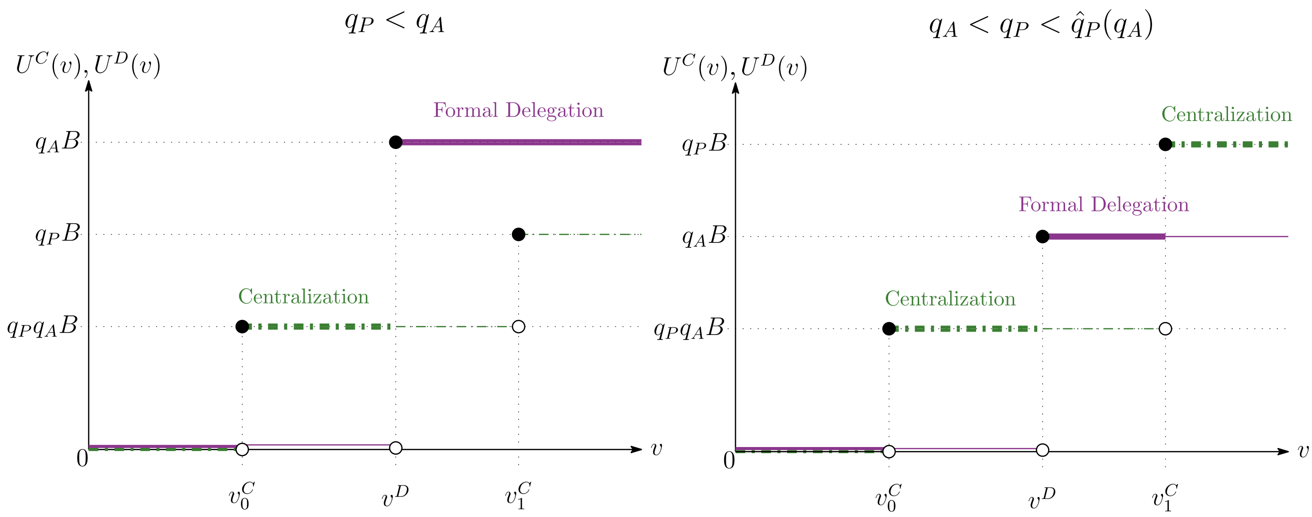
(a) $q_P < q_A$ and $v \geq v^D$; or

(b) $q_A \leq q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$.

Formal delegation may be beneficial for two reasons. First, if the agent has more precise information than the principal has (i.e., $q_P < q_A$), then delegating the right of the project choice increases the probability of choosing a promising project.[14] Second, and more impor-

[13] Throughout the paper, we assume that, following the existing works of choice and execution (e.g., Zábojník, 2002; Bester and Krähmer, 2008), the project must be executed by the agent regardless of the allocation of authority. Hence, centralization/formal delegation is defined by the party with the control right of project choice.

[14] Nevertheless, even if $q_P < q_A$, formal delegation is not always preferable, as illustrated in Figure 1. Specifically, if $v_0^C \leq v < v^D$, then centralization is better than formal delegation because the project is partially executed under the former by boosting the confidence under consensus, whereas it is never executed under the latter.



(Note: The dot-dash and solid lines express the payoffs under centralization and formal delegation, respectively. The bold line expresses the optimal equilibrium payoff.)

Figure 1: The Principal's Payoffs

tantly, formal delegation helps avoid the demotivating problem emerging under centralization. Specifically, when $q_A \leq q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$, the project is partially executed under centralization because of the motivational problem, whereas it is completely executed under formal delegation. The second benefit makes formal delegation better than centralization even though the principal has more precise information. Intuitively, formal delegation can be interpreted as a commitment not to reveal the principal's private signal to the agent. As the information revelation from the principal is shut down, the agent is not demotivated to execute the project.

3 Empowerment and Strategic Silence

We have demonstrated that formal delegation may be beneficial for the principal. However, as mentioned in Section 1, commitment to transfer formal authority is often difficult in practice due to institutional or legal constraints. Given this observation, we hereinafter assume that formal delegation is exogenously infeasible. The boss would attempt to empower subordinates by rubber-stamping their opinions as an alternative to formal delegation. To discuss whether such an informal way of delegation can replicate the outcome of desired formal delegation, we focus on the scenario of $U^C(v) < U^D(v)$ throughout Section 3.

Now, we introduce the agent's opportunity to report his signal before the project choice and discuss the credibility of *empowerment*, in which the principal chooses a project suggested by the agent, and the agent certainly executes it. As a main result of this study, we show that empowerment may not be credible even though the principal has no incentive to overturn the agent's suggestion. The impediment is a failure in information transmission from the agent. We also discuss potential remedies for the failure of empowerment.

3.1 Advice, Choice, and Execution

We now consider an organizational decision process where the agent may advise the principal as follows. Before the principal chooses a project, the agent can send a message about θ_A as in disclosure games (e.g., Milgrom, 1981). Specifically, the agent with signal $\theta_A \in \{1, -1\}$ sends a message $m \in M(\theta_A) \equiv \{\theta_A, \phi\}$, where $m = \theta_A$ and ϕ are associated with the "disclosure" and "concealment" of θ_A, respectively. The message space $M(\theta_A)$ implies that the agent cannot lie in the sense that $m = \theta_A$ is available only when his signal is θ_A. Intuitively, the agent must submit certifiable evidence supporting his claim rather than cheap-talk claims, and the fabrication of evidence is too costly.[15] The remaining setup is identical to that in the benchmark analysis. For easy exposition, the game after the communication stage is called the *continuation game*.

We define the following terminology frequently used below. A continuation strategy induces *rubber-stamping* if (i) the principal chooses project $d = m$ for each $m \in \{1, -1\}$ and (ii) the

[15] The certifiability of θ_A is for clarifying our argument and is not restrictive. In particular, the credibility of empowerment is never improved, even if the communication is represented by cheap-talk games (e.g., Crawford and Sobel, 1982). Specifically, if $M(1) = M(-1) \equiv \{1, -1, \phi\}$, then we need to impose additional incentive-compatible conditions requiring that each type has no incentive to mimic the other. As the additional requirement hinders information transmission, the condition for credible empowerment under cheap-talk communication is more demanding than that described below.

agent chooses $e = 1$ for d such that $d = m$.[16] A strategy profile (or an equilibrium) constitutes *empowerment* if (i) the agent sends $m = \theta_A$ for each $\theta_A \in \{1, -1\}$ and (ii) the continuation strategy induces rubber-stamping. We again adopt a PBE as the equilibrium concept.[17] As the model is a multi-stage sender–receiver game, there remains a multiplicity of equilibria because of the high flexibility in actions and beliefs in continuation games. To obtain reasonable predictions, we impose the following restrictions.

Requirement 1. *The equilibrium strategy profile and off-the-equilibrium-path beliefs satisfy the following properties.*

1. *(Symmetric Messages) The agent's message, specified by $m(\theta_A)$, satisfies either*
   - *(a) $m(\theta_A) = \theta_A$ for any θ_A; or*
   - *(b) $m(\theta_A) = \phi$ for any θ_A.*
2. *(Symmetric Beliefs) If $m = \phi$ is an off-the-equilibrium-path message, then the principal has a belief about θ_A such that* $\mathrm{Prob}(\theta_A \mid \theta_P, m = \phi) = \mathrm{Prob}(\theta_A \mid \theta_P)$.
3. *(Continuation Optimality) Given the beliefs formed after the communication stage, the parties' strategies in each continuation game constitute an optimal equilibrium for the principal.*

Requirements 1-1 and 1-2 impose the symmetry of the agent's communication behavior and updating of the principal's belief in the choice stage after observing the agent's deviation to $m = \phi$, respectively. It implicitly requires that as the agent's (*interim*) expected payoff in the communication stage is symmetric in types, each of $\theta_A = 1$ and -1 behaves symmetrically, and

[16] The project choice only matters when the agent chooses $e = 1$ on the equilibrium path. Hence, we focus on strategy profiles in which the agent executes the project on the equilibrium path. See Appendix A.2.1 for the formal definition.

[17] In addition to the standard sequential rationality, Bayes' rule is applied to derive the following: (a) on-the-equilibrium-path beliefs, (b) each party's belief on the state, and (c) the agent's belief about θ_P in the execution stage. Note that Cases (b) and (c) include off-the-equilibrium-path beliefs. Since the principal's strategy specifies how to behave after observing off-the-equilibrium-path messages, Bayes' rule is applicable to the posterior in Case (c). See Appendix A.2.1 for the formal definition of PBE in the model with advice.

the principal believes that both types of the agent are equally likely to deviate to concealment. Consequently, after observing $m = \phi$, the principal behaves only based on her private signal θ_P as under centralization. Requirement 1-3 guarantees a fair comparison with the benchmark analysis. As centralization is a special case of continuation games and we looked at equilibria optimal for the principal in the benchmark analysis, we require similar optimality in each continuation game.[18] We later argue that Requirement 1 is justified by *neologism-proofness* (Farrell, 1993).[19]

In the following, we consider PBEs that satisfy Requirement 1 and are optimal for the principal.[20] Let $U^*(v)$ represent the principal's *ex ante* expected payoff on the optimal PBE in the entire game when the agent's intrinsic incentive is v. The principal's expected payoff at an equilibrium constituting empowerment is identical to that under formal delegation. The following lemma guarantees that empowerment is the unique way to implement the outcome of formal delegation when it is preferred to centralization.

Lemma 3. *Suppose that $U^C(v) < U^D(v)$. Then, $U^*(v) \leq U^D(v)$ holds, where the equality holds if and only if the equilibrium constitutes empowerment.*

Let a PBE that constitutes empowerment and satisfies Requirement 1 be called an *empowerment equilibrium.* Hereinafter, we investigate whether there exists an empowerment equilibrium.

3.2 Non-credibility of Empowerment

Denote $v^E \equiv 1 + q_P(1 - q_A)/(1 - q_P)q_A$. The existence of empowerment equilibria is then characterized as follows.

Proposition 3. *There exists an empowerment equilibrium if and only if $q_P \leq q_A$ and $v \geq v^E$.*

[18] The formal definition is provided in Appendix A.

[19] See Section 4.1 and Appendix C.1 for the detail.

[20] Strictly speaking, a PBE is optimal if (i) it satisfies Requirement 1, and (ii) no PBE with Requirement 1 is strictly better for the principal.

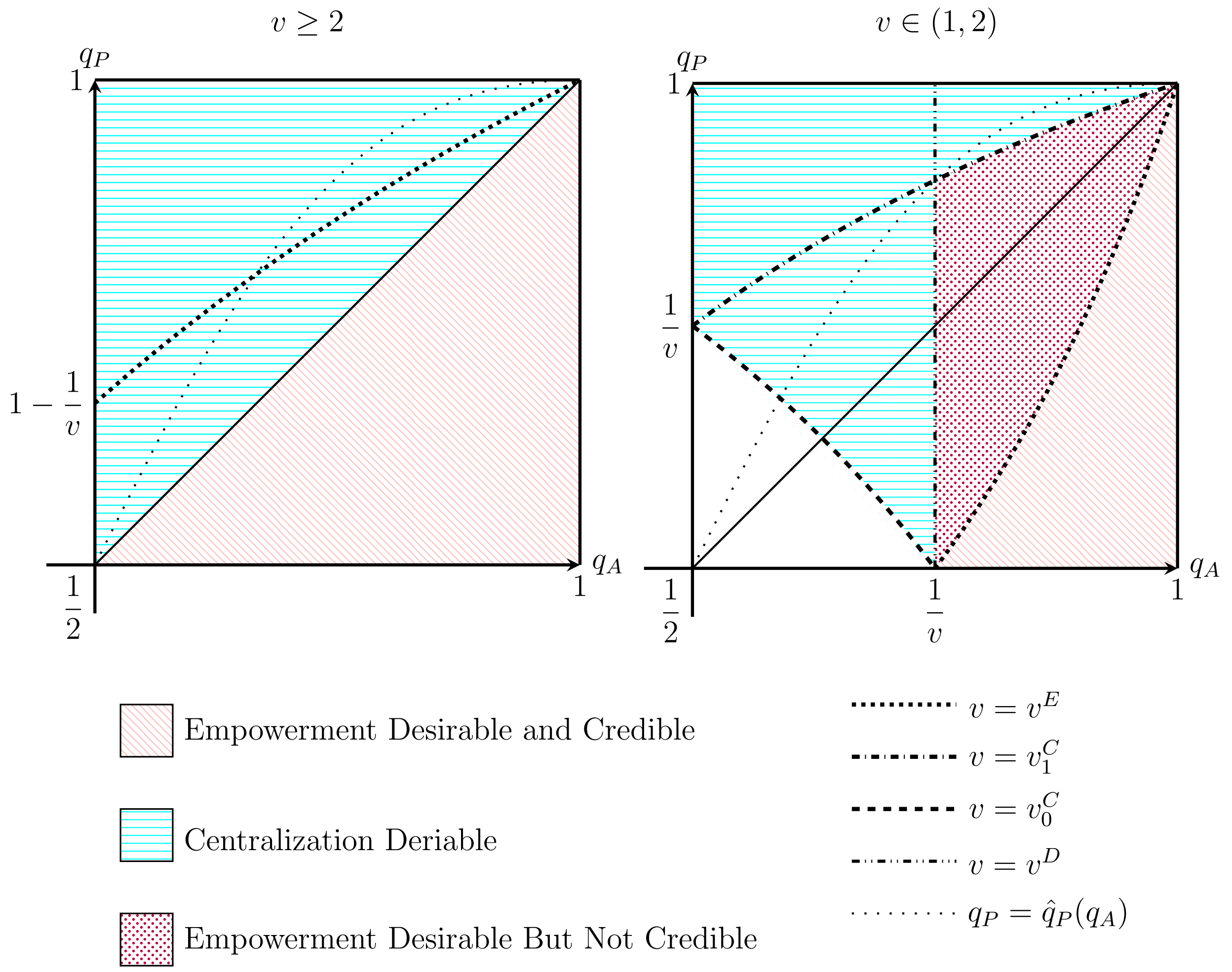


Figure 2: Credibility of Empowerment

Figure 2 illustrates the condition in Proposition 3 for each $q_P \in (1/2, 1)$ and $q_A \in (1/2, 1)$ with fixed $v > 1$.[21] The region below the bold dotted curve satisfies $v \geq v^E$ and the region below the 45-degree line satisfies $q_P \leq q_A$. When $v \geq 2$, as the border curve $v = v^E$ is above the 45-degree line, the necessary and sufficient condition in Proposition 3 is equivalent to that for $q_P \leq q_A$. Then, for $v \geq 2$, whenever formal delegation is preferable to centralization, the outcome under formal delegation is implemented through empowerment. For $v \in (1, 2)$, by contrast, as the right diagram in Figure 2 illustrates, the border curve $v = v^E$ is below the 45-degree line. Then, the necessary and sufficient condition in Proposition 3 is tighter than that for $q_P \leq q_A$. We find the dot-shaded region in Figure 2 in which there exists no empowerment equilibrium even though it is preferred to centralization. This observation is summarized in

[21]When $v \leq 1$, the agent does not execute the project for any q_P and q_A.

the following corollary, specifying the gap between formal and informal delegation.

Corollary 1. *Suppose that* $U^C(v) < U^D(v)$. *Then,* $U^*(v) < U^D(v)$ *holds if and only if* $q_P < \hat{q}_P(q_A)$ *and* $v^D \leq v < \min\{v^E, v_1^C\}$.

The agent's incentive in the communication stage is the driving force for the gap. Empowerment requires that the agent reveals his information. However, the agent may prefer to conceal his signal. To clarify the idea, we define that the agent is *strategically silent* given a strategy profile if (i) its continuation strategy induces rubber-stamping and (ii) the agent strictly prefers to conceal his signal.[22] In words, the agent denies revealing his signal when the project is supposed to be chosen based on the agent's information and is certainly executed. The following proposition characterizes the condition for inducing strategic silence when empowerment is desirable: either the principal's signal is more precise than the agent's or the intrinsic incentive is not sufficiently large.

Proposition 4. *Suppose that* $U^C(v) < U^D(v)$. *The agent is strategically silent for any optimal PBE satisfying Requirement 1 if and only if either* $q_P > q_A$ *or* $v < v^E$.

As a corollary of Propositions 3 and 4, the agent's intentionally passive attitude impedes successful empowerment.

Corollary 2. *Suppose that* $U^C(v) < U^D(v)$. *There exists no empowerment equilibrium if and only if the agent is strategically silent for any optimal PBE satisfying Requirement 1.*

To understand why the agent may prefer to hide his signal, observing the off-the-equilibrium-path actions in empowerment equilibria is useful, as specified by the following lemma.

Lemma 4. *In any empowerment equilibrium, the parties' actions in the continuation game after message* $m = \phi$ *are identical to those specified in Lemmas 1 and 2.*

[22] The formal definition is in Appendix A.2.1.

Lemma 4 implies that after the agent conceals his signal, the parties make decisions as if they were under centralization characterized in Section 2.2: the principal chooses the project solely based on her signal, and the agent executes the project based on his signal and the chosen project. Recall that the principal's project choice reveals her private signal to the agent. Importantly, learning the principal's information might be beneficial to the agent.

Specifically, suppose $v^D \leq v < v_1^C$, in which formal delegation is better than centralization. The outcome after $m = \theta_A$ is as if the parties were under formal delegation, whereas the outcome after $m = \phi$ is as if the parties were under centralization. Then, by Lemma 2 and Proposition 2, we find that the agent's expected payoffs from $m = \theta_A$ and ϕ are $q_A b - c$ and $q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_P)]c$, respectively.[23] Comparing the payoffs implies that the agent strictly prefers to conceal his signal if $v < v^E$, which is always satisfied when $q_P > q_A$.

The advantage of obtaining additional information arises in the execution stage. By learning the principal's signal, the agent learns more about the project to be executed. When the chosen project is aligned with his signal (i.e., consensus), the agent is willing to execute the project since it is more promising. However, when the project is misaligned with his signal (i.e., disagreement), he avoids execution to save the execution cost because he is suspicious about whether the chosen project is promising. Thus, instead of revealing the signal, the agent prefers keeping silent for conducting partial execution. Strategic silence in our model is interpreted as waiting to be told what to do by the principal and becomes more attractive to the agent as the principal has more precise signals.

Our result points out a novel insight that informal delegation may be prevented despite no conflict of interest in the project choice. In our model, if the parties know the promising project, then they are willing to choose the same promising project. Hence, unlike in the

[23] After $m = \phi$, the agent partially executes the project, and his payoff is derived as follows. From the *ex ante* view, with the probability of consensus (i.e., $q_P q_A + (1 - q_P)(1 - q_P)$), the agent executes the project and bears the cost c. Moreover, the chosen project is promising under consensus with probability $q_P q_A$, with which the agent receives benefit b.

standard discussion on real authority and informal delegation as in Aghion and Tirole (1997), the principal has no biased preference over projects to overturn the agent's suggestion. Our analysis illustrates that in addition to overturning, strategic silence by the agent may be another obstacle to informal delegation, which is rarely discussed in the literature.

In our model, the non-credibility of empowerment through strategic silence is caused by the parties' conflict of execution decisions. As the principal never bears the execution cost, she always prefers execution no matter the chosen project. By contrast, as the agent has to pay the cost of execution, he prefers not to execute the chosen project if it is less likely to be promising. By strategic silence, the agent can selectively execute promising projects. That is, partial execution is beneficial to the agent, whereas it is harmful to the principal.

Avoiding the execution of the project may be interpreted as an outside option guaranteeing a certain payoff irrespective of the state variable s. A similar structure is shared with Che et al. (2013) in the context of cheap-talk games. In their environment, instead of the sender (agent), the receiver (principal) has the right to choose an outside option, and the sender distorts information transmission to prevent the receiver from choosing the outside option.[24] By contrast, in our setup, the agent exercises the option not to execute the project, and he distorts information transmission to execute the outside option effectively.[25]

3.3 Toward Successful Empowerment

Strategic silence, which prevents the principal from desirable empowerment, is caused by the agent's incentive to learn the principal's private signal. In other words, changing the agent's incentive to learn the principal's signal might resolve strategic silence. In the following, we discuss two potential remedies for restoring desirable empowerment.

[24] Chiba and Leong (2018) assume that besides the conflict about the outside option, the players are in conflict about the other alternatives and show that these conflicts are countervailing and may enhance information transmission.

[25] Bester and Krähmer (2017) consider a model with contractible authority and show that it is optimal to allocate the authority of the project choice to the agent and the option to exit to the principal.

3.3.1 Bilateral Communication

One of the alternatives is to involve bilateral communication among the parties before the choice stage. If the agent learns the principal's signal through communication, then he does not need to take strategic actions to obtain the principal's signal. However, such a communication process does not achieve desirable empowerment even though the agent has no incentive to conceal his signal.

To understand the reason, consider a scenario where the principal can disclose her signal to the agent by sending message $m_P \in \{\theta_P, \phi\}$ before the agent sends a message. If $m_P = \theta_P$, then the agent initially observes θ_P as well as θ_A, which might demotivate execution as under centralization. More specifically, suppose that the agent recognizes that there is disagreement through the principal's disclosure. As at an empowerment equilibrium, if the agent also reveals his signal and the principal rubber-stamps the agent's proposal, then it is possible to confirm that the agent is willing to execute the project under disagreement if and only if $v \geq v^E$, which is the necessary condition for credible empowerment, as stated in Proposition 3. In other words, unless the conditions in Proposition 3 hold, empowerment is still impossible even if the agent reveals his signal following the principal's disclosure.[26]

Although communication processes other than the simple disclosure discussed here might be feasible for the parties, the basic argument would still hold.[27] The benefit of delegation in our model is to shut away the principal's signal from the agent, which prevents the agent from being demotivated by recognizing disagreement. However, revealing the principal's signal through communication uncovers the lack of consensus and restrains the agent's execution that is guaranteed unless he knows θ_P. As a consequence, although the problem of strategic silence

[26]It is possible to show the stronger result that disclosure never improves the principal's payoff. The formal analysis is available upon request.

[27]An alternative communication process is *consultation* as follows. The agent sends m_A to the principal, and then the principal sends m_P to the agent. Given θ_A and m_P, the agent suggests a project followed by the principal's project choice and the agent's execution decision. While both private signals might be unraveled through such pre-play communication, it does not resolve the demotivating problem. Once the agent recognizes the disagreement, the execution of the chosen project is not guaranteed.

might be mitigated, communication urges the principal to abandon the benefit of delegation. In summary, bilateral communication is helpless to simultaneously resolve the agent's silence and demotivating problem.

3.3.2 Less Informed Principals

In contrast to the bilateral communication process, the following remedy allows the parties to implement empowerment successfully. As the agent attempts to be strategically silent to obtain informative signals, he would not conceal the signal if the principal's signal is less informative. Furthermore, as the probability of choosing the promising project under empowerment depends solely on the precision of the agent's signal q_A, a deliberate reduction in the precision of the principal's signal could restore the credibility of desirable empowerment. The following corollary supports this argument.

Corollary 3. *1. Suppose that $U^C(v) < U^D(v)$. Then, $U^*(v) = U^D(v)$ holds if and only if $q_P \leq \bar{q}_P(q_A, v) \equiv q_A(v-1)/[1-q_A(2-v)]$.*

2. $U^D(v)$ is constant with respect to q_P.

The first part of the corollary is confirmed in Figure 2, where an empowerment equilibrium exists in the region below the bold dotted curve and the 45-degree line. With the second part of the corollary, when formal delegation is desirable, making the principal's signal less informative may allow her to implement empowerment credibly without worsening her payoff. Then, the corollary clarifies that the principal definitely prefers herself to be perceived as informationally inferior by the agent.[28]

[28] Theoretically, we also have the following remedies. First, the principal's commitment to a decision rule such that she chooses each project equally likely after $m = \phi$ resolves the problem. Such commitment corresponds to the principal with $q_P = 1/2$ and forces the agent to learn nothing from observing the project choice. Second, mediated communication helps solve the difficulties. Specifically, consider a *mediated-centralization mechanism*, in which a nonstrategic mediator aggregates private signals from the parties and then recommends the project choice and the execution decision to the principal and the agent, respectively. We can show that it weakly outperforms unmediated centralization/formal delegation. Nevertheless, as the principal must commit to a stochastic decision rule *ex ante*, implementing such remedies in practice would be at least as difficult as formal delegation. The detail is available upon request.

Corollary 3 argues that knowing less is beneficial to the principal. While the usefulness of the less-informed principals is also pointed out by Crémer (1995) and Aghion and Tirole (1997), our argument provides a new rationale for the value of less-informed principal. Specifically, they demonstrate that a less-informed principal encourages the agent's effort investment, whereas we demonstrate that the less-informed principal encourages the agent's information transmission.

3.4 Organizational Implications

3.4.1 The Case of HCL Technologies

The observation in Corollary 3 is consistent with Nayar's reminiscences of HCL Technologies (Nayar, 2010). As mentioned in Section 1, HCL Technologies employees never stated their own opinions in the initial phase of the reform. Nayar concluded that employees' passive behaviors would arise from their misperception that he "[d]id want to make all the decisions." To change the situation, Nayar began to ask employees for answers to the problems to impress that "[t]he CEO was not willing or able to answer all the employees' questions," which successfully changed the employees' minds. Nayar's challenge is interpreted as leading subordinates to perceive that his information was less precise than theirs.

3.4.2 The Case of Oticon

Oticon, a Danish hearing aids company, is another case where empowerment matters. In the early 1990s, Oticon introduced extensive delegation, known as the *spaghetti organization*, a flat, project-based organization where employees had broad discretion over the choice of project in which they engaged under ratification by the management team. Although the spaghetti organization had been profitable just after its introduction, it became ineffective, and the organization gradually transformed into a more hierarchical one, which is interpreted as a failure of empowerment. As the cause of the failure, Foss (2003) points out frequent interventions by the management team. More specifically, the management team believed itself knowledgeable enough about the true commercial and technical possibilities of projects to intervene frequently in bottom-up projects. Such intervention led to a severe loss of employee motivation. As the spaghetti organization could no longer motivate employees through extensive empowerment, the management team decided to shift the organization to more hierarchical structure.

Our analysis provides several insights into Oticon's failure. First, managerial intervention could result from the failure of information transmission from the agent. In our model, empowerment may be corrupted by the agent's attitude to be silent, inducing the principal to choose the project, which is interpreted as the principal's intervention. The failure of information transmission may be due to the passive employees following our model. Even if the employees did report something, it could be regarded as "identical to being silent" because, for instance, their reports were preliminary and interpreted as "saying nothing to be useful" for the management team, which induces the intervention. Second, shifting toward the hierarchical structure can be regarded as a remedy for failure. As the number of layers increases, the informational distance between the project and the management team tends to increase, which makes the top less informed about the project. As shown in Corollary 3, it encourages information transmission form employees.[29]

3.4.3 Inhibitors of Voice in Organizations

The motivating and inhibiting factors of hierarchical communication in organizations have received attention in organizational behavior literature. Morrison (2014), for example, reviews the factors that motivate or discourage employees' communication and emphasizes that employees' communication is inhibited by their pessimistic perspective, such as "[n]othing to gain, or

[29] Foss (2003) also emphasizes the importance of hierarchical organizations as remedies for successful empowerment. However, his argument is based on the perspective that empowerment fails due to the overturn by the top, as in Aghion and Tirole (1997). Although the mechanism behind the failure is different from ours, employing a less-informed top is the remedy for both mechanisms, as mentioned in Section 3.3.2.

something to lose" after raising the voice. Factors that inhibit employees' upward voice include organizational attributes such as job attitudes (e.g., detachment and powerlessness) and supervising behavior (e.g., abusive leadership), as well as individual attributes such as individual disposition, fear, and futility, among others.

Our theory provides an additional factor by which employees remain silent. Specifically, our model describes a mechanism in which employees intentionally remain silent even if they have no pessimistic perspective to the voice: they wait for instructions from the boss to obtain additional information. This mechanism would contribute to organizational behavior literature by proposing a new hypothesis from the economic perspective.

4 Robustness

Thus far, we have analyzed the stylized model to clarify our argument. One may wonder to what extent the analysis can be generalized and is robust. In the following, we discuss the robustness of our result with respect to various aspects. The formal analysis in this section is in Appendixes C to J.

4.1 Requirement 1: Revisit

Although we have imposed Requirement 1 *a priori*, it is formally replaced with *neologism-proofness* (Farrell, 1993), as shown in Appendix C.1. Specifically, we can show that any PBE constituted by asymmetric-message strategies or biased beliefs is not neologism-proof (Proposition C.1). Furthermore, the optimal PBE under Requirement 1 is neologism-proof (Proposition C.2). It is payoff equivalent to the optimal neologism-proof equilibrium for the principal (Proposition C.3).

Appendix C.2 investigates equilibria without imposing Requirement 1. Once either Requirement 1-1 (symmetric messages) or 1-2 (symmetric beliefs) is dropped, there exist equilibria constituting empowerment even when the conditions in Proposition 3 do not hold (Propositions C.4 and C.5). For example, suppose that the agent adopts an asymmetric-message strategy such that type $\theta_A = -1$ sends message $m = \phi$ while type $\theta_A = 1$ sends message $m = 1$. As message $m = \phi$ is used as a declaration of $\theta_A = -1$ rather than concealment, the agent has no option to conceal his signal. As a result, strategic silence disappears because mimicking the other type is less preferred than disclosing his type. A similar argument revives credible empowerment when the principal has a biased belief (e.g., $\text{Prob}(\theta_A = -1 \mid \theta_P, m = \phi) = 1$) under symmetric-message strategies. However, as mentioned above, such asymmetric equlibria are not neologism-proof.

4.2 Information Structure

4.2.1 Correlation between Signals

We have assumed that signals θ_P and θ_A are independently distributed conditional on state s. Appendix D extends the analysis to a case with correlation between the signals. Specifically, let γ represent the conditional variance between θ_P and θ_A given s, and the conditional joint distribution of the signals is modified as follows:

$$\text{Prob}(\theta_P, \theta_A \mid s) \equiv \begin{cases} q_P q_A + \gamma/4 & \text{if } \theta_P = \theta_A = s, \\ q_P(1-q_A) - \gamma/4 & \text{if } \theta_A \neq \theta_P = s, \\ (1-q_P)q_A - \gamma/4 & \text{if } \theta_P \neq \theta_A = s, \\ (1-q_P)(1-q_A) + \gamma/4 & \text{if } \theta_P = \theta_A \neq s. \end{cases} \tag{5}$$

Note that the baseline model is associated with $\gamma = 0$.

The comparison between centralization and formal delegation depends on the magnitude of the correlation. As in the baseline model, consensus enhances the confidence while disagreement discourages it under reasonable parametric restrictions. Hence, when γ is small (e.g., negatively correlated signals), the signals are likely to be disagreement, and then the cost of discouraging is non-negligible. As a result, formal delegation may be preferred even if the principal has better information, which is a generalization of the baseline model. In contrast, when γ is large (e.g., positively correlated signals), the signals are likely to be consensus, and the cost of discouraging is sufficiently small. As a result, the authority should be allocated to the party with better information (Proposition D.1).

As long as we restrict our attention to the case where formal delegation is preferred to centralization, our main argument is still true: desired empowerment may not be credible due to the agent's strategic silence. We show that the condition for credible empowerment is essentially equivalent to that of the baseline model (Proposition D.2).

4.2.2 Complementarity between Signals

Thus far, we have assumed that the signals are substitutes in that knowing either of the signals is sufficient to choose the promising project. We may consider another signal structure where the signals can be complements in the sense that knowing both signals is essential for choosing the promising project. In Appendix E, the baseline model is modified as follows to incorporate complementarity. Let $\omega \in \{0, 1\}$ be the parameter governing the signal structure. If $\omega = 0$, then θ_P and θ_A are substitutive as in the baseline model: that is, $\text{Prob}(s = 1 \mid \omega = 0) = 1/2$ and $\text{Prob}(\theta_i = s \mid \omega = 0, s) = q_i \in (1/2, 1)$ for each i. If $\omega = 1$, then we have $\text{Prob}(\theta_i = 1 \mid \omega = 1) = 1/2$ for each i and $\text{Prob}(s = 1 \mid \omega = 1, \theta_P = \theta_A) = \text{Prob}(s = -1 \mid \omega = 1, \theta_P \neq \theta_A) = 1$. Given $\omega = 1$, the signals are complement in that the promising project is determined depending on whether the parties' signals match (i.e., $\theta_P = \theta_A$) or differ (i.e., $\theta_P \neq \theta_A$).[30] We assume that parameter ω is unobservable to all parties and stochastically determined according to the common prior $\text{Prob}(\omega = 0) = \tau \in [0, 1]$. Note that the baseline model is associated with $\tau = 1$.

[30] This formulation is borrowed from McGee and Yang (2013) in the model of cheap-talk games where the senders' private information is complement.

This extension clarifies the range of strategic silence. As long as the signals are sufficiently substitutive (i.e., τ is sufficiently large), strategic silence makes empowerment non-credible as in the baseline model (Proposition E.2). Hence, the results in the baseline model are robust to small complementarity.

By contrast, strategic silence does not occur when the signals are sufficiently complementary (i.e., τ is sufficiently small) (Proposition E.3). The non-occurrence of strategic silence comes from the fact that the parties have no conflict over disclosing the principal's signal. When the signals are substitutive, the principal does not prefer to reveal her signal as long as the agent reveals his signal, whereas the agent wants to know the principal's signal for efficient execution. By contrast, when the signals are complement, the principal wants to choose a project based on both signals. As the principal has no incentive to conceal her signal in the choice stage, the agent also has no incentive to be strategically silent to induce the principal's signal. This observation suggests that the nature of each party's information may be a key determinant of the emergence of upward voices from subordinates.

4.2.3 Uncertain Precision of Signals

We have assumed that signal precision q_i is common knowledge among the parties, which is relaxed in Appendix F. Let $q_i \in Q_i \equiv \{q_i^-, q_i^+\}$ represent party i's signal precision with $1/2 < q_i^- < q_i^+ < 1$. We assume that in addition to signal θ_i, precision q_i is also party i's private information. The common prior over the precision is given by $\text{Prob}(q_i = q_i^+) \equiv \alpha_i \in (0, 1)$. Intuitively, this extension represents the environment in which the parties' signals differ not only in the "direction" but also in "strength."

The results do not qualitatively change from the baseline model, even though the precision is private information. Specifically, the structure of optimal equilibria under centralization does not change (Proposition F.1), and the characterization of the desired formal delegation and the credible empowerment are qualitatively identical to those in the baseline model (Propositions F.2 and F.3). Although whether q_i should be separating or pooling may be an issue in this extension, it does not substantially affect the parties' incentive to reveal or conceal θ_i.

4.3 Continuous Execution Decision

In the baseline model, the agent makes a binary decision of execution, which seems fairly reasonable in the organizational decision process (i.e., "execution" or "shirking"). Alternatively, the agent's *ex post* decision may be his costly effort or investment, which may be chosen more flexibly. To consider environments with flexible *ex post* decision, Appendix G investigates the following modified model. Suppose that the execution decision is continuous ($e \in [0, 1]$) and the agent's cost of execution is expressed by cost function $C(e) \equiv \bar{c}e^2/2$ with $\bar{c} > 0$. The probability of success is given by $\text{Prob}(x = 1 \mid s, d, e) = e$ if $s = d$ and 0 otherwise for each s, d, and e.[31]

Even if the execution decision is continuous, desirable empowerment may be prevented when the principal has a more precise signal (Proposition G.2), as in the baseline model. Recall that the underlying mechanism behind the non-credibility of empowerment is strategic silence; that is, the agent denies his information to the principal to obtain more precise information from her. This argument is still valid in the modified setup because it does not rely on the specification of the execution decision. Then, as in the case of a binary decision, strategic silence prevents desired empowerment in the case of a continuous decision if formal delegation is preferred to centralization under the agent's signal being less precise than the principal's.

Appendix G clarifies when formal delegation is preferred to centralization under the principal having a more precise signal. Specifically, this phenomenon appears when the intrinsic incentive, defined by $\bar{v} \equiv b/\bar{c}$, is moderate so that the agent chooses $e = 1$ under consensus and

[31] If the execution cost is linear (i.e., $C(e) = \bar{c}e$), then the result is exactly the same as the baseline model.

$e < 1$ under disagreement. In this case, the demotivating effect as the cost of centralization is fully counted, whereas the motivating effect as the benefit of centralization is limited. As a result, delegation is relatively attractive even though the principal has more precise information (Proposition G.1). Contrarily, if the optimal execution decisions are always on the interior (i.e., $e^* \in (0,1)$), then centralization is strictly better than formal delegation given $q_P \geq q_A$ because the motivating effect under consensus dominates the demotivating effect under disagreement.

4.4 Incentive Contracts

Throughout the paper, we have taken an incomplete contracting approach so that any *ex ante* contract cannot be agreed upon except in Section 2; neither a monetary bonus nor the allocation of authority is contractible. A related study by Zábojník (2002) considers a model where both monetary bonus and the allocation of authority are feasible. His study mainly focuses on the comparison between centralization and formal delegation, which corresponds to our analysis in Section 2. He shows that (i) when limited liability is not imposed on the agent, authority should be allocated to the party whose signal is more precise; and (ii) with limited liability, it may be better to allocate authority to the agent even when the agent's signal is less precise than the principal's.

To understand the effect of incentive contracts, let $w(\geq 0)$ be the incentive bonus when the project succeeds. As in (1), the incentive-compatibility constraint of the execution decision is expressed as

$$\text{Prob}(s = d \mid \theta_A, d)(b + w) - c \geq 0 \iff \hat{v}(w) \equiv \frac{b + w}{c} \geq \frac{1}{\text{Prob}(s = d \mid \theta_A, d)}, \tag{6}$$

from which we see that the incentive transfer w plays the role of increasing the intrinsic incentive from $v = b/c$ to $\hat{v}(w) \geq b/c$.[32] In other words, incentive contracts allow the parties to

[32] At the same time, the principal's benefit B is reduced by w.

control the intrinsic incentive v, and the parties can resolve the execution incentive problem by appropriately choosing w.

When limited liability is not imposed, shifting the incentive bonus w does not yield incentive costs incurred by the principal. This is as if the principal can increase v without any cost. Then, as in our model with high v, authority should be allocated to the party whose signal is more precise. In contrast, when the agent is protected by limited liability, positive incentive bonuses yield positive rents the principal must pay to the agent. This implies that increasing v through incentive contracts is costly for the principal. As the principal is willing to avoid paying rent through incentive contracts, it is often the case that authority is contractually delegated to the agent, even if his signal is less precise than the principal's.[33]

To clarify the impact of incentive contracts on the credibility of empowerment, in Appendix H, we investigate a model where incentive contracts are available, and the allocation of authority is not contractible. In this setting, the principal can incentivize the agent by appropriately designing the bonus though empowerment is necessary for implementing the outcome of desired formal delegation.

Strategic silence does not emerge when limited liability is not imposed. Recall that formal delegation is preferred to centralization only when the agent's signal is more precise than the principal's, as shown by Zábojník (2002). As increasing v by incentive contracts yields no costs, the principal is willing to choose bonus w so that $\hat{v}(w) \geq v^E$, by which empowerment can be supported under $q_P \leq q_A$.

However, when limited liability is imposed, empowerment may not be supported because of strategic silence as in the baseline model. In particular, we show the following three results. First, even when formal delegation is strictly preferred to centralization, no empowerment equilibrium exists if the principal's signal is more precise than the agent's (Proposition H.5).

[33] We provide complete characterization for comparing formal delegation and centralization (Proposition H.2), whereas Zábojník (2002, Proposition 2) simply notes the possibility that formal delegation is better than centralization when the principal has more precise information. See Appendix H for details.

Second, even when there is an empowerment equilibrium, the principal's payoff may be strictly less than the payoff under formal delegation (Propositions H.4 to H.6). These two results are derived from the principal's motive to reduce the bonus caused by the limited liability constraint. Specifically, to motivate execution, the bonus can be small under formal delegation relative to centralization. However, such a small bonus induces the agent to be strategically silent, by which the agent can obtain additional information valuable for making the execution decision. Hence, to incentivize the agent's voluntary disclosure, the principal has to pay more bonuses, making the principal worse off than formal delegation. Finally, even though the desired formal delegation is not implemented, an empowerment equilibrium could outperform centralization. (Proposition H.7). Thus, we conclude that incentive contracts cannot fully resolve strategic silence though it mitigates the problem.

4.5 Mediation Mechanisms

As the allocation of authority is a critical feature in organizational decision-making, we have focused on formal delegation as an alternative procedure to resolve the demotivating problem under centralization. Theoretically, we might consider more general procedures other than formal delegation. Following Forge (1986) and Myerson (1986), we introduce a nonstrategic mediator who aggregates all private information and recommends behaviors to the parties. Specifically, we consider the following procedure, referred to as *mediated-delegation mechanisms*. First, given his/her private signal, each party simultaneously sends message $m_i \in M(\theta_i) \equiv \{\theta_i, \phi\}$ to the mediator. Second, given the message pair $m \equiv (m_P, m_A) \in M^2 \equiv \{1, -1, \phi\}^2$, the mediator sends recommendation $r \in R \equiv \{r_{10}, r_{11}, r_{-10}, r_{-11}\}$ to the agent, where r_{ij} denotes the recommendation of choosing project $d = i$ and execution decision $e = j$. Finally, given recommendation r, the agent chooses both the project and the execution decision. Note that, in this procedure, (i) disclosing signal θ_i and (ii) obeying each possible recommendation must be optimal for the parties.

Appendix I uncovers the two properties of mediated-delegation mechanisms. First, when formal delegation is strictly preferred to centralization, where we have focused thus far, mediated-delegation mechanisms do not strictly dominate formal delegation (Proposition I.1). This justifies formal delegation as a benchmark for resolving the demotivating problem. Second, when centralization is strictly better than formal delegation (though it is not the scope of this study), mediated-delegation mechanisms could strictly dominate (unmediated) centralization/formal delegation (Proposition I.2). Mediated-delegation mechanisms tailor the agent's posterior so that the chosen project is executed even under signal disagreement.

4.6 Total Surplus

Throughout the analysis, we have focused on optimal equilibria for the principal and mainly investigated the case where the principal prefers formal delegation to centralization. The purpose of the organization might be different from the principal's own interest. For instance, if the lump-sum transfer is available before their decisions, the principal would attempt to maximize the surplus (i.e., the sum of the principal's and agent's payoffs) and set the lump-sum transfer to guarantee the agent's payoff to be the value of the outside option. One may also wonder how the optimal equilibrium for the principal is distorted from the efficient outcome that maximizes the total surplus.

Appendix J supposes that the parties play a PBE that maximizes the expected total surplus. We show that despite the difference of the objective function, the behavior on the equilibrium maximizing the total surplus is not different from that on the principal's optimal equilibrium whenever her benefit B from success is sufficiently large (Corollary J.1). Therefore, we obtain the same implication even when the lump-sum transfers are available. Furthermore, the equilibrium behavior we focused on is also efficient in terms of the total surplus.

5 Conclusion

We have investigated the credibility of empowerment in organizations with advice, choice, and execution when a state-contingent incentive bonus and the transfer of authority are prohibited. After highlighting the motivational problem under centralization and the value of delegation, we demonstrated that even though the principal has no incentive to overturn the agent's proposal, empowerment may be prevented because the agent conceals his signal to obtain more informative signals from the principal. Restricting the principal's expertise could be a useful means to implement empowerment successfully.

As in the case of HCL Technologies, organizations are often faced with discrepancies between their willingness to delegate and passive employees who refuse to take responsibility and make decisions by themselves. The concept of strategic silence can explain such discrepancies. Further investigation into passive employees and their effects would be interesting in future research.

A Appendix

A.1 Analyses of Section 2

The strategy profile under centralization is defined by (d^C, e^C), where $d^C(\theta_P) \in \{1, -1\}$ is the principal's choice of the project and $e^C(\theta_A, d) \in \{1, 0\}$ is the agent's execution decision. Similarly, a strategy profile under formal delegation is defined by (d^D, e^D), where $d^D(\theta_A) \in \{1, -1\}$ is the agent's choice of the project, $e^D(\theta_A, d) \in \{1, 0\}$ is the agent's execution decision.[34] See Appendixes B.1 and B.2 for details.

[34] As the agent's beliefs about θ_P in the choice and the execution stages are identical to the prior, their explicit representation is omitted.

A.1.1 Proof of Lemmas 1 and 2

We prove Lemmas 1 and 2 jointly. There can be three kinds of equilibria: (i) $d^C(\theta_P) = \theta_P$ for each θ_P; (ii) for some $\tilde{d} \in D$, $d^C(\theta_P) = \tilde{d}$ for each θ_P; and (iii) $d^C(\theta_P) = -\theta_P$ for each θ_P. In the following, we prove the statement by showing that (i) there exists an equilibrium in which $d^C(\theta_P) = \theta_P$ for each θ_P and v; and (ii) no other equilibrium induces the principal's payoff to be strictly greater and weakly greater for $v \geq v_0^C$.[35]

First, we show that the following strategies are supported by a PBE: $d^C(\theta_P) = \theta_P$ for each θ_P and $e^C(\theta_A, d)$ satisfying (1). Given d^C, since the agent certainly believes $\theta_P = d$ for all $d \in D$, his confidence is expressed as

$$\text{Prob}(s = d \mid \theta_A, d, \nu^C) = \begin{cases} \dfrac{q_P q_A}{q_P q_A + (1-q_P)(1-q_A)} & \text{if} \quad d = \theta_A, \\ \dfrac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A} & \text{if} \quad d \neq \theta_A. \end{cases} \tag{A.1}$$

Then, by (1), the agent's best response is characterized as follows:

$$e^C(\theta_A, d; v) = \begin{cases} 1 & \text{if } [v \geq v_1^C] \text{ or } [v_0^C \leq v < v_1^C \text{ and } \theta_A = d], \\ 0 & \text{otherwise.} \end{cases} \tag{A.2}$$

It remains to show the optimality of d^C. If the principal with θ_P chooses $d = \theta_P$, then because $\text{Prob}(\theta_A = \theta_P, s = \theta_P \mid \theta_P) = q_P q_A$ and $\text{Prob}(\theta_A = -\theta_P, s = \theta_P \mid \theta_P) = q_P(1-q_A)$, her expected payoff in the choice stage is

$$q_P \left[q_A \mathbb{1}(v \geq v_0^C) + (1-q_A)\mathbb{1}(v \geq v_1^C) \right] B. \tag{A.3}$$

Suppose that the principal with θ_P deviates to $d = -\theta_P$. Then, as $\text{Prob}(\theta_A = -\theta_P, s = -\theta_P \mid \theta_P) = (1-q_P)q_A$ and $\text{Prob}(\theta_A = \theta_P, s = -\theta_P \mid \theta_P) = (1-q_P)(1-q_A)$, her expected

[35] The uniqueness of optimal equilibria is guaranteed for $v \geq v_0^C$.

<table>
<tr><th></th><th>$d^C(\theta_P) = \theta_P$</th><th>$d^C(\theta_P) = \tilde{d}$</th></tr>
<tr><td>$v \geq \bar{v}_0$</td><td rowspan="2">$q_P B$</td><td>$B/2$</td></tr>
<tr><td>$v_1^C \leq v < \bar{v}_0$</td><td rowspan="2">$q_A B/2$</td></tr>
<tr><td>$v^D \leq v < v_1^C$</td><td rowspan="2">$q_P q_A B$</td></tr>
<tr><td>$v_0^C \leq v < v^D$</td><td rowspan="2">0</td></tr>
<tr><td>$v < v_0^C$</td><td>0</td></tr>
</table>

Table 1: Comparison of Payoffs: $q_P < \hat{q}_P(q_A)$

<table>
<tr><th></th><th>$d^C(\theta_P) = \theta_P$</th><th>$d^C(\theta_P) = \tilde{d}$</th></tr>
<tr><td>$v \geq \bar{v}_0$</td><td rowspan="3">$q_P B$</td><td>$B/2$</td></tr>
<tr><td>$v^D \leq v < \bar{v}_0$</td><td>$q_A B/2$</td></tr>
<tr><td>$v_1^C \leq v < v^D$</td><td rowspan="3">0</td></tr>
<tr><td>$v_0^C \leq v < v_1^C$</td><td>$q_P q_A B$</td></tr>
<tr><td>$v < v_0^C$</td><td>0</td></tr>
</table>

Table 2: Comparison of Payoffs: $q_P \geq \hat{q}_P(q_A)$

payoff is

$$(1 - q_P) \left[q_A \mathbb{1}(v \geq v_0^C) + (1 - q_A) \mathbb{1}(v \geq v_1^C) \right] B. \tag{A.4}$$

As $q_P > 1/2$, the deviation payoff (A.4) is not greater than the equilibrium payoff (A.3). Then, the principal has no incentive to deviate from $d^C(\theta_P)$. Based on $d^C(\theta_P)$ and $e^C(\theta_A, d)$ derived here, the principal's equilibrium payoff is derived depending on v, as in the second rows of Tables 1–4.

Second, suppose that there exists an equilibrium such that for some $\tilde{d} \in D$, $d^C(\theta_P) = \tilde{d}$ for each θ_P. Given d^C, as the agent believes $d = \tilde{d}$ for any $\theta_P \in \Theta$, he never learns θ_P through the project choice. Then, his confidence is expressed as

$$\text{Prob}(s = \tilde{d} \mid \theta_A, d = \tilde{d}, \nu^C) = \begin{cases} q_A & \text{if} \quad d = \theta_A, \\ 1 - q_A & \text{if} \quad d \neq \theta_A. \end{cases} \tag{A.5}$$

With (1) and (A.5), the agent's equilibrium execution decision is characterized as follows:

$$e^C(\theta_A, d; v) = \begin{cases} 1 & \text{if } [v \geq \bar{v}_0] \text{ or } [v^D \leq v < \bar{v}_0 \text{ and } d = \theta_A], \\ 0 & \text{otherwise,} \end{cases} \tag{A.6}$$

where $v^D \equiv 1/q_A$ and $\bar{v}_0 \equiv 1/(1 - q_A)$. Based on $d^C(\theta_P)$ and $e^C(\theta_A, d)$ derived here, the principal's equilibrium payoff is given by

$$\frac{1}{2}\left[q_A \mathbb{1}(v \geq v^D) + (1-q_A)\mathbb{1}(v \geq \bar{v}_0)\right] B, \tag{A.7}$$

summarized in the third rows of Tables 1 and 2. However, because $q_P > 1/2$, the principal's payoffs in the third rows are not strictly greater than those in the second rows for any v and not weakly greater for $v \geq v_0^C$.

Finally, suppose that there exists an equilibrium such that $d^C(\theta_P) = -\theta_P$ for each θ_P. Given d^C, as the agent believes $d = -\theta_P$ for all $\theta_P \in \Theta$, his confidence is expressed as

$$\text{Prob}(s = d \mid \theta_A, d, \nu^C) = \begin{cases} \dfrac{(1-q_P)q_A}{q_P(1-q_A)+(1-q_P)q_A} & \text{if} \quad d = \theta_A, \\ \dfrac{(1-q_P)(1-q_A)}{q_P q_A + (1-q_P)(1-q_A)} & \text{if} \quad d \neq \theta_A. \end{cases} \tag{A.8}$$

With (1) and (A.8), the agent's equilibrium execution decision is characterized as follows:

$$e^C(\theta_A, d; v) = \begin{cases} 1 & \text{if } [v \geq \bar{v}_1] \text{ or } [v^E \leq v < \bar{v}_1 \text{ and } d = \theta_A], \\ 0 & \text{otherwise}, \end{cases} \tag{A.9}$$

where $v^E \equiv 1 + q_P(1-q_A)/[(1-q_P)q_A]$ and $\bar{v}_1 \equiv 1 + q_P q_A/[(1-q_P)(1-q_A)]$. Based on $d^C(\theta_P)$ and $e^C(\theta_A, d)$ derived here, the principal's equilibrium payoff is given by

$$(1-q_P)\left[q_A \mathbb{1}(v \geq v^E) + (1-q_A)\mathbb{1}(v \geq \bar{v}_1)\right] B, \tag{A.10}$$

which is summarized in the third rows of Tables 3 and 4. Again, the principal's payoffs in the third rows are not strictly greater than those in the second rows for any v and not weakly greater for $v \geq v_0^C$ because of $q_P > 1/2$. ■

<table>
<tr><th></th><th>$d^C(\theta_P) = \theta_P$</th><th>$d^C(\theta_P) = -\theta_P$</th></tr>
<tr><td>$v \geq \bar{v}_1$</td><td rowspan="2">$q_P B$</td><td>$(1 - q_P)B$</td></tr>
<tr><td>$v_1^C \leq v < \bar{v}_1$</td><td rowspan="2">$(1 - q_P)q_A B$</td></tr>
<tr><td>$v^E \leq v < v_1^C$</td><td rowspan="2">$q_P q_A B$</td></tr>
<tr><td>$v_0^C \leq v < v^E$</td><td rowspan="2">0</td></tr>
<tr><td>$v < v_0^C$</td><td>0</td></tr>
</table>

Table 3: Comparison of Payoffs: $q_P < q_A$

<table>
<tr><th></th><th>$d^C(\theta_P) = \theta_P$</th><th>$d^C(\theta_P) = -\theta_P$</th></tr>
<tr><td>$v \geq \bar{v}_1$</td><td rowspan="3">$q_P B$</td><td>$(1 - q_P)B$</td></tr>
<tr><td>$v^E \leq v < \bar{v}_1$</td><td>$(1 - q_P)q_A B$</td></tr>
<tr><td>$v_1^C \leq v < v^E$</td><td rowspan="3">0</td></tr>
<tr><td>$v_0^C \leq v < v_1^C$</td><td>$q_P q_A B$</td></tr>
<tr><td>$v < v_0^C$</td><td>0</td></tr>
</table>

Table 4: Comparison of Payoffs: $q_P \geq q_A$

A.1.2 Proof of Proposition 1

It is straightforward from Lemmas 1 and 2 that the principal's payoff is given by (A.3), expressed as (3). ■

A.1.3 Proof of Proposition 2

The following lemma characterizes the optimal equilibria under formal delegation.

Lemma 5. *Consider formal delegation.*

1. *There exists an optimal PBE such that*

   (a) $d^D(\theta_A) = \theta_A$ *for any* $\theta_A \in \Theta$*; and*

   (b) *the execution decision satisfies:*

      i. *when* $v \geq v^D$, $e^D(\theta_A, d = \theta_A) = 1$ *for any* θ_A*;*

      ii. *when* $v < v^D$, $e^D(\theta_A, d = \theta_A) = 0$ *for any* θ_A*.*

2. *The principal's equilibrium payoff* $U^D(v)$ *is given by*

$$U^D(v) = \begin{cases} q_A B & \text{if } v \geq v^D, \\ 0 & \text{otherwise.} \end{cases} \tag{A.11}$$

Proof (Lemma 5)**.** We first show that for each θ_A, $d^D(\theta_A) = \theta_A$ constitutes a PBE. As the agent has no opportunity to learn θ_P, we obtain

$$\text{Prob}(s = d \mid \theta_A, d) = \begin{cases} q_A & \text{if} \quad d = \theta_A, \\ 1 - q_A & \text{if} \quad d \neq \theta_A. \end{cases} \tag{A.12}$$

Note that the agent's optimal execution under formal delegation is also characterized by (1), implying that

$$e^D(\theta_A, d = \theta_A; v) = \begin{cases} 1 & \text{if} \quad v \geq v^D, \\ 0 & \text{if} \quad v < v^D, \end{cases} \qquad e^D(\theta_A, d = -\theta_A) = \begin{cases} 1 & \text{if} \quad v \geq \bar{v}_0, \\ 0 & \text{if} \quad v < \bar{v}_0, \end{cases} \tag{A.13}$$

where $\bar{v}_0$ is defined in the proof of Lemmas 1 and 2. If the agent with θ_A chooses $d = \theta_A$, his expected payoff is

$$\begin{aligned} [\text{Prob}(s = d \mid \theta_A, d = \theta_A)b - c]e^D(\theta_A, d = \theta_A) &= (q_A b - c)e^D(\theta_A, d = \theta_A) \\ &= \max\{q_A b - c, 0\}, \end{aligned} \tag{A.14}$$

where the last equality is from (A.12) and (A.13). On the contrary, if he chooses $d = -\theta_A$, then his expected payoff is

$$\begin{aligned} [\text{Prob}(s = d \mid \theta_A, d = -\theta_A)b - c]e^D(\theta_A, d = -\theta_A) &= [(1 - q_A)b - c]e^D(\theta_A, d = -\theta_A) \\ &= \max\{(1 - q_A)b - c, 0\}, \end{aligned} \tag{A.15}$$

where the last equality is again from (A.12) and (A.13). As $q_A > 1/2$, implying $q_A b - c > (1 - q_A)b - c$, we find that the deviation payoff (A.15) is not greater than the equilibrium payoff (A.14). Then, the agent has no incentive to deviate from $d = \theta_A$. If the agent chooses $d = \theta_A$, then the principal's expected payoff is equivalent to $U^D(v)$ as in (A.11).

We conclude the proof by showing that $d^D(\theta_A) \neq \theta_A$ does not yield the principal's expected payoff strictly greater than $d^D(\theta_A) = \theta_A$ does. Suppose first $v \geq v^D$. Given θ_P and θ_A, if $d \neq \theta_A$, then the principal's conditional expected payoff is

$$(1 - q_A)Be^D(\theta_A, d = -\theta_A) \leq q_A B, \tag{A.16}$$

where the inequality is owing to $q_A > 1/2$ and $e^D(\theta_A, d = -\theta_A) \leq 1$. Then, $d^D(\theta_A) \neq \theta_A$ does not yield a strictly greater payoff than $d^D(\theta_A) = \theta_A$. Suppose next $v < v^D$. Since $\bar{v}_0 > v^D > v$, $e^D(\theta_A, d = -\theta_A) = 0$ by (A.13). Then, when $d^D(\theta_A) \neq \theta_A$, the principal's conditional expected payoff is zero, which is not strictly greater than the payoff from $d^D(\theta_A) = \theta_A$. ■

Proposition 2 is immediately derived from Proposition 1 and Lemma 5. ■

A.2 Analyses of Section 3

A.2.1 Preliminaries

In this subsection, we formally define strategies, beliefs, and equilibria in the main model, referred to as the *model of advice, choice, and execution* (hereinafter, ACE model). As explained below, centralization in Section 2 can be seen as a continuation game of the ACE model. Let $x : S \times D \times E \to \{0, 1\}$ represent the outcome defined by $x(s, d, e) \equiv \mathbb{1}(s = d, e = 1)$, where $\mathbb{1}(\cdot)$ is an indicator function.

The formal representation of the strategies and beliefs is as follows. Define $M \equiv \{1, -1, \phi\}$. Let $m^* : \Theta \to M$ and $e^* : \Theta \times M \times d \to E$ be the message and the execution decision chosen by the agent, respectively, and then his strategy is represented by a double (m^*, e^*). Let $d^* : \Theta \times M \to D$ be the project chosen by the principal. Denote the principal's and the agent's posterior beliefs about the opponent's private signal by $\mu^* : \Theta \times M \to \Delta(\Theta)$ and $\nu^* : \Theta \times M \times D \to \Delta(\Theta)$, respectively.

The equilibrium in the ACE model is defined as follows.

Definition 1. *An assessment* $\mathcal{E}^* \equiv (d^*, (m^*, e^*); \mu^*, \nu^*)$ *is a PBE if*

1. *for any* $\theta_A \in \Theta$,

$$m^*(\theta_A) \in \arg\max_{m \in M(\theta_A)} \sum_{\theta_P \in \Theta} \sum_{s \in S} [bx\left(s, d^*(\theta_P, m), e^*(\theta_A, m, d^*(\theta_P, m))\right) \\ -ce^*(\theta_A, m, d^*(\theta_P, m))] \operatorname{Prob}(s \mid \theta_P, \theta_A) \operatorname{Prob}(\theta_P \mid \theta_A); \tag{A.17}$$

2. *for any* $\theta_P \in \Theta$ *and* $m \in M$,

$$d^*(\theta_P, m) \in \arg\max_{d \in D} \sum_{\theta_A \in \Theta} \sum_{s \in S} Bx\left(s, d, e^*(\theta_A, m, d)\right) \operatorname{Prob}(s \mid \theta_P, \theta_A) \mu^*(\theta_A \mid \theta_P, m); \tag{A.18}$$

3. *for any* $\theta_A \in \Theta$, $m \in M(\theta_A)$, *and* $d \in D$,

$$e^*(\theta_A, m, d) \in \arg\max_{e \in E} \sum_{\theta_P \in \Theta} \sum_{s \in S} [bx(s, d, e) - ce] \operatorname{Prob}(s \mid \theta_P, \theta_A) \nu^*(\theta_P \mid \theta_A, m, d); \tag{A.19}$$

and

4. μ^* *and* ν^* *are derived from* m^* *and* d^* *using Bayes' rule whenever possible. Otherwise,* μ^* *and* ν^* *are any probability distributions satisfying* $\mu^*(\theta_A = m \mid \theta_P, m \neq \phi) = 1$.

Furthermore, a PBE is optimal if no other PBE strictly makes the principal better off.

The restriction $\mu^*(\theta_A = m \mid \theta_P, m \neq \phi) = 1$ imposed by Definition 1-4 is a standard requirement in disclosure games (Milgrom, 1981) and guarantees the certifiability of messages in that the principal believes the agent's signal to be θ_A after receiving $m = \theta_A$ even off the equilibrium path. Hereinafter, this restriction is referred to as *certifiability*.

Given PBE $\mathcal{E}^*$ and message $m \in M$, $\mathcal{E}^*(m) \equiv (d^*(\cdot, m), e^*(\cdot, m, \cdot); \mu^*(\cdot, m), \nu^*(\cdot, m, \cdot))$ is said to be a *continuation PBE after message* m. The *expected continuation payoff after message* m is the principal's expected payoff in the continuation game after message m, which is defined by

$$\sum_{\theta_P \in \Theta} \sum_{\theta_A \in \Theta} \sum_{s \in S} Bx\left(s, d^*(\theta_P, m), e^*\left(\theta_A, m, d^*(\theta_P, m)\right)\right)$$

$$\times \operatorname{Prob}(s \mid \theta_P, \theta_A, m) \mu^*(\theta_A \mid \theta_P, m) \operatorname{Prob}(\theta_P). \tag{A.20}$$

We say that given message m, a continuation PBE after message m is *optimal* if no other continuation PBE after message m induces a strictly higher expected continuation payoff.

Given continuation assessment $\mathcal{E}^*(m)$, the expected payoff of the agent with θ_A from message m is denoted by

$$V^*(\theta_A, m) \equiv \sum_{\theta_P \in \Theta} \sum_{s \in S} \left[bx\left(s, d^*(\theta_P, m), e^*(\theta_A, m, d^*(\theta_P, m))\right)\right.$$

$$\left. - ce^*\left(\theta_A, m, d^*(\theta_P, m)\right)\right] \operatorname{Prob}(s \mid \theta_P, \theta_A) \operatorname{Prob}(\theta_P \mid \theta_A). \tag{A.21}$$

Note that assessment $\mathcal{E}^*$ is a PBE if and only if the continuation assessment $\mathcal{E}^*(m)$ is a continuation PBE after message m for each $m \in \{1, -1, \phi\}$ and $m^*(\theta_A) \in \arg\max_{m \in M(\theta_A)} V^*(\theta_A, m)$ for each $\theta_A \in \{1, -1\}$. With abuse of some notation, PBE $\mathcal{E}^*$ is also represented by $\mathcal{E}^* = (m^*, (\mathcal{E}^*(m))_{m \in M})$.

The formal definition of our key notion, *rubber-stamping*, *empowerment*, and *strategic silence*, is as follows. Let $\sigma^* \equiv (d^*, (m^*, e^*))$ and $\sigma^*(m) \equiv (d^*(\cdot, m), e^*(\cdot, m, \cdot))$ be a strategy profile and a continuation strategy profile after message m in the ACE model, respectively.

Definition 2. *1. Continuation strategy profile* $\{\sigma^*(m)\}_{m \in M}$ *induces rubber-stamping if*

(a) $d^*(\theta_P, m) = m$ *for any* $\theta_P \in \Theta$ *and* $m \in \{1, -1\}$*, and;*

(b) $e^*(\theta_A, m = \theta_A, d = m) = 1$ *for each* $\theta_A \in \Theta$.

2. *Strategy profile* σ^* *constitutes empowerment if*

   (a) *its continuation strategy profile* $\{\sigma^*(m)\}_{m \in M}$ *induces rubber-stamping; and*

   (b) $m^*(\theta_A) = \theta_A$ *for any* $\theta_A \in \Theta$.

3. *The agent is strategically silent given strategy profile* σ^* *if*

   (a) *its continuation strategy profile* $\{\sigma^*(m)\}_{m \in M}$ *induces rubber-stamping; and*

   (b) $V^*(\theta_A, m = \phi) > V^*(\theta_A, m = \theta_A)$ *for some* $\theta_A \in \Theta$.

A.2.2 Auxiliary Claims

In the ACE model, as the continuation PBEs must be optimal by Requirement 1-3, we characterize the optimal continuation PBEs as the preliminary results. Specifically, we provide five claims on the optimal continuation PBEs. The proofs are in Appendix B.3.

The first claim characterizes the continuation PBEs after message $m \neq \phi$, a building block for the subsequent arguments.

Claim 1. *Consider the continuation game after message* $m \neq \phi$. *Suppose that there is a continuation PBE that satisfies* $d^*(\theta_P, m) = m$ *for each* θ_P.

1. *When* $v < v^D$, *the equilibrium satisfies*

   (a) $e^*(\theta_A, m = \theta_A, d = m; v) = 0$ *for all* θ_A*; and*

   (b) *that the principal's expected continuation payoff is zero.*

2. *When* $v \geq v^D$, *the equilibrium satisfies*

   (a) $e^*(\theta_A, m = \theta_A, d = m; v) = 1$ *for all* θ_A*; and*

(b) *that the principal's expected continuation payoff is*

$$\frac{q_A}{2}\left[\frac{q_P}{q_Pq_A+(1-q_P)(1-q_A)}+\frac{1-q_P}{q_P(1-q_A)+(1-q_P)q_A}\right]B. \tag{A.22}$$

The following three claims are useful for characterizing optimal continuation PBEs after message $m \neq \phi$.

Claim 2. *Consider the continuation game after message $m \neq \phi$.*

1. *Suppose that there is a continuation PBE that satisfies $d^*(\theta_P, m \neq \phi) = \theta_P$ for each θ_P. Then, the following holds.*

   (a) $v \notin [v_0^C, v_1^C)$.

   (b) *If $v \geq v_1^C$, then $e^*(\theta_A, m = \theta_A, d; v) = 1$ for any d, and the expected continuation payoff is*

$$\frac{q_P}{2}\left[\frac{q_A}{q_Pq_A+(1-q_P)(1-q_A)}+\frac{1-q_A}{q_P(1-q_A)+(1-q_P)q_A}\right]B. \tag{A.23}$$

   (c) *If $v < v_0^C$, then $e^*(\theta_A, m = \theta_A, d; v) = 0$ for any d, and the expected continuation payoff is zero.*

2. *When $q_P \geq q_A$ and $v \geq v_1^C$, there exists a continuation PBE such that $d^*(\theta_P, m \neq \phi) = \theta_P$ for each θ_P and $e^*(\theta_A, m = \theta_A, d; v) = 1$ for each d.*

Claim 3. *Consider the continuation game after message $m \neq \phi$.*

1. *Suppose that $v < \min\{v^D, v_1^C\}$. Then, in any continuation PBE,*

   (a) $e^*(\theta_A, m = \theta_A, d; v) = 0$ *for all θ_A and d, and*

   (b) *the expected continuation payoff is zero.*

Hence, any continuation PBE is optimal.

2. *Suppose that $v \geq \min\{v^D, v_1^C\}$. Then, in any optimal continuation PBE, either*

   (a) *$d^*(\theta_P, m) = m$ for each θ_P; or*

   (b) *$d^*(\theta_P, m) = \theta_P$ for each θ_P.*

Claim 4. *Consider the continuation game after message $m \neq \phi$, and suppose that either one of the following holds: (i) $q_A < q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$, or (ii) $q_P \leq q_A$ and $v \geq v^D$.*

1. *There exists an optimal continuation PBE in which rubber-stamping is induced.*

2. *Suppose, furthermore, that $v < v_1^C$ holds when $q_P = q_A$. Then, rubber-stamping must be induced in any optimal continuation PBE.*

The final is for characterizing optimal continuation PBEs after message $m = \phi$.

Claim 5. *Consider the continuation game after message $m = \phi$. Suppose that $v \geq v_0^C$ and the principal has a belief such that $\mu^*(\cdot \mid \theta_P, m = \phi) = \mathrm{Prob}(\cdot \mid \theta_P)$ for each θ_P. Then, there exists a unique optimal continuation PBE that*

1. *is identical to the optimal PBE in centralization; and*

2. *induces the expected continuation payoff $U^C(v)$.*

A.2.3 Proof of Lemma 3

Lemma 3 is a corollary of the following claim.

Claim 6. *Suppose that $U^C(v) < U^D(v)(= q_A B)$.*

1. *There exists an optimal PBE $\mathcal{E}^* = \left(m^*, (\mathcal{E}^*(m))_{m \in M}\right)$ such that*

(a) for $m \neq \phi$, continuation strategy profile $\{\sigma^*(m)\}_{m \in M}$ induces rubber-stamping:

$$\begin{cases} d^*(\theta_P, m) = m & \text{for each } \theta_P, \\ e^*(\theta_A, m = \theta_A, d = m) = 1 & \text{for each } \theta_A, \end{cases} \tag{A.24}$$

(b) $\mathcal{E}^*(\phi)$ satisfies

$$\mu^*(\cdot \mid \theta_P, m = \phi) = \text{Prob}(\cdot \mid \theta_P) \text{ for each } \theta_P,$$

$$d^*(\theta_P, m = \phi) = \theta_P \text{ for each } \theta_P, \tag{A.25}$$

$$e^*(\theta_A, m = \phi, d) = \begin{cases} 1 & \text{if } [v \geq v_1^C] \text{ or } [v^D \leq v < v_1^C \text{ and } d = \theta_A], \\ 0 & \text{otherwise}, \end{cases} \tag{A.26}$$

(c) $m^*(\theta_A) = \theta_A$ if and only if $V^*(\theta_A, m = \theta_A) \geq V^*(\theta_A, m = \phi)$, and

(d) The principal's payoff is

$$U^*(v) = \begin{cases} q_A B & \text{if } V^*(\theta_A, m = \theta_A) \geq V^*(\theta_A, m = \phi), \\ U^C(v)(< q_A B) & \text{if } V^*(\theta_A, m = \theta_A) < V^*(\theta_A, m = \phi). \end{cases}$$

2. *The principal's equilibrium payoff is $U^*(v) = q_A B$ if and only if the equilibrium constitutes empowerment.*

Proof (Claim 6)**.** As $U^C(v) < U^D(v)$, Proposition 2-3 implies either $q_A \leq q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$ or $q_P < q_A$ and $v \geq v^D$. Then, by Claim 4-1, there exists an optimal continuation PBE $\mathcal{E}^*(m)$ for $m \neq \phi$ specified by (A.24). Likewise, by Claim 5, there exists an optimal continuation PBE $\mathcal{E}^*(\phi)$ specified by (A.25) and (A.26). By construction, each type of the agent has no incentive to deviate from m^*. Furthermore, either $m^*(\theta_A) = \theta_A$ for each θ_A or $m^*(\theta_A) = \phi$ for each θ_A since both $V^*(\theta_A = 1, m = 1) = V^*(\theta_A = -1, m = -1)$ and $V^*(\theta_A = 1, m = \phi) = V^*(\theta_A = -1, m = \phi)$. Hence, $\mathcal{E}^*$ is a PBE of the entire game satisfying

Requirement 1. By the construction of $\mathcal{E}^*$, when $V^*(\theta_A, m = \theta_A) \geq V^*(\theta_A, m = \phi)$, the players choose the actions specified by (A.24), which constitutes empowerment, and then the principal's *ex ante* expected payoff is $U^*(v) = q_A B$. When $V^*(\theta_A, m = \theta_A) < V^*(\theta_A, m = \phi)$, the players choose the actions specified by (A.25) and (A.26), which does not constitute empowerment, and then the principal's *ex ante* expected payoff is $U^*(v) = U^C(v)$ as characterized in Proposition 1. As $U^C(v) < U^D(v)(= q_A B)$, the equilibrium payoff satisfies $U^C(v) \leq U^*(v) \leq q_A B$.

We now demonstrate that $\mathcal{E}^*$ is optimal. Consider an arbitrary optimal PBE $\tilde{\mathcal{E}} \equiv (\tilde{m}, (\tilde{\mathcal{E}}(m))_{m \in M})$, and let $\tilde{V}(\theta_A, m)$ be the agent's *interim* expected payoff and $\tilde{U}(v)$ be the principal's *ex ante* expected payoff in PBE $\tilde{\sigma}$. Claims 4-2 and 5 imply that the chosen actions on any optimal continuation PBE are uniquely determined. Hence, as long as Requirements 1-2 and 1-3 hold, for each $m \in \{1, -1, \phi\}$, the players' continuation payoffs under $\tilde{\mathcal{E}}(m)$ must be the same as those under $\mathcal{E}^*(m)$. Then, $\tilde{V}(\theta_A, m) = V^*(\theta_A, m)$ holds for each θ_A and m. By Requirement 1-1, either $\tilde{m}(\theta_A) = \phi$ for each θ_A or $\tilde{m}(\theta_A) = \theta_A$ for each θ_A. In the former case, for $\tilde{\mathcal{E}}$ to be an optimal PBE, $\tilde{V}(\theta_A, m = \theta_A) < \tilde{V}(\theta_A, m = \phi)$ must hold for each θ_A, which implies that $\tilde{U}(v) = U^C(v)$. As $\tilde{V}(\theta_A, m) = V^*(\theta_A, m)$, $U^*(v) = \tilde{U}(v) = U^C(v)$ holds. In the latter case, for $\tilde{\mathcal{E}}$ to be an optimal PBE, $\tilde{V}(\theta_A, m = \theta_A) \geq \tilde{V}(\theta_A, m = \phi)$ must hold for each θ_A, which implies that $\tilde{U}(v) = q_A B$. Then, since $\tilde{V}(\theta_A, m) = V^*(\theta_A, m)$, $U^*(v) = \tilde{U}(v) = q_A B$ holds. Therefore, we conclude that $\mathcal{E}^*$ is optimal.

Finally, the construction of $\tilde{\mathcal{E}}$ above implies that any optimal PBE satisfies $U^*(v) \leq q_A B$, where the equality holds if and only if the equilibrium constitutes empowerment. ■

A.2.4 Proof of Proposition 3

The following claim is useful for proving the necessary condition of the existence of empowerment equilibrium.

Claim 7. *There exists an empowerment equilibrium only when $v \geq v^D$.*

Proof (Claim 7). Suppose to the contrary that there exists an empowerment equilibrium when $v < v^D$. By the definition of empowerment equilibria, $m^*(\theta_A) = \theta_A$ for each θ_A on the equilibrium path. However, Claim 1 implies that if $v < v^D$, then $e^*(\theta_A, m = \theta_A, d = \theta_A) = 0$ for all θ_A, which contradicts the definition of the empowerment equilibrium. ■

(Necessity) Suppose that there exists an empowerment equilibrium. By Claim 7, $v \geq v^D$ must hold. As the principal chooses project $d = m$, Claim 1 implies that the agent always executes the project on the equilibrium path. Hence, the agent's equilibrium payoff is $V^*(\theta_A, m = \theta_A) = q_A b - c$. Now, suppose that the agent deviates to $m = \phi$. As $v^D > v_0^C$, Requirements 1-2 and 1-3, as well as Claim 5, imply that the parties' actions in the continuation game after message $m = \phi$ are given by Lemmas 1 and 2. Then, the agent's expected payoff from deviation is expressed as

$$V^*(\theta_A, m = \phi) = \begin{cases} q_P b - c & \text{if } v \geq v_1^C, \\ q_P q_A b - [q_P q_A + (1-q_P)(1-q_A)]c & \text{if } v^D \leq v < v_1^C. \end{cases} \tag{A.27}$$

Hence, the difference in the payoffs is computed as

$$\begin{cases} (q_A - q_P)b & \text{if } v \geq v_1^C, \\ (1-q_P)q_A b - [q_P(1-q_A) + (1-q_P)q_A b]c & \text{if } v^D \leq v < v_1^C. \end{cases} \tag{A.28}$$

As there exists an empowerment equilibrium, (A.28) must be non-negative; otherwise, the agent has the incentive to deviate to $m = \phi$. Note that $(1-q_P)q_A b - [q_P(1-q_A) + (1-q_P)q_A b]c \geq 0$ if and only if $v \geq v^E$. Then, (A.28) is non-negative if and only if either (i) $q_P \leq q_A$ and $v \geq v_1^C$, or (ii) $v^E \leq v < v_1^C$. By taking into account that (a) $v^E \leq v_1^C$ if and only if $q_P \leq q_A$, and (b) $v^E > v^D$ if $q_P \leq q_A$, we observe that (A.28) is non-negative if and only if $q_P \leq q_A$ and $v \geq v^E$.

(Sufficiency) Suppose that $q_P \leq q_A$ and $v \geq v^E$. As $v \geq v^E > v^D$, Proposition 2-3 implies that $U^C(v) < U^D(v)(= q_A B)$. Hence, there exists an optimal PBE specified in Claim 6, where the agent's expected payoffs from $m = \theta_A$ and $m = \phi$ are represented by $V^*(\theta_A, m = \theta_A) = q_A b - c$ and (A.27), respectively. As the payoff difference (A.28) is non-negative as long as $q_P \leq q_A$ and $v \geq v^E$, the optimal PBE satisfies $m^*(\theta_A) = \theta_A$ for each θ_A, which implies that the equilibrium constitutes empowerment. ■

A.2.5 Proof of Corollary 1

Proposition 2-3 implies that $U^C(v) < U^D(v)$ if and only if either (i) $q_A \leq q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$, or (ii) $q_P < q_A$ and $v \geq v^D$.

Suppose that $U^*(v) < U^D(v)$. In both cases (i) and (ii), we obtain $q_P < \hat{q}_P(q_A)$. Then, we show $v^D \leq v < \min\{v^E, v_1^C\}$. Note that $v_1^C \leq v^E$ if and only if $q_P \geq q_A$. By Lemma 3, empowerment equilibria never exist. Hence, Proposition 3 implies that either $q_P > q_A$ or $v < v^E$ must hold. Suppose that case (i) holds. If $q_P > q_A$, then since $v^E > v_1^C$, we obtain $v^D \leq v < v_1^C = \min\{v^E, v_1^C\}$. If $v < v^E$ and $q_P \leq q_A$, then $v^D \leq v < v^E = \min\{v^E, v_1^C\}$. Suppose next that case (ii) holds, which implies $v < v^E$. Since $q_P < q_A$ implies $v^E < v_1^C$, we have $v^D \leq v < v^E = \min\{v^E, v_1^C\}$.

Suppose that $q_P < \hat{q}_P(q_A)$ and $v^D \leq v < \min\{v^E, v_1^C\}$. Since $v < v^E$, Proposition 3 implies that there exists no empowerment equilibrium. Therefore, by Lemma 3, $U^*(v) < U^D(v)$. ■

A.2.6 Proof of Proposition 4

(Necessity) We show the statement by contraposition: if $q_P \leq q_A$ and $v \geq v^E$, then there exists an optimal PBE in which the agent is not strategically silent. Suppose $q_P \leq q_A$ and $v \geq v^E$. By Proposition 3, there exists an empowerment equilibrium. Evidently, the agent is not strategically silent there.

(Sufficiency) Suppose that $q_P > q_A$ or $v < v^E$ holds. Furthermore, suppose to the contrary that there exists an optimal PBE $\mathcal{E}^*$ satisfying Requirement 1 in which the agent is not strategically silent. Then, $\mathcal{E}^*$ satisfies either one of the following: (i) there exists θ_P and $m \neq \phi$ such that $d^*(\theta_P, m) \neq m$, (ii) there exists θ_A such that $e^*(\theta_A, m = \theta_A, d = m) \neq 1$, or (iii) $V^*(\theta_A, m = \theta_A) \geq V^*(\theta_A, m = \phi)$ for any θ_A. As $U^C(v) < U^D(v)$, $v \geq v^D$ must hold by Proposition 2-3. Hence, by Claim 1-2, (ii) is never satisfied. Now, suppose that (i) holds. By Claim 3-2, $d^*(\theta_P, m) = \theta_P$ must hold for any θ_P and $m \neq \phi$. However, by Claim 2-1, $v \notin [v_0^C, v_1^C)$ must hold, which is a contradiction because of $v_0^C < v^D \leq v < v^E < v_1^C$. Hence, only (iii) holds, implying that if $m \neq \phi$, then $d = m$ and $e = 1$ follow for any θ_P and θ_A. Hence, we have $V^*(\theta_A, m = \theta_A) = q_A b - c$. Because of Requirement 1-2, $\mu^*(\theta_A \mid \theta_P, m = \phi) = \text{Prob}(\theta_A \mid \theta_A)$. Requirement 1-3, Claim 5, and Lemmas 1 and 2 imply that the optimal continuation PBE after $m = \phi$ is identical to that under centralization. Hence, we have $V^*(\theta_A, m = \phi) = q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_A)]c$ because of $v_0^C < v^D \leq v < v^E < v_1^C$. However, as $v < v^E$, $V^*(\theta_A, m = \phi) > V^*(\theta_A, m = \theta_A)$ holds for any θ_A, which is a contradiction. ■

A.2.7 Proof of Corollary 2

It is immediate from Propositions 3 and 4. ■

A.2.8 Proof of Lemma 4

Claim 7 implies that there exists an empowerment equilibrium only when $v \geq v^D$. As Requirements 1-2 and 1-3 are imposed on the empowerment equilibrium and $v \geq v^D > v_0^C$, Claim 5 immediately implies the result. ■

A.2.9 Proof of Corollary 3

Suppose that $U^C(v) < U^D(v)$, or equivalently either (i) $q_A \leq q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$ or (ii) $q_P < q_A$ and $v \geq v^D$ by Proposition 2-3.

Suppose $q_P > \bar{q}_P(q_A, v)$. As $q_P > \bar{q}_P(q_A, v)$ is equivalent to $v < v^E$, Proposition 3 immediately implies that there is no empowerment equilibrium. Therefore, by Claim 6-2, $U^*(v) < U^D(v) = (q_A B)$ holds.

Suppose that $q_P \leq \bar{q}_P(q_A, v)$. Furthermore, suppose, on the contrary, that case (i) holds. As $v_1^C \leq v^E$, we have $v < v^E$. However, it contradicts $q_P \leq \bar{q}_P(q_A, v)$ or, equivalently, $v \geq v^E$. Then, case (ii) must hold. Then, as $q_P < q_A$ and $v \geq v^E$, Proposition 3 implies that there is an empowerment equilibrium. Therefore, by Claim 6-2, we have $U^*(v) = U^D(v)(= q_A B)$.

The second part of Corollary 3 is straightforward by Proposition 2-2. ■

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B Omitted Results (for Online Appendix)

This section provides the formal representation and definition in the benchmark analysis and the omitted proofs in Appendix A.2.

B.1 Centralization

Centralization in Section 2 can be regarded as a continuation game after message $m = \phi$ given that $m^*(\theta_A) = \phi$ for any θ_A. The strategies and beliefs under centralization are defined by $(d^C, e^C; \nu^C)$, where

$$\begin{aligned} d^C(\theta_P) &\equiv d^*(\theta_P, m = \phi), \\ e^C(\theta_A, d) &\equiv e^*(\theta_A, m = \phi, d), \\ \nu^C(\theta_P \mid \theta_A, d) &\equiv \nu^*(\theta_P \mid \theta_A, m = \phi, d), \end{aligned} \tag{B.1}$$

given $m^*(\theta_A) = \phi$ for any θ_A.[36] A PBE under centralization is defined similarly to that in the ACE model. We say that a PBE is *optimal* under centralization if it is an optimal continuation PBE after message $m = \phi$ with $\mu^*(\theta_A \mid \theta_P, m = \phi) = \text{Prob}(\theta_A \mid \theta_P)$. Given PBE $(d^C, e^C; \nu^C)$, the principal's *ex ante* PBE payoff is defined as

$$U^C(v) \equiv \sum_{\theta_P \in \Theta} \sum_{\theta_A \in \Theta} \sum_{s \in S} Bx\left(s, d^C(\theta_P), e^C\left(\theta_A, d^C(\theta_P)\right)\right) \text{Prob}(s \mid \theta_P, \theta_A)\text{Prob}(\theta_A \mid \theta_P)\text{Prob}(\theta_P). \tag{B.2}$$

[36] The principal's belief is defined as $\mu^C(\theta_A \mid \theta_P) \equiv \mu^*(\theta_A \mid \theta_P, m = \phi) = \text{Prob}(\theta_A \mid \theta_P)$, which does not need to be explicitly discussed in the benchmark analysis.

B.2 Formal Delegation

Let $d^D : \Theta \to D$ and $e^D : \Theta \times D \to E$ represent the agent's project choice and execution decision under formal delegation.[37]

Definition 3. *A double (d^D, e^D) is a PBE under formal delegation if*

1. *for any $\theta_A \in \Theta$,*

$$d^D(\theta_A) \in \arg\max_{d \in D} \sum_{s \in S} \left[bx(s, d, e^D(\theta_A, d)) - ce^D(\theta_A, d) \right] \text{Prob}(s \mid \theta_A); \tag{B.3}$$

and

2. *for any $\theta_A \in \Theta$ and $d \in D$,*

$$e^D(\theta_A, d) \in \arg\max_{e \in E} \sum_{s \in S} [bx(s, d, e) - ce] \text{Prob}(s \mid \theta_A). \tag{B.4}$$

The optimal PBE under formal delegation is defined similarly to under centralization. The principal's *ex ante* PBE payoff $U^D(v)$ is similarly defined as in (B.2).

B.3 Omitted Proof in Appendix A.2

B.3.1 Proof of Claim 1

Without loss of generality, suppose that $\theta_A = m = 1$, implying $\mu^*(\theta_A = 1 \mid \theta_P, m = 1) = 1$ because of Bayes' rule or certifiability. Suppose that there is a continuation PBE that satisfies $d^*(\theta_P, m) = m$ for each θ_P. Given d^*, Bayes' rule implies that the agent's confidence after observing $d = 1$ is $\text{Prob}(s = d \mid \theta_A = 1, m = 1, d = 1) = q_A$. Hence, (1) implies that his best response to this confidence is $e^*(\theta_A, m = \theta_A, d = \theta_A) = 1$ if and only if $v \geq v^D$. Furthermore,

[37] As the agent's beliefs about θ_P in the choice and the execution stages are identical to the prior, their explicit representation is omitted.

as $\text{Prob}(\theta_P = 1) = 1/2$,

$$\text{Prob}(s \mid \theta_P, \theta_A = 1) = \begin{cases} \dfrac{q_P q_A}{q_P q_A + (1-q_P)(1-q_A)} & \text{if } s = 1 \text{ and } \theta_P = 1, \\ \dfrac{(1-q_P)(1-q_A)}{q_P q_A + (1-q_P)(1-q_A)} & \text{if } s = -1 \text{ and } \theta_P = 1, \\ \dfrac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A} & \text{if } s = -1 \text{ and } \theta_P = -1, \\ \dfrac{(1-q_P)q_A}{q_P(1-q_A) + (1-q_P)q_A} & \text{if } s = 1 \text{ and } \theta_P = -1. \end{cases} \tag{B.5}$$

Hence, (A.20) implies that the expected continuation payoff must be

$$\begin{cases} \dfrac{q_A}{2}\left[\dfrac{q_P}{q_P q_A + (1-q_P)(1-q_A)} + \dfrac{1-q_P}{q_P(1-q_A) + (1-q_P)q_A}\right] B & \text{if } v \geq v^D, \\ 0 & \text{otherwise,} \end{cases} \tag{B.6}$$

which completes the first statement. ■

B.3.2 Proof of Claim 2

The following claim is essential for the proof of Claim 2.

Claim 8. *Consider the continuation game after message $m \neq \phi$. When $q_P \leq q_A$ or $v < \bar{v}_0 \equiv 1/(1-q_A)$, there is a continuation PBE that satisfies $d^*(\theta_P, m) = m$ for each θ_P.*

Proof (Claim 8)**.** Suppose $q_P \leq q_A$ or $v < \bar{v}_0$, and consider the following profile in the continuation game after $m = 1$:

$$d^*(\theta_P, m=1) = 1,$$
$$e^*(\theta_A = 1, m=1, d; v) = \begin{cases} 1 & \text{if } [v \geq \bar{v}_0] \text{ or } [v^D \leq v < \bar{v}_0 \text{ and } d = 1], \\ 0 & \text{otherwise,} \end{cases}$$
$$\mu^*(\theta_A \mid \theta_P, m=1) = \begin{cases} 1 & \text{if } \theta_A = 1, \\ 0 & \text{if } \theta_A = -1, \end{cases} \tag{B.7}$$
$$\nu^*(\theta_P \mid \theta_A = 1, m=1, d) = \text{Prob}(\theta_P \mid \theta_A = 1) \text{ for any } d.$$

Given ν^*, the agent's confidence is $\text{Prob}(s = d \mid \theta_A = 1, m = 1, d = 1, \nu^*) = q_A$ and $\text{Prob}(s = d \mid \theta_A = 1, m = 1, d = -1, \nu^*) = 1 - q_A$, implying that e^* satisfies (1). Given e^*, μ^*, $m = \theta_A = 1$, and θ_P, the principal has a belief as in (B.5) in the choice stage. When $\theta_P = 1$, the continuation payoffs are

$$\begin{cases} \dfrac{q_P q_A}{q_P q_A + (1-q_P)(1-q_A)} B \mathbb{1}(v \geq v^D) & \text{if } d = 1, \\ \dfrac{(1-q_P)(1-q_A)}{q_P q_A + (1-q_P)(1-q_A)} B \mathbb{1}(v \geq \bar{v}_0) & \text{if } d = -1. \end{cases} \tag{B.8}$$

Owing to $q_P q_A > (1-q_P)(1-q_A)$ and $\mathbb{1}(v \geq v^D) \geq \mathbb{1}(v \geq \bar{v}_0)$, the principal does not deviate to $d = -1$. Similarly, the continuation payoffs when $\theta_P = -1$ are

$$\begin{cases} \dfrac{(1-q_P)q_A}{q_P(1-q_A) + (1-q_P)q_A} B \mathbb{1}(v \geq v^D) & \text{if } d = 1, \\ \dfrac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A} B \mathbb{1}(v \geq \bar{v}_0) & \text{if } d = -1. \end{cases} \tag{B.9}$$

The principal does not deviate to $d = -1$ if and only if the payoff difference

$$\frac{(1-q_P)q_A \mathbb{1}(v \geq v^D) - q_P(1-q_A)\mathbb{1}(v \geq \bar{v}_0)}{q_P(1-q_A) + (1-q_P)q_A} B \tag{B.10}$$

is non-negative. When $v < \bar{v}_0$, as $\mathbb{1}(v \geq \bar{v}_0) = 0$, (B.10) is non-negative. When $v \geq \bar{v}_0$ and $q_P \leq q_A$, as $\mathbb{1}(v \geq v^D) = \mathbb{1}(v \geq \bar{v}_0) = 1$, (B.10) is

$$\frac{q_A - q_P}{q_P(1-q_A) + (1-q_P)q_A} B, \tag{B.11}$$

which is non-negative. Then, d^* satisfies Definition 1-2. As μ^* and ν^* are consistent with Bayes' rule, (B.7) is a continuation PBE after $m = \theta_A$. ■

Proof (Claim 2)**.** As in the proof of Claims 1 and 8, without loss of generality, suppose that $\theta_A = m = 1$ and $\mu^*(\theta_A = 1 \mid \theta_P, m = 1) = 1$. Suppose that there exists a continuation PBE satisfying $d^*(\theta_P, m = 1) = \theta_P$ for each θ_P. Given d^*, Bayes' rule implies that the agent's confidence is given as (2). Hence, (1) implies that his best response is characterized as in (A.2): $e^*(\theta_A = 1, m = 1, d) = 1$ if and only if either (i) $v \geq v_1^C$, or (ii) $v_0^C \leq v < v_1^C$ and $d = 1$ (i.e., $\theta_P = \theta_A$). Therefore, the expected continuation payoffs for $v < v_0^C$ and $v \geq v_1^C$ are zero and expressed as (A.23), respectively.

We now show that when $v_0^C \leq v < v_1^C$, there is no continuation PBE such that $d^*(\theta_P, m = 1) = \theta_P$ for each θ_P. Suppose, on the contrary, that such an equilibrium exists. Given d^*, the agent's confidence is represented by (2). Hence, we have $e^*(\theta_A = 1, m = 1, d) = 1$ if and only if either (i) $v \geq v_1^C$, or (ii) $v_0^C \leq v < v_1^C$ and $d = 1$. For $\theta_P = -1$, Bayes' rule or certifiability implies that $\mu^*(\theta_A = 1 \mid \theta_P = -1, m = 1) = 1$. Then, the continuation payoffs from $d = -1$ and 1 are

$$\begin{cases} \dfrac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A} B\mathbb{1}(v \geq v_1^C) & \text{if } d = -1, \\ \dfrac{(1-q_P)q_A}{q_P(1-q_A) + (1-q_P)q_A} B\mathbb{1}(v \geq v_0^C) & \text{if } d = 1. \end{cases} \tag{B.12}$$

As $v_0^C \leq v < v_1^C$, the former is zero, whereas the latter is positive. Then, the principal with $\theta_P = -1$ strictly prefers to deviate to $d = 1$, which is a contradiction.

Finally, we show that when $q_P \geq q_A$ and $v \geq v_1^C$, the following profile is a continuation PBE after message $m = 1$:

$$\begin{aligned}
d^*(\theta_P, m = 1) &= \theta_P, \\
e^*(\theta_A = 1, m = 1, d; v) &= 1 \text{ for each } d, \\
\mu^*(\theta_A \mid \theta_P, m = 1) &= \begin{cases} 1 & \text{if } \theta_A = 1, \\ 0 & \text{if } \theta_A = -1, \end{cases} \\
\nu^*(\theta_P \mid \theta_A = 1, m = 1, d) &= \begin{cases} 1 & \text{if } \theta_P = d, \\ 0 & \text{otherwise.} \end{cases}
\end{aligned} \tag{B.13}$$

As confirmed above, e^* satisfies (1) because $v \geq v_1^C$. As the continuation payoffs from $d = -1$ and 1 when $\theta_P = -1$ are expressed as (B.12), $q_P \geq q_A$ implies that the principal does not deviate to $d = 1$. When $\theta_P = 1$, the continuation payoffs are expressed as

$$\begin{cases} \dfrac{q_P q_A}{q_P q_A + (1 - q_P)(1 - q_A)} B & \text{if } d = 1, \\ \dfrac{(1 - q_P)(1 - q_A)}{q_P q_A + (1 - q_P)(1 - q_A)} B & \text{if } d = -1. \end{cases} \tag{B.14}$$

As $q_P q_A > (1 - q_P)(1 - q_A)$, the principal does not deviate $d = -1$. Then, d^* satisfies Definition 1-2. As μ^* and ν^* are consistent with Bayes' rule, (B.13) is a continuation PBE after $m = \theta_A$. ■

B.3.3 Proof of Claim 3

Again, without loss of generality, suppose that $\theta_A = m = 1$ and $\mu^*(\theta_A = 1 \mid \theta_P, m = 1) = 1$. For any continuation PBE, either of the following four cases must hold: (i) $d^*(\theta_P, m = 1) = 1$ for each θ_P; (ii) $d^*(\theta_P, m = 1) = \theta_P$ for each θ_P; (iii) $d^*(\theta_P, m = 1) = -\theta_P$ for each θ_P; and (iv) $d^*(\theta_P, m = 1) = -1$ for each θ_P. The continuation payoffs in cases (i) and (ii) (given that such

PBEs exist) are characterized by Claims 1 and 2-1, respectively. Then, we first characterize the continuation payoffs in cases (iii) and (iv).

When a continuation PBE satisfies case (iii), given d^*, Bayes' rule implies that the agent's confidence is given as in (A.8). Hence, (1) implies that the agent's best response is characterized as in (A.9): $e^*(\theta_A = 1, m = 1, d; v) = 1$ if and only if either (a) $v \geq \bar{v}_1$ or (b) $v^E \leq v < \bar{v}_1$ and $d = 1$. Therefore, (A.20) implies that the expected continuation payoff is

$$\begin{cases} \dfrac{1-q_P}{2}\left[\dfrac{1-q_A}{q_P q_A + (1-q_P)(1-q_A)} + \dfrac{q_A}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v \geq \bar{v}_1, \\ \dfrac{1}{2}\left[\dfrac{(1-q_P)q_A}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v^E \leq v < \bar{v}_1, \\ 0 & \text{otherwise.} \end{cases} \tag{B.15}$$

Likewise, when a continuation PBE satisfies case (iv), given d^*, Bayes' rule implies that the agent's confidence after observing $d = -1$ is $\text{Prob}(s = d \mid \theta_A = 1, m = 1, d = -1) = 1 - q_A$. Hence, (1) implies that the agent's best response is characterized as in (A.6): $e^*(\theta_A = 1, m = 1, d = -1; v) = 1$ if and only if $v \geq \bar{v}_0$. Therefore, (A.20) implies that the expected continuation payoff is

$$\begin{cases} \dfrac{1-q_A}{2}\left[\dfrac{1-q_P}{q_P q_A + (1-q_P)(1-q_A)} + \dfrac{q_P}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v \geq \bar{v}_0, \\ 0 & \text{otherwise.} \end{cases} \tag{B.16}$$

When $v < \min\{v^D, v_1^C\}$, since $v < v^D < \min\{v^E, \bar{v}_0\}$, by (B.15), (B.16), and Claims 1 and 2-1, the expected continuation payoff must be zero on any continuation PBE. This means that any continuation PBE is optimal.

In the following, suppose $v \geq \min\{v^D, v_1^C\}$. There are two cases to be investigated. First, suppose $q_P \leq q_A$ or $v^D \leq v < \bar{v}_0$. When $q_P \leq q_A$, we have $v \geq \min\{v^D, v_1^C\} = v^D$. Then, by Claims 1 and 8, there exists a continuation PBE of case (i), on which the expected continuation payoff is expressed by (A.22). The difference between (A.22) and (B.15) is

$$\begin{cases} \left[\dfrac{q_P+q_A-1}{q_Pq_A+(1-q_P)(1-q_A)}\right]\dfrac{B}{2} & \text{if } v \geq \bar{v}_1, \\ \left[\dfrac{q_Pq_A}{q_Pq_A+(1-q_P)(1-q_A)}\right]\dfrac{B}{2} & \text{if } v^E \leq v < \bar{v}_1, \\ \dfrac{q_A}{2}\left[\dfrac{q_P}{q_Pq_A+(1-q_P)(1-q_A)}+\dfrac{1-q_P}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v^D \leq v < v^E, \end{cases} \tag{B.17}$$

which is positive for all $v \geq v^D$. As $\bar{v}_0 > v^D$, the difference between (A.22) and (B.16) is

$$\begin{cases} \dfrac{1}{2}\left[\dfrac{q_P+q_A-1}{q_Pq_A+(1-q_P)(1-q_A)}+\dfrac{q_A-q_P}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v \geq \bar{v}_0, \\ \dfrac{q_A}{2}\left[\dfrac{q_P}{q_Pq_A+(1-q_P)(1-q_A)}+\dfrac{1-q_P}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v^D \leq v < \bar{v}_0, \end{cases} \tag{B.18}$$

which is positive for all $v \geq v^D$ and $q_P \leq q_A$. Therefore, no continuation PBE of case (iii) or (iv) is optimal.

Second, suppose $q_P > q_A$ and $v \notin [v^D, \bar{v}_0)$. If $\min\{v^D, v_1^C\} = v_1^C$, then $v \geq \min\{v^D, v_1^C\}$ implies $v \geq v_1^C$. Even if $\min\{v^D, v_1^C\} = v^D$, as $v_1^C < \bar{v}_0$, $v \geq \min\{v^D, v_1^C\}$ and $v \notin [v_D, \bar{v}_0)$ imply that $v > v_1^C$. Then, by Claim 2, there exists a continuation PBE of case (ii), on which the expected continuation payoff is expressed by (A.23). As $v_1^C < v^E < \bar{v}_1$ when $q_P > q_A$, the difference between (A.23) and (B.15) is

$$\begin{cases} \dfrac{1}{2}\left[\dfrac{q_P+q_A-1}{q_Pq_A+(1-q_P)(1-q_A)}+\dfrac{q_P-q_A}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v \geq \bar{v}_1, \\ \dfrac{1}{2}\left[\dfrac{q_Pq_A}{q_Pq_A+(1-q_P)(1-q_A)}+\dfrac{q_P-q_A}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{if } v^E \leq v < \bar{v}_1, \\ \dfrac{q_P}{2}\left[\dfrac{q_A}{q_Pq_A+(1-q_P)(1-q_A)}+\dfrac{1-q_A}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{otherwise}, \end{cases} \tag{B.19}$$

which is positive for all $v \notin [v^D, \bar{v}_0)$ and $q_P > q_A$. As $\bar{v}_0 > v_1^C$, the difference between (A.23) and (B.16) is

$$\begin{cases} \dfrac{1}{2}\left[\dfrac{q_A+q_P-1}{q_Pq_A+(1-q_P)(1-q_A)}\right]B & \text{if } v \geq \bar{v}_0, \\ \dfrac{q_P}{2}\left[\dfrac{q_A}{q_Pq_A+(1-q_P)(1-q_A)}+\dfrac{1-q_A}{q_P(1-q_A)+(1-q_P)q_A}\right]B & \text{otherwise,} \end{cases} \tag{B.20}$$

which is positive for all $v \notin [v^D, \bar{v}_0)$. Therefore, no continuation PBE of case (iii) or (iv) is optimal. ■

B.3.4 Proof of Claim 4

Suppose that either (i) $q_A < q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$, or (ii) $q_P \leq q_A$ and $v \geq v^D$. As $v \geq \min\{v^D, v_1^C\} = v^D$ in both (i) and (ii), by Claim 3-2, in any optimal continuation PBE, either (a) $d^*(\theta_P, m \neq \phi) = m$ for each θ_P or (b) $d^*(\theta_P, m \neq \phi) = \theta_P$ for each θ_P holds. As $v_1^C < \bar{v}_0$, $v^D \leq v < \bar{v}_0$ or $q_P \leq q_A$ holds in both (i) and (ii). Then, Claim 8 guarantees the existence of a continuation PBE of case (a). Furthermore, as $v \geq v^D$, Claim 1 guarantees that, on the equilibrium path, $e^*(\theta_A, m = \theta_A, d = m) = 1$ holds for each θ_A, which yields a positive expected continuation payoff expressed as (A.22).

We now show that even if there exists a continuation PBE of case (b), its expected continuation payoff is not strictly greater than (A.22). By Claim 2-1, if there exists a continuation PBE of case (b), then its expected continuation payoff is (A.23) for $v \geq v_1^C$ and zero otherwise. Evidently, the continuation PBE of case (b) is not optimal when $v < v_1^C$. When $v \geq v_1^C$, the difference between (A.22) and (A.23) is

$$\left[\frac{q_A - q_P}{q_P(1-q_A)+(1-q_P)q_A}\right]\frac{B}{2}. \tag{B.21}$$

As the parametric assumption implies $q_A \geq q_P$ when $v \geq v_1^C$, the difference is non-negative. Therefore, the continuation PBE of case (a) is also optimal when $v \geq v_1^C$.

Furthermore, if $v < v_1^C$ holds when $q_P = q_A$, then (B.21) is strictly positive for all $v \geq v_1^C$. Therefore, we conclude that the continuation PBEs of case (b) are never optimal. ■

B.3.5 Proof of Claim 5

As the principal has beliefs such that $\mu^*(\theta_A \mid \theta_P, m = \phi) = \text{Prob}(\theta_A \mid \theta_P)$, Bayes' rule implies that the principal's belief about states is given by $\text{Prob}(s = \theta_P \mid \theta_P, m = \phi) = q_P$. Furthermore, as the agent's confidence after $m = \phi$ could be updated from the principal's project choice using Bayes' rule, the continuation game after $m = \phi$ is equivalent to centralization. Therefore, the same argument as the proof of Lemmas 1 and 2 implies the results. ■

C Requirement 1: Revisit (for Online Appendix)

In this appendix, we revisit Requirement 1. We first demonstrate that Requirement 1 is formally replaced with a standard criterion on equilibrium selection. We then investigate whether empowerment can be supported without Requirement 1.

C.1 Requirement 1 and Neologism-Proofness

We have imposed Requirement 1 *a priori* in the baseline model. In this subsection, we adopt *neologism-proofness* (Farrell, 1993) as a selection criterion rather than imposing Requirement 1. We then show that the optimal PBE under Requirement 1 and the optimal neologism-proof equilibrium are payoff equivalent to the principal. This suggests that imposing Requirement 1 is justified by neologism-proofness.

C.1.1 Definition

To define the neologism-proof equilibrium, the following additional notations are introduced. Let $n \in N \equiv \{\{1\}, \{-1\}, \{1, -1\}\}$ be a *neologism*. Intuitively, neologism n is an additional off-the-equilibrium-path message that has intrinsic meaning, claiming that "my private signal is in n." Let $\xi : \Theta \times N \to \Delta(\Theta)$ be the principal's belief about θ_A when she naïvely believes neologisms, which is defined by

$$\xi(\theta_A \mid \theta_P, n) \equiv \frac{\text{Prob}(\theta_A \mid \theta_P)}{\sum_{\theta'_A \in n} \text{Prob}(\theta'_A \mid \theta_P)}. \tag{C.1}$$

A continuation game in which the agent sends neologism n and the principal naïvely believes it is referred to as the *continuation game under neologism* n. Likewise, given neologism n, we say that $(d^n(\theta_P),\ e^n(\theta_A, d); \mu^n(\theta_A \mid \theta_P), \nu^n(\theta_P \mid \theta_A, d))$ is a *continuation PBE under neologism* n if it is a PBE in the continuation game under neologism n (i.e., Definitions 1-2, 1-3, and 1-4 are satisfied given that the principal holds belief $\mu^n(\theta_A \mid \theta_P) = \xi(\theta_A \mid \theta_P, n)$). A continuation PBE under neologism n is optimal if no other continuation PBE under neologism n is strictly better for the principal in the continuation game under neologism n. Let $V(\theta_A, n)$ represent the *interim* expected payoff of the agent with signal θ_A on the continuation PBE under neologism n, which is defined by

$$\begin{aligned} V(\theta_A, n) \equiv \sum_{\theta_P \in \Theta} \sum_{s \in S} &\left[bx(s, d^n(\theta_P), e^n(\theta_A, d^n(\theta_P))) - ce^n\left(\theta_A, d^n(\theta_P)\right)\right] \\ &\times \text{Prob}(s \mid \theta_P, \theta_A)\text{Prob}(\theta_P \mid \theta_A). \end{aligned} \tag{C.2}$$

Neologism-proofness in our disclosure game is defined as follows.

Definition C.1. *1. Neologism $n \in N$ is credible relative to the PBE associated with m^* if for any optimal continuation PBE under neologism n, the following condition holds: $V(\theta_A, n) > V^*(\theta_A, m^*)$ if and only if $\theta_A \in n$.*

2. A PBE is neologism-proof if no neologism is credible relative to it.

Intuitively, neologism-proof equilibria are immune to additional opportunities for credibly claiming the agent's private signal. The credibility of the neologism is assured by the self-signaling property, meaning that sending the neologism yields strictly higher payoffs than without sending the neologism when and only when the agent's type is in the neologism. Note that the definition of credibility is modified. The original definition in Farrell (1993) requires that any of the receiver's best responses to a neologism must provide strictly higher payoffs. This is reasonable in games where, like Crawford and Sobel (1982), there is a single decision-making stage after communication. In our model, by contrast, as multiple players decide after the deviation to a neologism, we modify the credibility of neologisms such that any optimal continuation PBE under neologism n provides strictly higher payoffs.

C.1.2 Neologism-Proof Equilibria

Hereinafter, we assume $q_P < \hat{q}_P(q_A)$ and $v^D \leq v < \min\{v_1^C, v^E\}$. We first derive the following claim to show the result.

Claim C.1. *Suppose that $q_P < \hat{q}_P(q_A)$ and $v^D \leq v < \min\{v^E, v_1^C\}$.*

1. *On any optimal continuation PBE under neologism $n = \{\theta_A\}$, $V(\theta_A, n = \{\theta_A\}) = q_A b - c$ for each θ_A.*

2. *On any optimal continuation PBE under neologism $n = \{1, -1\}$, $V(\theta_A, n = \{1, -1\}) = q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_A)]c$ for each θ_A.*

Proof (Claim C.1)**.** First, consider the continuation game under neologism $n = \{\theta_A\}$. Without loss of generality, assume that $\theta_A = 1$. By (C.1), the principal's naïve belief given neologism $n = \{1\}$ is $\mu^n(\theta_A = 1 \mid \theta_P) = 1$. Then, the continuation game under neologism $n = \{1\}$ is identical to when the agent sends $m = 1$. Therefore, as $v^D \leq v < v_1^C$, Claim 4 implies that in any optimal continuation PBE, the principal chooses $d = m$ and the agent certainly executes it. Then, $V(\theta_A, n = \{\theta_A\}) = q_A b - c$.

Next, consider the continuation game under neologism $n = \{1, -1\}$. By (C.1), the principal's naïve belief is $\mu^n(\theta_P = \theta_A \mid \theta_P) = q_P q_A + (1 - q_P)(1 - q_A)$, which is equivalent to $\text{Prob}(\theta_A = \theta_P \mid \theta_P)$. Then, the continuation game under neologism $n = \{1, -1\}$ is identical to that after message $m = \phi$ given $m^*(1) = m^*(-1) = \phi$. Hence, Claim 5 implies that the optimal continuation PBE under neologism $n = \{1, -1\}$ is uniquely represented as follows: the principal chooses $d = \theta_P$ and the agent executes it if and only if $d = \theta_A$. Therefore, $V(\theta_A, n = \{1, -1\}) = q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_A)]c$. ■

Then, we observe that no equilibrium that constitutes empowerment is neologism-proof.

Proposition C.1. *Suppose that $q_P < \hat{q}_P(q_A)$, and $v^D \leq v < \min\{v^E, v_1^C\}$. Then, any PBE that constitutes empowerment is not neologism-proof.*

Proof (Proposition C.1)**.** Let $\mathcal{E}^*$ be a PBE that constitutes empowerment. By the construction of the PBE, $\mu^*\left(\theta_A = (m^*)^{-1}(m) \mid \theta_P, m\right) = 1$ for each θ_P and on-the-equilibrium-path message m, which implies that the continuation game after $m = m^*(\theta_A)$ is equivalent to that after $m = \theta_A$. Then, as $v \geq v^D$ and $d^*(\theta_P, m) = (m^*)^{-1}(m)$ for each θ_P, Claim 1 implies that given that the agent's signal is θ_A, the principal chooses $d = \theta_A$ and the agent chooses $e = 1$ on this PBE. Consequently, the agent's *interim* payoff for θ_A is $V^*(\theta_A, m^*) = q_A b - c$.

Now, we show that neologism $n = \{1, -1\}$ is credible relative to this PBE. Claim C.1-2 implies that the agent obtains $V(\theta_A, n = \{1, -1\}) = q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_A)]c$ by sending neologism $n = \{1, -1\}$. As $v < v^E$, we obtain $V(\theta_A, n = \{1, -1\}) > V^*(\theta_A, m^*)$ for each $\theta_A \in \{1, -1\}$. Then, neologism $n \in \{1, -1\}$ is credible relative to the PBE. ■

Propositions 2 and 3 imply that when $q_P < \hat{q}_P(q_A)$ and $v^D \leq v < \min\{v_1^C, v^E\}$, empowerment is better than centralization, although there is no empowerment equilibrium under Requirement 1. Proposition C.1 implies that neologism-proofness is another foundation of the non-credibility of empowerment desired by the principal even if Requirement 1 is dropped. The interpretation of the vulnerability to neologisms is as follows. Recall that under centralization, it is optimal for the principal to choose the project based on her signal, which allows the agent to make the execution decision based on both θ_P and θ_A. The agent can induce the same situation by sending neologism $n = \{1, -1\}$ to the principal given that she believes it naïvely. As it is optimal for both $\theta_A = 1$ and $\theta_A = -1$, to send neologism $n = \{1, -1\}$ is self-signaling and then credible.

In the following, we demonstrate that the optimal PBE satisfying Requirement 1 does not constitute empowerment but is neologism-proof.

Proposition C.2. *Suppose that $q_P < \hat{q}_P(q_A)$ and $v^D \leq v < \min\{v^E, v_1^C\}$.*

1. *There exists an optimal PBE under Requirement 1, on which $U^*(v) = U^C(v)(= q_P q_A B)$.*

2. *The optimal PBE under Requirement 1 is neologism-proof.*

Proof (Proposition C.2)**.** As $U^C(v) < U^E$ holds in this parameter range, there exists optimal PBE $\mathcal{E}^*$ constructed in Claim 6. As $v < v^E$, we have $V^*(\theta_A, m = \theta_A) = q_A b - c < q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_A)]c = V^*(\theta_A, m = \phi)$, implying that $m^*(\theta_A) = \phi$ for each θ_A. Thus, from (A.25) and (A.26), $U^*(v) = q_P q_A B$.

We now show that there exists no credible neologism relative to the optimal PBE. As mentioned above, the agent's expected payoff in the optimal PBE is given by $V^*(\theta_A, m^*) = q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_A)]c$. Two neologisms might be credible: $n \in \{\{\theta_A\}, \{1, -1\}\}$. For $n = \{\theta_A\}$, Claim C.1-1 implies $V(\theta_A, n = \{\theta_A\}) = q_A b - c < V^*(\theta_A, m^*)$, where the inequality holds since $v < v^E$. Therefore, this neologism is not credible. Likewise, by Claim C.1-2, $V(\theta_A, n = \{1, -1\}) = q_P q_A b - [q_P q_A + (1 - q_P)(1 - q_A)]c = V^*(\theta_A, m^*)$, implying that neologism $n = \{1, -1\}$ is not credible. ■

To argue that Requirement 1 can be replaced with neologism-proofness, we now show that no neologism-proof equilibrium yields the principal's payoff greater than $U^C(v) = q_P q_A B$. The following claim is immediately implied as an analogy of Claim 3.

Claim C.2. *Suppose that $q_P < \hat{q}_P(q_A)$ and $v^D \le v < \min\{v^E, v_1^C\}$. Consider the continuation game after message $m \neq \phi$. If the continuation PBE satisfies either*

1. *$d^*(\theta_P, m = \theta_A) = -\theta_P$ for each θ_P; or*

2. *$d^*(\theta_P, m = \theta_A) = -m$ for each θ_P,*

then the expected continuation payoff must be zero.

Proof (Claim C.2)**.** Suppose that the continuation PBE satisfies d^* in the statement. Then, the principal's continuation payoff is computed as (B.15) or (B.16) in the proof of Claim 3. Since $v < v^E$ and $v < v_1^C < \bar{v}^0$, (B.15) and (B.16) imply that the principal's continuation payoff is zero. ■

Proposition C.3. *Suppose that $q_P < \hat{q}_P(q_A)$ and $v^D \le v < \min\{v^E, v_1^C\}$. Then, the principal's payoff on the optimal neologism-proof equilibrium is $U^C(v) = q_P q_A B$.*

Proof (Proposition C.3)**.** By Propositions C.1 and C.2, the principal can obtain payoff $q_P q_A B$ on a neologism-proof equilibrium, but payoff $q_A B$ is unattainable. Hence, it is sufficient to show that there exists no PBE on which the principal's payoff is $\tilde{U} \in (q_P q_A B, q_A B)$. Suppose, on the contrary, that there exists a neologism-proof equilibrium $\mathcal{E}^*$ on which the principal's payoff is $\tilde{U} \in (q_P q_A B, q_A B)$.

There are two possibilities. First, suppose $m^*(1) = m^*(-1) = \phi$. As $\mu^*(\theta_A \mid \theta_P, m = \phi) = \text{Prob}(\theta_A \mid \theta_P)$ by Bayes' rule, the continuation game after message $m = \phi$ is identical to that under centralization. Recall from Proposition 1 that the optimal equilibrium payoff under centralization is given by $q_P q_A B$. Then, as $v_0^C < v^D \le v < v_1^C$, we observe $U^C(v) = q_P q_A B \ge \tilde{U}$, which contradicts $\tilde{U} \in (q_P q_A B, q_A B)$.

Next, suppose $m^*(1) \neq m^*(-1)$. By Bayes' rule, the principal's updated belief satisfies $\mu^*\left(\theta_A = (m^*)^{-1}(m) \mid \theta_P, m\right) = 1$ for each θ_P and on-the-equilibrium-path message m. This implies that the continuation game after $m = m^*(\theta_A)$ is identical to that after $m = \theta_A$. Without loss of generality, assume that $\theta_A = 1$. In the continuation game after message $m = m^*(1)$, there are four possibilities: (a) $d^*(\theta_P, m^*(1)) = 1$ for each θ_P, (b) $d^*(\theta_P, m^*(1)) = \theta_P$ for each θ_P, (c) $d^*(\theta_P, m^*(1)) = -1$ for each θ_P, and (d) $d^*(\theta_P, m^*(1)) = -\theta_P$ for each θ_P. As $v < v_1^C$, by Claims 2-1 and C.2, except for case (a), the expected continuation payoff must be zero. Then, As $\tilde{U} > 0$, we assume that, without loss of generality, in the continuation game after message $m = m^*(1)$, $d^*(\theta_P, m^*(1)) = 1$ for each θ_P. If $d^*(\theta_P, m^*(-1)) = -1$ for each θ_P, then Claim 1 implies that the equilibrium constitutes empowerment, which contradicts Proposition C.1. Hence, in the continuation game after message $m = m^*(-1)$, the principal adopts strategy associated with either (b), (c), or (d). Nevertheless, since $\text{Prob}(1) = \text{Prob}(-1) = 1/2$, the principal's *ex ante* equilibrium payoff is then $\tilde{U} = q_A B/2 \notin (q_P q_A B, q_A B)$, which is a contradiction. ■

C.2 Empowerment Equilibria without Requirement 1

In this subsection, we clarify the role of Requirement 1 by constructing equilibria without imposing it. Specifically, we demonstrate that if either the requirement of symmetric messages or symmetric beliefs is dropped, then desirable empowerment becomes credible even though the condition specified in Proposition 3 is violated.

Allowing asymmetric strategies or beliefs makes it possible to construct another strategy to implement the outcome under formal delegation. To consider this possibility, here we slightly modify the definition of empowerment. An equilibrium $\mathcal{E}^* = (d^*, (m^*, e^*); \mu^*, \nu^*)$ constitutes empowerment if (i) $m^*(1) \neq m^*(-1)$, (ii) $d^*(\theta_P, m) = (m^*)^{-1}(m)$ for each θ_P and on-the-equilibrium-path message m, and (iii) $e^*(\theta_A, m^*(\theta_A), d^*(\theta_P, m^*(\theta_A))) = 1$ for each θ_P and θ_A, where $(m^*)^{-1}(\cdot)$ is the inverse function of $m^*(\cdot)$.

C.2.1 Empowerment Equilibria with Asymmetric Messages

First, we drop Requirement 1-1, the symmetric messages. As shown below, as long as the message is asymmetric, the outcome under formal delegation is always implemented by empowerment. Note that if Requirement 1-1 is dropped, then the agent sends message $m = \phi$ on the equilibrium path, implying that Requirement 1-2 is irrelevant. Throughout this subsection, an optimal PBE that constitutes empowerment and satisfies (only) Requirement 1-3 (continuation optimality) is referred to as an *asymmetric empowerment equilibrium.*

Proposition C.4. *Suppose that $U^C(v) < U^D(v)$. Then, there always exists an asymmetric empowerment equilibrium.*

Proof (Proposition C.4)**.** If there exists an empowerment equilibrium satisfying Requirement 1, then the statement is straightforward. Suppose that there does not exist such an empowerment equilibrium. By Propositions 2-3 and 3, either (i) $q_A \leq q_P < \hat{q}_P(q_A)$ and $v^D \leq v < v_1^C$ or (ii) $q_P < q_A$ and $v^D \leq v < v^E$. Note that if $q_P < q_A$, then $v < v^E < v_1^C$. Define an asymmetric message strategy as follows:

$$m^*(\theta_A) \equiv \begin{cases} 1 & \text{if } \theta_A = 1, \\ \phi & \text{if } \theta_A = -1. \end{cases} \tag{C.3}$$

Given m^*, the continuation game after $m = \phi$ is essentially equivalent to that after $m = 1$.[38] Hence, by the same argument used in the proof of Claim 6-1, there exists an optimal continuation PBE $\mathcal{E}^*(m)$ for each $m \in M$ such that (a) for $m \neq \phi$, (I) $d^*(\theta_P, m \neq \phi) = m$ for each θ_P, and (II) $e^*(\theta_A, m = \theta_A, d = m) = 1$ for each θ_A; and (b) for $m = \phi$, (I) $d^*(\theta_P, m = \phi) = -1$ for each θ_P and (II) $e^*(\theta_A = -1, m = \phi, d = -1) = 1$.

Now, we show that given continuation PBEs $(\mathcal{E}^*(m))_{m \in M}$, each type of the agent has no

[38]Formally, the posterior derived from m^* by using Bayes' rule is $\mu^*(\cdot \mid \theta_P, m = \phi) = \mu^*(\cdot \mid \theta_P, m = -1)$ for each θ_P.

incentive to deviate from m^*. As $m = \phi$ and -1 induce the same outcome for type $\theta_A = -1$, it is evident that $m = \phi$ and -1 are indifferent for the agent with $\theta_A = -1$. For $\theta_A = 1$, the agent's expected payoff is

$$V^*(\theta_A = 1, m) = \begin{cases} q_A b - c & \text{if } m = 1, \\ 0 & \text{if } m = \phi, \end{cases} \tag{C.4}$$

where the second line comes from the fact that $d = -1$ and $e = 0$ are induced because $v < v_1^C < \bar{v}_0 (\equiv 1/(1 - q_A))$. Hence, type $\theta_A = 1$ has no incentive to deviate from $m = 1$. Therefore, $(m^*, (\mathcal{E}^*(m))_{m \in M})$ is a PBE and constitutes empowerment. ■

The possibility of empowerment by asymmetric messages comes from the limitation of available messages. Once $m = \phi$ is used on the equilibrium path, the certifiability of θ_A makes it impossible for the agent to conceal his signal. For example, if type $\theta_A = -1$ sends message $m = \phi$ on the equilibrium path, then type $\theta_A = 1$ has to decide whether to mimic the opponent type by sending $m = \phi$ or disclosing $\theta_A = 1$. As it is not beneficial for the agent to mimic the other type, his signal is fully transmitted to the principal. As a result, when formal delegation is strictly better than centralization, its outcome is always implemented through empowerment.

C.2.2 Empowerment Equilibria with Asymmetric Beliefs

As in the previous subsection, dropping the requirement of the symmetric beliefs also makes desired empowerment credible. Specifically, if the principal has a biased belief after $m = \phi$ (e.g., $\mu^*(\theta_A = -1 \mid \theta_P, m = \phi) = 1$), then it is impossible for the agent to conceal θ_A. A PBE that constitutes empowerment and satisfies Requirements 1-1 (symmetric messages) and 1-3 (continuation optimality) is referred to as a *biased empowerment equilibrium.*

Proposition C.5. *Suppose that $U^C(v) < U^D(v)$. Then, there always exists a biased empowerment equilibrium.*

Proof (Proposition C.5). Define $m^*(\theta_A) = \theta_A$ for each θ_A. Given the symmetric message strategy, the belief after message $m = \phi$ is set to be $\mu^*(\theta_A = -1 \mid \theta_P, m = \phi) = 1$ for each θ_P. Given μ^*, the continuation games are equivalent to those specified in the proof of Proposition C.4. Thus, the statement is proven by the same argument used in the proof of Proposition C.4. ■

D Correlation between Signals (for Online Appendix)

In this appendix, the correlation between θ_P and θ_A is allowed while they are statistically independent in the baseline model. We show that our insight mentioned in the body of the paper still holds as long as the correlation is not sufficiently high.

D.1 Preliminaries

The information structure is modified as follows. We maintain symmetry of the state variable and the signals in that the joint probability distribution satisfies

$$\begin{aligned}
&\text{Prob}(\theta_P = \theta_A = s \mid s = 1) = \text{Prob}(\theta_P = \theta_A = s \mid s = -1) \equiv \bar{p}, \\
&\text{Prob}(\theta_A \neq \theta_P = s \mid s = 1) = \text{Prob}(\theta_A \neq \theta_P = s \mid s = -1) \equiv p_P, \qquad \text{(D.1)} \\
&\text{Prob}(\theta_P \neq \theta_A = s \mid s = 1) = \text{Prob}(\theta_P \neq \theta_A = s \mid s = -1) \equiv p_A, \\
&\text{Prob}(\theta_P = \theta_A \neq s \mid s = 1) = \text{Prob}(\theta_P = \theta_A \neq s \mid s = -1) = 1 - (\bar{p} + p_P + p_A).
\end{aligned}$$

For each $i \in I$, denote the marginal distribution by $q_i \equiv \text{Prob}(\theta_i = s \mid s) = \bar{p} + p_i$. As in our baseline model, Bayes' rule implies that $\text{Prob}(s = \theta_i \mid \theta_i) = q_i$ for each i so that q_i is again interpreted as the precision of the signal. We assume $q_i \in (1/2, 1)$ for each i so that the signal is informative.

Denote the conditional covariance between θ_P and θ_A by

$$\gamma \equiv Cov(\theta_P, \theta_A \mid s) = 4(\bar{p} - q_P q_A), \tag{D.2}$$

which captures the degree of statistical correlation between θ_P and θ_A. Then, the joint distribution can be represented by

$$\begin{aligned} \text{Prob}(\theta_P = \theta_A = s \mid s) &= \bar{p} = q_P q_A - q_P q_A + \bar{p} = q_P q_A + \frac{\gamma}{4}, \\ \text{Prob}(\theta_j \neq \theta_i = s \mid s) &= p_i = q_i(1-q_j) - \bar{p} + q_P q_A = q_i(1-q_j) - \frac{\gamma}{4}, \\ \text{Prob}(\theta_P = \theta_A \neq s \mid s) &= 1 - (\bar{p} + p_P + p_A) = (1-q_P)(1-q_A) + \frac{\gamma}{4}. \end{aligned} \tag{D.3}$$

for $i, j \in I$ with $j \neq i$, implying that it is parameterized by the marginal distribution (or precision of the signal) q_i and the conditional covariance γ.[39] The baseline model where θ_P and θ_A are independent conditional on s is a special case of this representation with $\gamma = 0$.

Throughout this section, we restrict our attention to the following parameter range.

Assumption D.1. *The following conditions hold:*

$$-4(1-q_P)(1-q_A) < \gamma < 4\min\{q_P(1-q_A), q_A(1-q_P)\}, \tag{D.4}$$

$$\gamma < \frac{4(2q_A - 1)q_P(1-q_P)}{2q_P - 1}. \tag{D.5}$$

(D.4) guarantees that the joint probability of (θ_P, θ_A) has full support. (D.5) rules out the possibility that disagreement (i.e., $\theta_P \neq \theta_A$) induces the agent's confidence to be higher than consensus (i.e., $\theta_P = \theta_A$) under centralization, which occurs when q_A is sufficiently small while γ is sufficiently large.[40] The reversal of the confidence comes from the following facts. On

[39] The similar representation is obtained by Fleckinger (2012) in the model of moral hazard with multiple agents.

[40] Given (D.4), (D.5) is restrictive only when $q_A \leq q_P$.

the one hand, when γ is sufficiently large, because signals are sufficiently likely to be aligned, consensus is weak to convince that the promising project is chosen, and its encouraging effect is discounted. On the other hand, as q_A is sufficiently small, disagreement is strong to convince that θ_A is wrong and θ_P is correct. Hence, $d = \theta_P$ is highly promising.

The remaining setup is identical to the baseline model. For easy reference, the modified model is referred to as the *correlated signal model*.

D.2 Centralization and Formal Delegation

D.2.1 Centralization

Under centralization, by the same procedure as in the proof of Lemma 1, it is shown that the optimal equilibrium satisfies $d^C(\theta_P) = \theta_P$ for any θ_P. The agent executes the project if and only if $v \geq 1/\text{Prob}(s = d \mid \theta_A, d)$, where his confidence is

$$\text{Prob}(s = d \mid \theta_A, d) = \begin{cases} \eta_0^{corr} \equiv \dfrac{q_P q_A + \gamma/4}{q_P q_A + (1-q_P)(1-q_A) + \gamma/2} & \text{if } \theta_A = d, \\[2ex] \eta_1^{corr} \equiv \dfrac{q_P(1-q_A) - \gamma/4}{q_P(1-q_A) + (1-q_P)q_A - \gamma/2} & \text{if } \theta_A \neq d. \end{cases} \tag{D.6}$$

Note that (D.5) guarantees $\eta_0^{corr} > \eta_1^{corr}$. Then, based on the confidence, the principal's payoff under centralization is expressed as

$$U^{Ccorr}(v) = \begin{cases} q_P B & \text{if } v \geq v_1^{Ccorr}, \\ \left(q_P q_A + \dfrac{\gamma}{4}\right) B & \text{if } v_0^{Ccorr} \leq v < v_1^{Ccorr}, \\ 0 & \text{if } v < v_0^{Ccorr}, \end{cases} \tag{D.7}$$

where $v_k^{Ccorr} \equiv 1/\eta_k^{corr}$ for $k = 0, 1$.

D.2.2 The Value of Formal Delegation

Under formal delegation, given that the agent chooses $d = \theta_A$, the agent's confidence is equal to $\text{Prob}(s = d \mid \theta_A, d) = q_A$, which does not change from the baseline model. Then, the principal's payoff is also the same as the baseline model: $U^D(v) = q_A B$ for $v \geq v^D \equiv 1/q_A$ and $U^D(v) = 0$ otherwise. The value of formal delegation in the correlated signal model is as follows.

Proposition D.1. *Consider the correlated signal model with Assumption D.1. Then, $U^{Ccorr}(v) < U^D(v)$ holds if and only if either one of the following holds:*

1. *$q_A > q_P$ and $v \geq v^D$; or*

2. *$q_A \leq q_P$, $\gamma < 4\{q_A^2 - q_P[q_A^2 + (1-q_A)^2]\}/(2q_A - 1)$, and $v^D \leq v < v_1^{Ccorr}$.*

Proof (Proposition D.1)**.** First, suppose $q_A > q_P$. It is possible to confirm that $0 < q_P q_A + \gamma/4 < q_A$ and $v^D < v_1^{Ccorr}$. Then, $U^{Ccorr}(v) < U^D(v)$ if and only if $v \geq v^D$. Second, suppose $q_A \leq q_P$. It is possible to confirm that $0 < q_P q_A + \gamma/4 < q_A$, $v_0^{Ccorr} < v^D$, and

$$v_1^{Ccorr} \gtreqless v^D \iff \gamma \lesseqgtr \frac{4\{q_A^2 - q_P[q_A^2 + (1-q_A)^2]\}}{2q_A - 1}. \tag{D.8}$$

Then, $U^{Ccorr}(v) < U^D(v)$ if and only if $\gamma < 4\{q_A^2 - q_P[q_A^2 + (1-q_A)^2]\}/(2q_A - 1)$ and $v^D \leq v < v_1^{Ccorr}$. ■

When $\gamma = 0$, the conditions in Proposition D.1 coincide with those in Proposition 2. Then, Proposition D.1 is a generalization of Proposition 2. Given $q_A \leq q_P$, formal delegation tends to be preferred when γ is low.[41] As in the baseline model, delegation is valuable owing to avoiding the demotivating problem because disagreement demotivates the agent to execute the project. When γ is low, demotivation by disagreement is likely to occur, implying that the benefit of

[41] Whenever $q_A \leq q_P < \hat{q}_P(q_A) \equiv q_A^2/[q_A^2 + (1-q_A)^2]$, we obtain $4\{q_A^2 - q_P[q_A^2 + (1-q_A)^2]\}/(2q_A - 1) > 0$. This implies that given $q_P < \hat{q}_P(q_A)$, delegation may be strictly preferred even if γ is positive.

avoiding demotivation under formal delegation is large. As a result, formal delegation is better than centralization even when the principal has a better signal, as in the baseline model.

By contrast, centralization dominates formal delegation when $q_A \leq q_P$ and γ is large. As γ is sufficiently large, disagreement is little likely to occur, and then the benefit of avoiding demotivation is highly discounted. As a result, centralization tends to be preferred.

D.3 Non-credibility of Empowerment

Hereinafter, we assume the conditions in Proposition D.1 hold and investigate whether there exists an empowerment equilibrium in the ACE model. On the empowerment equilibrium, the agent sends message $m^*(\theta_A) = \theta_A$ and his expected payoff is $V^*(\theta_A, m = \theta_A) = q_A b - c$. We now check the agent's incentive to deviate to $m = \phi$. By the similar argument used in the body of the paper, the principal chooses the project consistently with her signal (i.e., $d^*(\theta_P, m = \phi) = \theta_P$ for each θ_P) in the optimal continuation PBE after $m = \phi$. Then, we provide a necessary condition for credible empowerment as follows.

Proposition D.2. *Consider the correlated signal model with Assumption D.1, and suppose that $U^{Ccorr}(v) < U^D(v)$. Then, there exists an empowerment equilibrium only if $q_A > q_P$ and $v \geq v^{Ecorr}$.*

Proof (Proposition D.2)**.** Suppose first $q_A > q_P$ and $v \geq v^D$. After deviating to $m = \phi$, the agent's expected payoff is

$$V^*(\theta_A, m = \phi) = \begin{cases} q_P b - c & \text{if } v \geq v_1^{Ccorr}, \\ \left(q_P q_A + \frac{\gamma}{4}\right) b - \left[q_P q_A + (1-q_P)(1-q_A) + \frac{\gamma}{2}\right] c & \text{if } v_0^{Ccorr} \leq v < v_1^{Ccorr}, \\ 0 & \text{if } v < v_0^{Ccorr}. \end{cases} \tag{D.9}$$

As $q_A > q_P$ and $v \geq v^D$, it is obvious that the deviation payoff is not greater than the equilibrium payoff if $v \geq v_1^{Ccorr}$ or $v < v_0^{Ccorr}$. For $v \in [\max\{v_0^{Ccorr}, v^D\}, v_1^{Ccorr})$, the agent has a strict incentive to deviate if

$$\begin{aligned} &\left[(1-q_P)q_A - \frac{\gamma}{4}\right] b - \left[q_P(1-q_A) + (1-q_P)q_A b - \frac{\gamma}{2}\right] c < 0 \\ \iff\ & v < v^{Ecorr} \equiv \frac{q_P(1-q_A) + (1-q_P)q_A - \gamma/2}{(1-q_P)q_A - \gamma/4}. \end{aligned} \tag{D.10}$$

When $\gamma \geq 4(1-q_A)q_A(2q_P-1)/(2q_A-1)$, we have $v^{Ecorr} \leq v^D \leq v_0^{Ccorr}$. As $v \geq v^D \geq v^{Ecorr}$, the agent does not deviate to $m = \phi$. When $\gamma < 4(1-q_A)q_A(2q_P-1)/(2q_A-1)$, we have $v_0^{Ccorr} < v^D < v^{Ecorr} < v_1^{Ccorr}$. Then, the agent deviates to $m = \phi$ for $v \in (v^D, v^{Ecorr})$.

Suppose next $q_A \leq q_P$, $\gamma < 4\{q_A^2 - q_P[q_A^2 + (1-q_A)^2]\}/(2q_A-1)$, and $v^D \leq v < v_1^{Ccorr}$. Note that $v_0^{Ccorr} < v^D < v_1^{Ccorr} \leq v^{Ecorr}$ holds in this parameter range. After $m = \phi$, the agent executes the project if and only if there is consensus. Then, as the payoff is given by (D.9), the same argument adopted above implies that the agent has a strict incentive to deviate if and only if $v < v^{Ecorr}$. As $v < v_1^{Ccorr} < v^{Ecorr}$, the agent always prefers to deviate. ■

Proposition D.2 argues that there is an empowerment equilibrium only when v is sufficiently high and the agent has a better signal, which is a counterpart of Proposition 3. As long as formal delegation is beneficial to the principal, strategic silence may prevent successful empowerment even when the signals are correlated. The condition for the agent being not strategically silent is essentially equivalent to that under the baseline model. Note that v^{Ecorr} is decreasing in γ when $q_A > q_P$. Then, given $q_A > q_P$, by introducing a negative correlation between θ_P and θ_A, desirable empowerment is more likely to be prevented. Contrarily, with a positive correlation, empowerment may be supported more successfully, though delegation tends to be less valuable.

E Complementarity between Signals (for Online Appendix)

In this appendix, we take into account a different signal structure. The signals we consider in the baseline model are substitutes in the sense that knowing either one of them derives better inferences than that under the prior. The baseline model is modified so that signals could be complements in the sense that knowing only one of the signals is insufficient to infer the true state. We show that if the degree of signal substitutability is not too small, our result still holds qualitatively. By contrast, if the degree of signal complementarity is sufficiently large, then strategic silence never occurs. Furthermore, decision-making with communication strictly dominates centralization and formal delegation.[42]

E.1 Preliminaries

The information structure is modified as follows. Let $\omega \in \{0, 1\}$ represent another state determining the signal structure. When $\omega = 0$, the signals are substitutes for inferring the state in the sense that s, θ_P, and θ_A are governed as in the baseline model; that is, $\text{Prob}(s = 1 \mid \omega = 0) = 1/2$ and $\text{Prob}(\theta_i = s \mid \omega = 0, s) = q_i \in (1/2, 1)$ for each i and $s \in S$. When $\omega = 1$, the signals are complements for inferring the state. Specifically, $\text{Prob}(\theta_i = 1 \mid \omega = 1) = 1/2$ for each i and $\text{Prob}(s = 1 \mid \omega = 1, \theta_P = \theta_A) = \text{Prob}(s = -1 \mid \omega = 1, \theta_P \neq \theta_A) = 1$. When the signals are complements, knowing either one of θ_P and θ_A is insufficient to derive meaningful inference on the state.[43] We assume that ω is unobservable to all parties, and the common prior over ω is given by $\text{Prob}(\omega = 0) = \tau \in [0, 1]$. The probability τ is interpreted as the degree of signal substitutability. Note that the formulation of the signal structure here includes the baseline model as a special case by $\tau = 1$. The remaining setup is identical to that of the baseline model. The modified setup is referred to as the *mixed signal model.*

[42] The omitted algebra in this section is available upon request.

[43] The similar formulation is adopted by McGee and Yang (2013) in the model of cheap-talk games for representing complementarity. Even if signals are noisy in the sense that $\text{Prob}(s = 1 \mid \omega = 1, \theta_P = \theta_A) = \text{Prob}(s = -1 \mid \omega = 1, \theta_P \neq \theta_A) = 1 - \varepsilon$ for some $\varepsilon > 0$, we have the qualitatively same results.

Now, we suppose that, under centralization, the principal adopts a separating strategy such that $d^C(\theta_P) = \theta_P$ for each θ_P. As in the baseline model, the agent chooses $e = 1$ if and only if $v \geq 1/\text{Prob}(s = d \mid \theta_A, d)$. Note that the agent's confidence is given by

$$\text{Prob}(s = d \mid \theta_A, d) = \begin{cases} \eta_{11}^{mix} \equiv \dfrac{2q_P q_A \tau + (1-\tau)}{2[q_P q_A + (1-q_P)(1-q_A)]\tau + (1-\tau)} & \text{if } (\theta_A, d) = (1, 1), \\[2em] \eta_{1-1}^{mix} \equiv \dfrac{2q_P(1-q_A)\tau + (1-\tau)}{2[q_P(1-q_A) + (1-q_P)q_A]\tau + (1-\tau)} & \text{if } (\theta_A, d) = (1, -1), \\[2em] \eta_{-11}^{mix} \equiv \dfrac{2q_P(1-q_A)\tau}{2[q_P(1-q_A) + (1-q_P)q_A]\tau + (1-\tau)} & \text{if } (\theta_A, d) = (-1, 1), \\[2em] \eta_{-1-1}^{mix} \equiv \dfrac{2q_P q_A \tau}{2[q_P q_A + (1-q_P)(1-q_A)]\tau + (1-\tau)} & \text{if } (\theta_A, d) = (-1, -1). \end{cases} \tag{E.1}$$

Contrary to the baseline model, the confidence depends not only on whether $d = \theta_A$ but also on whether $\theta_A = 1$. Note that the chosen project is not promising for certain given $\omega = 1$ and $\theta_A = -1$, generating the difference. Define $v_{\theta_A d}^{Cmix} \equiv 1/\eta_{\theta_A d}^{mix}$ for each d and θ_A.[44] Likewise, under formal delegation, the agent's confidence given $d = \theta_A$ is

$$\text{Prob}(s = d \mid \theta_A, d = \theta_A) = \eta^{Dmix} \equiv q_A \tau + \frac{1}{2}(1-\tau). \tag{E.2}$$

Define $v^{Dmix} \equiv 1/\eta^{Dmix}$.

We have the following observations. First, there exists $\tau^{CM} \in (0, 1)$ such that $v_{1-1}^{Cmix} \leq v_{-1-1}^{Cmix}$ if and only if $\tau \leq \tau^{CM}$. Second, there exists $\tau_1^{DM} \in \mathbb{R}_{++}$ such that $v_{1-1}^{Cmix} \leq v^{Dmix}$ if and only if $\tau \leq \tau_1^{DM}$. Third, there exists $\tau_2^{DM} \in (0, 1)$ such that $v^{Dmix} \leq v_{-1-1}^{Cmix}$ if and only if $\tau \leq \tau_2^{DM}$. Given those observations, the order of the thresholds is summarized as follows. If

[44] When $\tau = 0$ (i.e., signals are perfectly complementary), let $v_{-11}^{mix} = v_{-1-1}^{mix} = \infty$.

$\tau > \max\{\tau^{CM}, \tau_1^{DM}, \tau_2^{DM}$, then we have

$$v_{11}^{Cmix} < v_{-1-1}^{Cmix} < v^{Dmix} < v_{1-1}^{Cmix} < v_{-11}^{Cmix}. \tag{E.3}$$

Conversely, if $\tau < \min\{\tau^{CM}, \tau_1^{DM}, \tau_2^{DM}\}$, then we have

$$v_{11}^{Cmix} < v_{1-1}^{Cmix} < v^{Dmix} < v_{-1-1}^{Cmix} < v_{-11}^{Cmix}. \tag{E.4}$$

To focus on our argument, we restrict our attention to the following parameter range.

Assumption E.1. *Either one of the following holds:*

1. $\tau > \max\{\tau^{CM}, \tau_1^{DM}, \tau_2^{DM}\}$ *and* $v^{Dmix} \leq v < v_{1-1}^{Cmix}$.
2. $\tau < \min\{\tau^{COD}, 1/2\}$ *and* $v^{Dmix} \leq v < v_{-1-1}^{Cmix}$, *where*

$$\tau^{COD} \equiv \frac{-(q_P + 2q_A - 1) + \sqrt{(2q_A - 1 + q_P)^2 + (2q_P - 1)(2q_A - 1)^2}}{(2q_P - 1)(2q_A - 1)^2}. \tag{E.5}$$

Assumption E.1 implies that the signals are sufficiently substitutive ($\tau > \max\{\tau^{CM}, \tau_1^{DM}, \tau_2^{DM}\}$) or complementary ($\tau < \min\{\tau^{COD}, 1/2\}$), and the intrinsic incentive is moderate so that the demotivating effect under centralization is non-negligible.[45] The comprehensive analysis is left for future research.

E.2 Centralization and Formal Delegation

E.2.1 Centralization

Using a similar argument adopted in the proof of Lemma 1, we can show that, under Assumption E.1, the separating strategy (i.e., $d^P(\theta_P) = \theta_P$ for each θ_P) constitutes an optimal

[45] We can show that $\min\left\{\tau^{CM}, \tau_1^{DM}, \tau_2^{DM}, 1/2, \tau^{COD}\right\} = \min\left\{1/2, \tau^{COD}\right\}$.

equilibrium. When Assumption E.1-1 holds, $e = 1$ is chosen if and only if $\theta_A = d$. As a result, the principal's expected payoff is given by

$$U^{Cmix}(\tau) = \left[q_P q_A \tau + \frac{1}{4}(1-\tau)\right] B. \tag{E.6}$$

Likewise, when Assumption E.1-2 holds, the agent chooses $e = 1$ if and only if $\theta_A = 1$. Hence, the principal's expected payoff under centralization is expressed as

$$U^{Cmix}(\tau) = \left[\frac{1}{2} q_P \tau + \frac{1}{2}(1-\tau)\right] B. \tag{E.7}$$

E.2.2 The Value of Formal Delegation

As we restrict our attention to the case of $v \geq v^{Dmix}$, the agent chooses $e = 1$ given $d = \theta_A$ under formal delegation. Hence, the principal's expected payoff is expressed as

$$U^{Dmix}(\tau) = \left[q_A \tau + \frac{1}{2}(1-\tau)\right] B. \tag{E.8}$$

The value of formal delegation in the mixed signal model under Assumption E.1 is summarized as follows.

Proposition E.1. *Consider the mixed signal model, and suppose that Assumption E.1 holds. Then, $U^{Ccomp}(\tau) < U^{Dcomp}(\tau)$ holds.*

Proof (Proposition E.1)**.** As $q_P/2 < q_A < 1$, a comparison between (E.8) and either (E.6) or (E.7) immediately implies the statement. ■

The advantage of formal delegation can be understood as in the baseline model: under the parameter range, formal delegation is strictly preferred because demotivation caused by disagreement can be avoided by shutting down the principal's signal. This mechanism is irrelevant to the signal structure as long as the signals are sufficiently substitutable or complementary.

E.3 Possibility of Strategic Silence

E.3.1 Sufficiently Substitutive Signals

First, we show that if the signals are sufficiently substitutive, then strategic silence may prevent empowerment as in the baseline model. Define

$$v^{Emix} \equiv 1 + \frac{2q_P(1-q_A)\tau + (1-\tau)}{2(1-q_P)q_A\tau}. \tag{E.9}$$

Note that $v^{Dmix} < v^{Emix}$ holds for any τ. The following is a counterpart of Proposition 4.

Proposition E.2. *Consider the mixed signal model, and suppose that Assumption E.1-1 holds. Then, strategic silence occurs if* $v < \min\{v_{1-1}^{Cmix}, v^{Emix}\}$*.*

Proof (Proposition E.2)**.** Suppose that there exists an empowerment equilibrium under Assumption E.1-1. As the agent discloses his signal followed by rubber-stamping and execution on the empowerment equilibrium, his expected payoff is as follows: for each θ_A,

$$V^{*mix}(\theta_A, m = \theta_A) = \left[q_A\tau + \frac{1}{2}(1-\tau)\right]b - c. \tag{E.10}$$

Consider that the agent deviates to $m = \phi$. Because of Requirement 1, the continuation game after $m = \phi$ is identical to that under centralization. Hence, the agent's expected payoff after the deviation is

$$V^{*mix}(\theta_A, m = \phi) = \begin{cases} \left[q_Pq_A\tau + \frac{1}{2}(1-\tau)\right]b - \left[(q_Pq_A + (1-q_P)(1-q_A))\tau + \frac{1}{2}(1-\tau)\right]c & \text{if } \theta_A = 1, \\ q_Pq_A\tau b - \left[(q_Pq_A + (1-q_P)(1-q_A))\tau + \frac{1}{2}(1-\tau)\right]c & \text{if } \theta_A = -1. \end{cases} \tag{E.11}$$

As $V^{*mix}(\theta_A = 1, m = \phi) > V^{*mix}(\theta_A = -1, m = \phi)$ and $V^{*mix}(\theta_A = m = 1) = V^{*mix}(\theta_A =$

$m = -1$), a necessary condition for the existence of an empowerment equilibrium is $V^{*mix}(\theta_A = m = 1) \geq V^{*mix}(\theta_A = 1, m = \phi)$. That is,

$$\left[q_A\tau + \frac{1}{2}(1-\tau)\right] b - c \geq \left[q_P q_A \tau + \frac{1}{2}(1-\tau)\right] b - \left[\left(q_P q_A + (1-q_P)(1-q_A)\right)\tau + \frac{1}{2}(1-\tau)\right] c, \tag{E.12}$$

or still, $v \geq v^{Emix}$. In other words, when $v < v^{Emix}$, the agent prefers to deviate to $m = \phi$, and then strategic silence occurs. ■

E.3.2 Sufficiently Complementary Signals

Contrary to the previous case, strategic silence no longer occurs if signals are sufficiently complementary. Knowing both signals is essential for inferring the true state when the signals are complementary. Hence, after knowing the agent's signal, overturning the agent's suggestion might be optimal for both parties. Under Assumption E.1-2, we hereinafter focus on the following strategy: for each θ_P, θ_A and d,

$$\begin{aligned} m^*(\theta_A) &= \theta_A, \\ d^*(\theta_P, m \neq \phi) &= \begin{cases} 1 & \text{if } m = \theta_P, \\ -1 & \text{if } m = -\theta_P, \end{cases} \\ e^*(\theta_A, m = \theta_A, d) &= 1. \end{aligned} \tag{E.13}$$

This strategy profile constitutes *coordination* of information because the principal's project choice crucially relies on both θ_P and $m(= \theta_A)$. An equilibrium satisfying (E.13) and Requirement 1 is referred to as a *coordination equilibrium.* Let $U^{CO}(\tau)$ represent the principal's *ex ante* expected payoff on a coordination equilibrium. The existence of coordination equilibria is guaranteed when the signals are sufficiently complementary, as shown below.

Proposition E.3. *Consider the mixed signal model, and suppose that Assumption E.1-2 holds. Then, there exists a coordination equilibrium with* $U^{CO}(\tau) > U^{Dmix}(\tau) > U^{Cmix}(\tau)$ *for any* τ*.*

Proof (Proposition E.3)**.** We show that the following is a PBE under $\tau < \tau^{COD}$:

$$\begin{aligned}
m^*(\theta_A) &= \theta_A \text{ for each } \theta_A, \\
d^*(\theta_P, m) &= \begin{cases} 1 & \text{if } m = \theta_P \text{ or } [m = \phi \text{ and } \theta_P = 1], \\ -1 & \text{if } m = -\theta_P \text{ or } [m = \phi \text{ and } \theta_P = -1], \end{cases} \\
e^*(\theta_A, m, d) &= \begin{cases} 0 & \text{if } \theta_A = -1 \text{ and } m = \phi, \\ 1 & \text{otherwise,} \end{cases} \\
\mu^*(\theta_A \mid \theta_P, m) &= \begin{cases} \mathcal{D}(m) & \text{if } m \neq \phi, \\ \text{Prob}(\theta_A \mid \theta_P) & \text{if } m = \phi, \end{cases} \\
\nu^*(\theta_P \mid \theta_A, m, d) &= \begin{cases} \mathcal{D}(d) & \text{if } m = 1 \text{ or } m = \phi, \\ \mathcal{D}(-d) & \text{if } m = -1, \end{cases}
\end{aligned} \tag{E.14}$$

where $\mathcal{D}(x)$ represents a degenerate distribution on point x.

The optimality of e^* is shown as follows. Note that the agent's confidence is summarized as follows:

$$\text{Prob}(s = d \mid \theta_A, m, d) = \begin{cases} \eta_{11}^{Cmix} & \text{if } (\theta_A, m, d) = (1, 1, 1) \text{ or } (1, \phi, 1), \\ \eta_{1-1}^{Cmix} & \text{if } (\theta_A, m, d) = (1, 1, -1) \text{ or } (1, \phi, -1), \\ \eta_{-11}^{CO} & \text{if } (\theta_A, m, d) = (-1, -1, 1), \\ \eta_{-1-1}^{CO} & \text{if } (\theta_A, m, d) = (-1, -1, -1), \\ \eta_{-11}^{Cmix} & \text{if } (\theta_A, m, d) = (-1, \phi, 1), \\ \eta_{-1-1}^{Cmix} & \text{if } (\theta_A, m, d) = (-1, \phi, -1), \end{cases} \tag{E.15}$$

where

$$\eta^{CO}_{-11} \equiv \frac{2(1-q_P)(1-q_A)\tau + (1-\tau)}{2[q_P q_A + (1-q_P)(1-q_A)]\tau + (1-\tau)}, \tag{E.16}$$

$$\eta^{CO}_{-1-1} \equiv \frac{2(1-q_P)q_A\tau + (1-\tau)}{2[q_P(1-q_A) + (1-q_P)q_A]\tau + (1-\tau)}. \tag{E.17}$$

Define $v^{CO}_{\theta_A d} \equiv 1/\eta^{CO}_{\theta_A d}$. By simple algebra, it is possible to confirm that $v^{CO}_{-11} \leq v^{Dmix}$ if and only if $\tau \leq \tau^{COD}$ and $v^{CO}_{-1-1} < v^{CO}_{-11}$ hold. Hence, in this parameter range, the agent's best response is to execute the chosen project unless $(\theta_A, m, d) = (-1, \phi, 1)$ or $(-1, \phi, -1)$.

The optimality of d^* is shown as follows. For $(\theta_P, m) = (1, 1)$, the principal's expected payoffs are:

$$\begin{cases} \left[\left(\dfrac{q_P q_A}{q_P q_A + (1-q_P)(1-q_A)}\right)\tau + (1-\tau)\right] B & \text{if } d = 1, \\ \\ \left(\dfrac{(1-q_P)(1-q_A)}{q_P q_A + (1-q_P)(1-q_A)}\right)\tau B. & \text{if } d = -1. \end{cases} \tag{E.18}$$

As $q_i \in (1/2, 1)$ for each i, $d = 1$ is optimal. For $(\theta_P, m) = (1, -1)$, the principal's expected payoffs are:

$$\begin{cases} \left[\left(\dfrac{(1-q_P)q_A}{q_P(1-q_A) + (1-q_P)q_A}\right)\tau + (1-\tau)\right] B & \text{if } d = -1, \\ \\ \left(\dfrac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A}\right)\tau B & \text{if } d = 1. \end{cases} \tag{E.19}$$

As $\tau < 1/2$ by Assumption E.1-2, $d = -1$ is optimal. For $(\theta_P, m) = (1, \phi)$, the principal's expected payoffs from $d = 1$ and -1 are $[q_P q_A\tau + (1-\tau)/2]B$ and $(1-q_P)(1-q_A)\tau B$, respectively. As $q_i \in (1/2, 1)$ for each i, $d = 1$ is optimal. For $(\theta_P, m) = (-1, 1)$, the principal's expected payoffs are:

$$
\begin{cases}
\left[\left(\dfrac{q_P(1-q_A)}{q_P(1-q_A)+(1-q_P)q_A}\right)\tau+(1-\tau)\right]B & \text{if } d=-1, \\[2em]
\left(\dfrac{(1-q_P)q_A}{q_P(1-q_A)+(1-q_P)q_A}\right)\tau B & \text{if } d=1.
\end{cases}
\tag{E.20}
$$

Because $\tau < 1/2$, $d=-1$ is optimal. For $(\theta_P, m) = (-1,-1)$, the principal's expected payoffs are:

$$
\begin{cases}
\left[\left(\dfrac{(1-q_P)(1-q_A)}{q_Pq_A+(1-q_P)(1-q_A)}\right)\tau+(1-\tau)\right]B & \text{if } d=1, \\[2em]
\left(\dfrac{q_Pq_A}{q_Pq_A+(1-q_P)(1-q_A)}\right)\tau B & \text{if } d=-1.
\end{cases}
\tag{E.21}
$$

As in the previous case, $d=1$ is optimal because of $\tau < 1/2$. For $(\theta_P, m) = (-1, \phi)$, the principal's expected payoffs from $d=-1$ and 1 are $[q_P(1-q_A)\tau+(1-\tau)/2]B$ and $(1-q_P)q_A\tau B$, respectively. As $\tau < 1/2$, $d=-1$ is optimal.

The optimality of m^* is shown as follows. Note that if the agent deviates to $m=\phi$, the parties behave as in centralization. For $\theta_A = 1$, the expected payoffs from $m=1$ and ϕ are both $[q_P\tau+(1-\tau)]b-c$. Hence, $m=1$ is clearly optimal. Likewise, for $\theta_A=-1$, the expected payoffs from $m=-1$ and ϕ are $[(1-q_P)\tau+(1-\tau)]b-c$ and 0, respectively. Again, $m=-1$ is optimal.

Evidently, μ^* and ν^* are consistently derived from m^* and d^* by using Bayes' rule whenever it is possible. Therefore, (E.14) is a PBE. Clearly, (E.14) satisfies the requirements of symmetric messages and symmetric beliefs. Furthermore, by tedious algebra, it can be confirmed that the continuation optimality is satisfied. Therefore, we conclude that the PBE characterized in (E.14) is a coordination equilibrium.

The principal's expected payoff in the coordination equilibrium is

$$U^{CO} \equiv \left(1 - \frac{1}{2}\tau\right) B. \tag{E.22}$$

Hence, the difference from (E.7) is

$$\left(1 - \frac{1}{2}\tau\right) B - \left[\frac{1}{2}q_P\tau + \frac{1}{2}(1-\tau)\right] B = \frac{1}{2}\left[(1-q_P)\tau + (1-\tau)\right] > 0. \tag{E.23}$$

Likewise, the difference from (E.8) is

$$\begin{aligned}\left(1 - \frac{1}{2}\tau\right) B - \left[q_A\tau + \frac{1}{2}(1-\tau)\right] B &= \left(\frac{1}{2} - q_A\right)\tau + \frac{1}{2}(1-\tau) \\ &= \frac{1}{2} - q_A\tau > 0,\end{aligned} \tag{E.24}$$

where the last inequality comes from $\tau < 1/2$. ■

When the signals are sufficiently complementary, introducing communication may strictly outperform formal delegation without communication. Recall that when the signals are sufficiently substitutive, empowerment is beneficial because the principal prefers to avoid incorporating her signal into the project choice as long as the agent discloses his signal. This is mainly because knowing either one of the signals is sufficient to choose the promising project. In contrast to the principal, the agent desires both signals for his execution decision. The conflict over disclosing the principal's signal generates strategic silence, as mentioned in the body of the paper.

The conflict disappears when the signals are sufficiently complementary. As the project choice should rely on both signals, the principal prefers to incorporate her signal into the project choice. As the agent learns the principal's signal no matter how he behaves in the communication stage, he has no incentive to be silent. The superiority of the coordination equilibrium over centralization and formal delegation implies that the decision process with communication outperforms those without communication when the signals are sufficiently complementary. The comparison between substitutive and complementary signals suggests that upward voice from subordinates are more active in organizations in which the private information of the top and the subordinates are complement than those with substitutive information.

F Uncertain Precision of Signals (for Online Appendix)

In this appendix, we relax the assumption of the baseline model that precision q_i is common knowledge and consider an environment where the precision of his/her signal is also the parties' private information. We then show that the qualitatively same results still hold in this extension.[46]

F.1 Preliminaries

We assume that in addition to signal θ_i, precision q_i is also party i's private information. Let $q_i \in Q_i \equiv \{q_i^-, q_i^+\}$ represent the precision of signal θ_i with $1/2 < q_i^- < q_i^+ < 1$ for each $i \in \{P, A\}$ and satisfy $\text{Prob}(\theta_i = s \mid s) = q_i$ for each i and s. Let $\text{Prob}(q_i = q_i^+) = \alpha_i \in (0, 1)$ be the common prior over the precision of signal θ_i. We assume that q_P and q_A are independently determined governed by the above distribution. Let $\bar{q}_i \equiv \alpha_i q_i^+ + (1-\alpha) q_i^-$ represent the expectation of precision q_i. The remaining setup is identical to that of the baseline model. The modified setup is referred to as the *uncertain precision model.*

Given the above extension, the parties' strategies in the ACE procedure are modified as follows. Let $m^U : \Theta \times Q_A \to M$ and $e^U : \Theta \times Q_A \times M \times D \to E$ represent the agent's local strategies at the communication stage and the execution stage, respectively. Likewise,

[46] The omitted algebra and proof are available upon request.

let $d^U : \Theta \times Q_P \times M \to D$ represent the principal's strategy. Given the agent's execution strategy e^U, the principal's *interim* expected payoff from project d after observing message m is represented by

$$U^U(\theta_P, q_P, d \mid m) \equiv \sum_{q_A \in Q_A} \sum_{\theta_A \in \Theta} \sum_{s \in S} Bx\left(s, d, e^U(\theta_A, q_A, m, d)\right) \mathrm{Prob}(s \mid \theta_P, \theta_A, q_P, q_A)$$

$$\times \mathrm{Prob}(\theta_A \mid \theta_P, q_P, q_A, m)\mathrm{Prob}(q_A \mid m). \tag{F.1}$$

F.2 Centralization

First, we show that this extension does not change the structure of optimal equilibria under centralization. With the abuse of some notation, the parties' strategies under centralization are also represented by d^U and e^U for simplification.

F.2.1 Preliminaries

As the principal's private information is multidimensional and the project choice is binary, we have the following pooling structures:

(i) $d^U(\theta_P, q_P) = \tilde{d}$ for each θ_P and q_P (*fully pooling*);

(ii) $d^U(\theta_P, q_P) = \theta_P$ for each θ_P and q_P (θ*-separating*);

(iii) $d^U(\theta_P, q_P) = d'$ if $q_P = q_P^+$ and d'' if $q_P = q_P^-$ with $d' \neq d''$ (q*-separating*);

(iv) $d^U(\theta_P, q_P) = d'$ if $(\theta_P, q_P) = (\theta'_P, q'_P)$ and d'' otherwise with $d' \neq d''$ (*semi-separating*);

(v) $d^U(\theta_P, q_P) = d'$ if $(\theta_P, q_P) = (\theta'_P, q'_P)$ or (θ''_P, q''_P) and d'' if $(\theta_P, q_P) = (\theta'_P, q''_P)$ or (θ''_P, q'_P) with $\theta'_P \neq \theta''_P$, $q'_P \neq q''_P$, and $d' \neq d''$ (*diagonal-pooling*).

Note that, with some abuse of notation, the principal's *interim* expected payoff under centralization can be rewritten as follows:

$$U^U(\theta_P, q_P, d) = \left(\text{Prob}(s = d \mid \theta_P, q_P) \sum_{(\theta_A, d) \in \Omega(d)} \text{Prob}\left((\theta_A, q_A) \mid s = d\right) \right) B, \tag{F.2}$$

where $\Omega(d) \equiv \left\{(\theta_A, q_A) \in \Theta \times Q_A \mid e^U(\theta_A, q_A, d) = 1\right\}$. Let $\eta^U_{\theta_A d}(q_A)$ represent the agent's confidence after observing project d when his type is (θ_A, q_A). Define $v^U_{\theta_A d}(q_A) \equiv 1/\eta^U_{\theta_A d}(q_A)$.

We can show that there exists a θ-separating equilibrium that dominates any fully pooling equilibrium.

Lemma F.1. *Consider the uncertain precision model. Then, there exists a θ-separating equilibrium. Furthermore, the principal's ex ante expected payoff in the θ-separating equilibrium is greater than in any fully pooling equilibrium.*

Proof (Lemma F.1)**.** By replacing q_i with $\bar{q}_i$, we can apply the same argument adopted in the proof of Lemmas 1 and 2 to prove the statement. ■

Hereinafter, we show that the other strategies are not supported in equilibria unless the intrinsic incentive is sufficiently small.

F.2.2 Semi-Separating Equilibria

Consider, without loss of generality, the following semi-separating strategy:[47]

$$d^U(\theta_P, q_P) = \begin{cases} 1 & \text{if } (\theta_P, q_P) = (1, q_P^+), \\ -1 & \text{otherwise.} \end{cases} \tag{F.4}$$

The non-existence of semi-separating equilibria is shown by using the following claim.

[47] Another semi-separating strategy is

$$d^U(\theta_P, q_P) = \begin{cases} -1 & \text{if } (\theta_P, q_P) = (1, q_P^+), \\ 1 & \text{otherwise.} \end{cases} \tag{F.3}$$

However, we can show that the above structure is neither supported in equilibrium by the same argument adopted below. The details are available upon request.

Claim F.1. *Consider the uncertain precision model, and suppose that there exists a semi-separating equilibrium with (F.4). Then,*

$$\sum_{(\theta_A,q_A)\in\Omega(1;v)} \text{Prob}\left((\theta_A,q_A)\mid s=1\right) = \begin{cases} 1 & \text{if } v \geq v^U_{-11}(q_A^+), \\ \alpha_A q_A^+ + (1-\alpha_A) & \text{if } v^U_{-11}(q_A^-) \leq v < v^U_{-11}(q_A^+), \\ \alpha_A q_A^+ + (1-\alpha_A)q_A^- & \text{if } v^U_{11}(q_A^-) \leq v < v^U_{-11}(q_A^-), \\ \alpha_A q_A^+ & \text{if } v^U_{11}(q_A^+) \leq v < v^U_{11}(q_A^-), \\ 0 & \text{otherwise.} \end{cases} \tag{F.5}$$

$$\sum_{(\theta_A,q_A)\in\Omega(-1;v)} \text{Prob}\left((\theta_A,q_A)\mid s=-1\right) = \begin{cases} 1 & \text{if } v \geq v^U_{1-1}(q_A^+), \\ \alpha_A q_A^+ + (1-\alpha_A) & \text{if } v^U_{1-1}(q_A^-) \leq v < v^U_{1-1}(q_A^+), \\ \alpha_A q_A^+ + (1-\alpha_A)q_A^- & \text{if } v^U_{-1-1}(q_A^-) \leq v < v^U_{1-1}(q_A^-), \\ \alpha_A q_A^+ & \text{if } v^U_{-1-1}(q_A^+) \leq v < v^U_{-1-1}(q_A^-), \\ 0 & \text{otherwise.} \end{cases} \tag{F.6}$$

Proof (Claim F.1)**.** Given (F.4), the agent's confidence is as follows: for each q_A,

$$\begin{aligned} \eta^U_{11}(q_A) &= \frac{q_P^+ q_A}{q_P^+ q_A + (1-q_P^+)(1-q_A)}, \\ \eta^U_{-11}(q_A) &= \frac{q_P^+(1-q_A)}{q_P^+(1-q_A) + (1-q_P^+)q_A}, \\ \eta^U_{1-1}(q_A) &= \frac{(1-q_A)(\alpha_P q_P^+ + 1 - \alpha_P)}{\alpha_P[q_P^+(1-q_A) + (1-q_P^+)q_A] + 1 - \alpha_P}, \\ \eta^U_{-1-1}(q_A) &= \frac{q_A(\alpha_P q_P^+ + 1 - \alpha_P)}{\alpha_P[q_P^+(1-q_A) + (1-q_P^+)q_A] + 1 - \alpha_P}. \end{aligned} \tag{F.7}$$

By tedious algebra, the order of $v^U_{\theta_A d}(q_A)$ is summarized as follows. If $\alpha_P q^+_P(1-q^+_P)(q^+_A - q^-_A) \leq (1-\alpha_P)\left[q^+_P(q^+_A + q^-_A - 2q^+_A q^-_A) - q^+_A(1-q^-_A)\right]$, then

$$\begin{aligned}
& v^U_{11}(q^+_A) < v^U_{11}(q^-_A) \leq v^U_{-1-1}(q^+_A) < v^U_{-1-1}(q^-_A) \\
& \quad < v^U_{-11}(q^-_A) < v^U_{-11}(q^+_A) \leq v^U_{1-1}(q^-_A) < v^U_{1-1}(q^+_A).
\end{aligned} \tag{F.8}$$

Otherwise, the order is

$$\begin{aligned}
& v^U_{11}(q^+_A) < v^U_{-1-1}(q^+_A) < v^U_{11}(q^-_A) < v^U_{-1-1}(q^-_A) \\
& \quad < v^U_{-11}(q^-_A) < v^U_{1-1}(q^-_A) < v^U_{-11}(q^+_A) < v^U_{1-1}(q^+_A).
\end{aligned} \tag{F.9}$$

Given (F.7), the agent's best response is characterized as follows. For $d = 1$,

$$e^U(\theta_A, q_A, d=1; v) = 1 \begin{cases} \text{for any } \theta_A \text{ and } q_A & \text{when } v \geq v^U_{-11}(q^+_A), \\ \text{unless } (\theta_A, q_A) = (-1, q^+_A) & \text{when } v^U_{-11}(q^-_A) \leq v < v^U_{-11}(q^+_A), \\ \text{if and only if } \theta_A = 1 & \text{when } v^U_{11}(q^-_A) \leq v < v^U_{-11}(q^-_A), \\ \text{if and only if } (\theta_A, q_A) = (1, q^+_A) & \text{when } v^U_{11}(q^+_A) \leq v < v^U_{11}(q^-_A). \end{cases} \tag{F.10}$$

Likewise, for $d = -1$,

$$e^U(\theta_A, q_A, d=-1; v) = 1 \begin{cases} \text{for any } \theta_A \text{ and } q_A & \text{when } v \geq v^U_{1-1}(q^+_A), \\ \text{unless } (\theta_A, q_A) = (1, q^+_A) & \text{when } v^U_{1-1}(q^-_A) \leq v < v^U_{1-1}(q^+_A), \\ \text{if and only if } \theta_A = -1 & \text{when } v^U_{-1-1}(q^-_A) \leq v < v^U_{1-1}(q^-_A), \\ \text{if and only if } (\theta_A, q_A) = (-1, q^+_A) & \text{when } v^U_{-1-1}(q^+_A) \leq v < v^U_{-1-1}(q^-_A). \end{cases} \tag{F.11}$$

As a result, we characterize the probability of execution conditional on the promising project being chosen. ■

Lemma F.2. *Consider the uncertain precision model and suppose that* $v \geq v_{11}^U(q_A^+)$*. Then, there exists no semi-separating equilibrium.*

Proof (Lemma F.2)**.** Suppose, in contrast, that there exists a semi-separating equilibrium satisfying (F.4). Note that, by Claim F.1, (F.8) and (F.9) imply that for any $v \geq v_{11}^U(q_A^+)$,

$$\sum_{(\theta_A,q_A)\in\Omega(1;v)} \mathrm{Prob}\left((\theta_A, q_A) \mid s = 1\right) \geq \sum_{(\theta_A,q_A)\in\Omega(-1;v)} \mathrm{Prob}\left((\theta_A, q_A) \mid s = -1\right). \tag{F.12}$$

Hence, for any $v \geq v_{11}^U(q_A^+)$, we have $U^U(1, q_P^-, 1) > U^U(1, q_P^-, -1)$ because of (F.2) and $q_P^- > 1/2$. However, it means that type $(\theta_P, q_P) = (1, q_P^-)$ has an incentive to deviate, which is a contradiction. Even if we consider other semi-separating strategies, the similar argument above shows that the principal has the incentive to deviate. ■

F.2.3 q-Separating Equilibria

Consider, without loss of generality, the following q-separating strategy:

$$d^U(\theta_P, q_P) = \begin{cases} 1 & \text{if } q_P = q_P^+, \\ -1 & \text{if } q_P = q_P^-. \end{cases} \tag{F.13}$$

The existence of q-separating equilibria is also denied by using the following claim.

Claim F.2. *Consider the uncertain precision model, and suppose that there exists a q-separating equilibrium. Then, for any d,*

$$\sum_{(\theta_A,q_A)\in\Omega(d;v)} \mathrm{Prob}((\theta_A,q_A)\mid s=d) = \begin{cases} 1 & \textit{if } v \geq 1/[1-q_A^+], \\ \alpha_A q_A^+ + (1-\alpha_A) & \textit{if } 1/[1-q_A^-] \leq v < 1/[1-q_A^+], \\ \alpha_A q_A^+ + (1-\alpha_A) q_A^- & \textit{if } 1/q_A^- \leq v < 1/[1-q_A^-], \\ \alpha_A q_A^+ & \textit{if } 1/q_A^+ \leq v < 1/q_A^-, \\ 0 & \textit{otherwise.} \end{cases} \tag{F.14}$$

Proof (Claim F.2)**.** As the principal never reveals θ_P through the project choice, the agent's confidence is identical to that under formal delegation in the baseline model. Hence, for each q_A, $v_{11}^U(q_A) = v_{-1-1}^U(q_A) = 1/q_A$ and $v_{1-1}^U(q_A) = v_{-11}^U(q_A) = 1/(1-q_A)$ holds. Then, $v_{\theta_A d}^U(q_A)$ satisfies

$$\begin{aligned} v_{11}^U(q_A^+) &= v_{-1-1}^U(q_A^+) < v_{11}^U(q_A^-) = v_{-1-1}^U(q_A^-) \\ &< v_{-11}^U(q_A^-) = v_{1-1}^U(q_A^-) < v_{-11}^U(q_A^+) = v_{1-1}^U(q_A^+). \end{aligned} \tag{F.15}$$

Given the confidence, the agent's best response is characterized as follows: for each d,

$$e^U(\theta_A,q_A,d;v) = 1 \begin{cases} \text{for any } \theta_A \text{ and } q_A & \text{when } v \geq 1/(1-q_A^+), \\ \text{unless } \theta_A \neq d \text{ and } q_A = q_A^+ & \text{when } 1/(1-q_A^-) \leq v < 1/(1-q_A^+), \\ \text{if and only if } \theta_A = d & \text{when } 1/q_A^- \leq v < 1/(1-q_A^-), \\ \text{if and only if } (\theta_A.q_A) = (d, q_A^+) & \text{when } 1/q_A^+ \leq v < 1/q_A^-, \end{cases} \tag{F.16}$$

which implies the statement. ■

Lemma F.3. *Consider the uncertain precision model, and suppose that $v \geq 1/q_A^+$. Then, there exists no q-separating equilibrium.*

Proof (Lemma F.3)**.** Suppose, in contrast, that there exists a q-separating equilibrium satisfying (F.13). By Claim F.2, for any $v \geq 1/q_A^+$, we have

$$\zeta \equiv \sum_{(\theta_A, q_A) \in \Omega(1;v)} \text{Prob}((\theta_A, q_A) \mid s = 1) = \sum_{(\theta_A, q_A) \in \Omega(-1;v)} \text{Prob}((\theta_A, q_A) \mid s = -1). \tag{F.17}$$

By (F.2), the principal with $(\theta_P, q_P) = (1, q_P^-)$ obtains expected payoffs $q_P^- \zeta$ and $(1 - q_P^-)\zeta$ by choosing $d = 1$ and -1, respectively. However, it means that the principal has the incentive to deviate to $d = 1$, which is a contradiction. ■

F.2.4 Diagonal-Pooling Equilibria

Consider, without loss of generality, the following diagonal-pooling strategy:

$$d^U(\theta_P, q_P) = \begin{cases} 1 & \text{if } (\theta_P, q_P) = (1, q_P^+) \text{ or } (-1, q_P^-), \\ -1 & \text{otherwise.} \end{cases} \tag{F.18}$$

Lemma F.4. *Consider the uncertain precision model, and suppose that $v \geq v_{11}^U(q_A^+)$. Then, there exists no diagonal-pooling equilibrium.*

Proof (Lemma F.4)**.** Suppose, in contrast, that there exists a diagonal-pooling equilibrium satisfying (F.18). Given (F.18), the confidence satisfies

$$\eta_{11}^U(q_A) = \eta_{-1-1}^U(q_A) = \frac{q_A[\alpha_P q_P^+ + (1-\alpha_P)(1-q_P^-)]}{q_A[\alpha_P q_P^+ + (1-\alpha_P)(1-q_P^-)] + (1-q_A)[\alpha_P(1-q_P^+) + (1-\alpha_P)q_P^-]}, \tag{F.19}$$

$$\eta_{1-1}^U(q_A) = \eta_{-11}^U(q_A) = \frac{(1-q_A)[\alpha_P q_P^+ + (1-\alpha_P)(1-q_P^-)]}{q_A[\alpha_P(1-q_P^+) + (1-\alpha_P)q_P^-] + (1-q_A)[\alpha_P q_P^+ + (1-\alpha_P)(1-q_P^-)]}. \tag{F.20}$$

By some algebra, $v^U_{\theta_A d}(q_A)$ satisfies

$$v^U_{11}(q^+_A) = v^U_{-1-1}(q^+_A) < v^U_{11}(q^-_A) = v^U_{-1-1}(q^-_A)$$
$$< v^U_{-11}(q^-_A) = v^U_{1-1}(q^-_A) < v^U_{-11}(q^+_A) = v^U_{1-1}(q^+_A). \tag{F.21}$$

Note that the order of $v^U_{\theta_A d}(q_A)$ is identical to (F.15). Hence, by the same argument used in the proof of Lemma F.3, we derive a contradiction. ■

F.2.5 Optimal Equilibria

Because of the series of lemmas above, the optimal equilibrium under centralization is characterized as follows. For each q_A, let

$$v^{Cunce}_0(q_A) \equiv v^U_{11}(q_A) = v^U_{-1-1}(q_A) = 1 + \frac{(1-\bar{q}_P)(1-q_A)}{\bar{q}_P q_A}, \tag{F.22}$$
$$v^{Cunce}_1(q_A) \equiv v^U_{1-1}(q_A) = v^U_{-11}(q_A) = 1 + \frac{(1-\bar{q}_P)q_A}{\bar{q}_P(1-q_A)}. \tag{F.23}$$

Proposition F.1. *Consider the uncertain precision model.*

1. *There exists a θ-separating equilibrium that is optimal under centralization.*

2. *The principal's ex ante expected payoff on the optimal equilibrium is*

$$U^{Cunce}(v) = \begin{cases} \bar{q}_P B & \text{if } v \geq v^{Cunce}_1(q^+_A), \\ \bar{q}_P\left(\alpha_A q^+_A + 1 - \alpha_A\right)B & \text{if } v^{Cunce}_1(q^-_A) \leq v < v^{Cunce}_1(q^+_A), \\ \bar{q}_P\bar{q}_A B & \text{if } v^{Cunce}_0(q^-_A) \leq v < v^{Cunce}_0(q^-_A), \\ \bar{q}_P\alpha_A q^+_A B & \text{if } v^{Cunce}_0(q^+_A) \leq v < v^{Cunce}_0(q^-_A), \\ 0 & \text{if } v < v^{Cunce}_0(q^+_A). \end{cases} \tag{F.24}$$

Proof (Proposition F.1)**.** 1. By Lemmas F.2, F.3, and F.4, if there exists an equilibrium other than θ-separating or fully pooling equilibria, then the principal's expected payoff should be zero. Hence, with Lemma F.1, we conclude that a θ-separating equilibrium is optimal.

2. By algebra, the probability of execution conditional on the promising project being chosen is summarized as follows: for each d,

$$\sum_{(\theta_A, q_A) \in \Omega(d;v)} \text{Prob}\left((\theta_A, q_A) \mid s = d\right) = \begin{cases} 1 & \text{if } v \geq v_1^{Cunce}(q_A^+), \\ \alpha_A q_A^+ + 1 - \alpha_A & \text{if } v_1^{Cunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^+), \\ \bar{q}_A & \text{if } v_0^{Cunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^-), \\ \alpha_A q_A^+ & \text{if } v_0^{Cunce}(q_A^+) \leq v < v_0^{Cunce}(q_A^-), \\ 0 & \text{if } v < v_0^{Cunce}(q_A^+). \end{cases} \tag{F.25}$$

Because of (F.2) and (F.25), we have the characterization in the statement. ■

Proposition F.1 means that the structure of optimal equilibrium is essentially equivalent to that of the baseline model. Recall that in the baseline model, the optimal equilibrium payoff $U^C(v)$ is a step function with two discontinuous points $v = v_0^C$ and v_1^C. When the precision is private information, there are more discontinuous points that depend on whether the agent's precision is high or low.

F.3 The Value of Formal Delegation

The optimal equilibrium under formal delegation is also essentially equivalent to the baseline model's. Let $d^{DU} : \Theta \times Q_A \to D$ and $e^{DU} : \Theta \times Q_A \times D \to E$ represent the agent's local strategies under formal delegation. By the similar argument used in the body of the paper, we can show that the optimal equilibrium has the following structure: for each θ_A and q_A, (i) $d^{DU}(\theta_A, q_A) = \theta_A$, and (ii) $e^{DU}(\theta_A, q_A, d = \theta_A) = 1$ if and only if $v \geq v^{Dunce}(q_A) \equiv 1/q_A$. As $v^{Dunce}(q_A^+) < v^{Dunce}(q_A^-)$, the principal's *ex ante* expected payoff under formal delegation is given by

$$U^{Dunce}(v) = \begin{cases} \bar{q}_A B & \text{if } v \geq v^{Dunce}(q_A^-), \\ \alpha_A q_A^+ B & \text{if } v^{Dunce}(q_A^+) \leq v < v^{Dunce}(q_A^-), \\ 0 & \text{if } v < v^{Dunce}(q_A^+). \end{cases} \tag{F.26}$$

By comparing (F.26) with (F.24), we can characterize the value of formal delegation. To clarify our argument, we hereinafter restrict our attention to the following case.

Assumption F.1. *The following conditions hold:*

$$\bar{q}_P < \hat{q}_P(q_A^-) \equiv \frac{(q_A^-)^2}{(q_A^-)^2 + (1-q_A^-)^2}, \tag{F.27}$$

$$q_A^+ > \frac{(q_A^-)^3}{(q_A^-)^3 + (1-q_A^-)^3}. \tag{F.28}$$

(F.27) requires that $\bar{q}_P$ is not sufficiently large, which corresponds $q_P < \hat{q}_P(q_A)$ in the baseline model and implies that $v^{Dunce}(q_A^-) < v_1^{Cunce}(q_A^-)$. (F.28) requires that the difference between q_A^+ and q_A^- is sufficiently large, which is equivalent to that $q_A^+(1-q_A^-)/[q_A^+(1-q_A^-) + q_A^-(1-q_A^+)] \geq \hat{q}_P(q_A^-)$. Hence, with (F.27), we have $v^{Dunce}(q_A^+) < v_0^{Cunce}(q_A^-)$, which further implies

$$\begin{aligned} v_0^{Cunce}(q_A^+) < v^{Dunce}(q_A^+) < v_0^{Cunce}(q_A^-) \\ < v^{Dunce}(q_A^-) < v_1^{Cunce}(q_A^-) < v_1^{Cunce}(q_A^+). \end{aligned} \tag{F.29}$$

By simple algebra, the necessary and sufficient conditions for $U^{Dunce}(v) > U^{Cunce}(v)$ is either one of the following: (i) $v^{Dunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^-)$, (ii) $v^{Dunce}(q_A^+) \leq v < v_0^{Cunce}(q_A^-)$, or (iii) either one of them:

$$\bar{q}_P < \begin{cases} \bar{q}_A & \text{if } v \geq v_1^{Cunce}(q_A^+), \\ q'_P(\alpha_A) \equiv \dfrac{\bar{q}_A}{\alpha_A q_A^+ + 1 - \alpha_A} & \text{if } v_1^{Cunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^-), \\ q''_P(\alpha_A) \equiv \dfrac{\alpha_A q_A^+}{\bar{q}_A} & \text{if } v_0^{Cunce}(q_A^-) \leq v < v^{Dunce}(q_A^-). \end{cases} \tag{F.30}$$

As the order of thresholds on $\bar{q}_P$ depends on α_A, we put the following restriction on α_A for easy exposition.

Assumption F.2. *The following condition holds:*

$$\frac{q_A^-(2q_A^- - 1)}{q_A^+(1 - q_A^-) + q_A^-(2q_A^- - 1)} < \alpha_A < \frac{q_A^-(1 - q_A^-)(2q_A^- - 1)}{(q_A^+ - q_A^-)\left[(q_A^-)^2 + (1 - q_A^-)^2\right]}. \tag{F.31}$$

Assumption F.2 implies that $q''_P(\alpha_A) < \bar{q}_A < \hat{q}_P(q_A^-) < q'_P(\alpha_A)$.[48] Given those observations, the value of formal delegation is characterized as follows.

Proposition F.2. *Consider the uncertain precision model, and suppose that Assumptions F.1 and F.2 hold. Then, $U^{Cunce}(v) < U^{Dunce}(v)$ holds if and only if one of the following holds:*

1. *$\bar{q}_P < q''_P(\alpha_A)$ and $v \geq v^{Dunce}(q_A^+)$;*
2. *$q''_P(\alpha_A) \leq \bar{q}_P < \bar{q}_A$ and either (i) $v \geq v^{Dunce}(q_A^-)$ or (ii) $v^{Dunce}(q_A^+) \leq v < v_0^{Cunce}(q_A^-)$; or*
3. *$\bar{q}_A \leq \bar{q}_P < \hat{q}_P(q_A^-)$ and either (i) $v^{Dunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^+)$ or (ii) $v^{Dunce}(q_A^+) \leq v < v_0^{Cunce}(q_A^-)$.*

[48]Specifically, the first and the second inequalities in Assumption F.2 imply that $\hat{q}_P(q_A^-) < q'_P(\alpha_A)$ and $\bar{q}_A < \hat{q}_P(q_A^-)$, respectively. Furthermore, the characterization of the value of formal delegation without Assumption F.2 is qualitatively identical to that derived below. The details are available upon request.

Proposition F.2 is a generalization of Proposition 2. As in the baseline model, formal delegation is better than centralization when the execution is demotivated under centralization, but not under formal delegation. More specifically, when either $v^{Dunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^+)$ or $v^{Dunce}(q_A^+) \leq v < v_0^{Cunce}(q_A^-)$, learning disagreement through the project choice under centralization discourages execution. Formal delegation completely resolves the demotivating problem by shutting down the principal's information.

F.4 Non-Credibility of Empowerment

Now, we discuss the possibility of credible empowerment in the ACE procedure. We focus on a strategy profile σ^U constituting *empowerment* with full execution: (i) $m^U(\theta_A, q_A) = \theta_A$ for each θ_A and q_A, (ii) $d^U(\theta_P, q_P, m) = m$ for each θ_P, q_P, and $m \neq \phi$, and (iii) $e^U(\theta_A, q_A, m = \theta_A, d = m) = 1$ for each θ_A and q_A. Define $v^{Eunce}(q_A) \equiv 1 + \bar{q}_P(1 - q_A)/[(1 - \bar{q}_P)q_A]$. We still impose Assumption F.1 throughout this subsection, which implies (i) $v^{Dunce}(q_A) < v^{Eunce}(q_A)$ for each q_A, and (ii) $v^{Eunce}(q_A) < v_1^{Cunce}(q_A)$ if and only if $q_A \geq \bar{q}_P$. In what follows, we investigate cases where $v \geq v^{Dunce}(q_A^-)$.[49] The credibility of empowerment is characterized as follows.

Proposition F.3. *Consider the uncertain precision model, and suppose that Assumption F.1 holds and $v \geq v^{Dunce}(q_A^-)$. Then, there exists an empowerment equilibrium only if $\bar{q}_P \leq q_A^-$ and $v \geq v^{Eunce}(q_A^-)$.*

Proof (Proposition F.3)**.** Suppose that there exists an empowerment equilibrium $\mathcal{E}^U$. It is necessary that the agent with $q_A = q_A^-$ has no incentive to conceal his signal on assessment $\mathcal{E}^U$. As the principal chooses the project based on disclosed θ_A and the agent executes it on the equilibrium path, the agent's *interim* expected payoff from $m = \theta_A$ is given by $q_A^- b - c$ when $q_A = q_A^-$.

Now, suppose that the agent with $q_A = q_A^-$ deviates to $m = \phi$. Because of Requirement

[49]It is possible to check that there is no empowerment equilibrium with full execution for $v < v^{Dunce}(q_A^-)$.

1 and the same argument used above, θ-separating equilibrium is played in the continuation game after $m = \phi$. Hence, given $v \geq v^{Dunce}(q_A^-)$, the agent's expected payoff from the deviation is summarized as follows:

$$\begin{cases} \bar{q}_P b - c & \text{if } v \geq v_1^{Cunce}(q_A^-), \\ \bar{q}_P q_A^- b - [\bar{q}_P q_A^- + (1-\bar{q}_P)(1-q_A^-)]c & \text{if } v^{Dunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^-). \end{cases} \tag{F.32}$$

Hence, the payoff difference between $m = \theta_A$ and $m = \phi$ is as follows:

$$\begin{cases} (q_A^- - \bar{q}_P)b & \text{if } v \geq v_1^{Cunce}(q_A^-), \\ (1-\bar{q}_P)b - [\bar{q}_P(1-q_A^-) + (1-\bar{q}_P)q_A^-]c & \text{if } v^{Dunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^-). \end{cases} \tag{F.33}$$

The agent with $q_A = q_A^-$ does not deviate to $m = \phi$ only if the payoff difference is non-negative. Now, we check the agent's incentive to disclose. When $v \geq v_1^{Cunce}(q_A^-)$, the payoff difference is non-negative if and only if $\bar{q}_P \leq q_A^-$. Note that $\bar{q}_P \leq q_A^-$ implies that $v \geq v_1^{Cunce}(q_A^-) \geq v^{Eunce}(q_A^-)$. When $v^{Dunce}(q_A^-) \leq v < v_1^{Cunce}(q_A^-)$, the payoff difference is non-negative if and only if

$$(1-\bar{q}_P)b - [\bar{q}_P(1-q_A^-) + (1-\bar{q}_P)q_A^-]c \geq 0 \iff v \geq v^{Eunce}(q_A^-). \tag{F.34}$$

Note that since $v < v_1^{Cunce}(q_A^-)$, (F.34) holds only if $v_1^{Cunce}(q_A^-) > v^{Eunce}(q_A^-)$, or equivalently $\bar{q}_P < q_A^-$. ■

Propositions F.2 and F.3 demonstrate that the condition for credible empowerment is more demanding than that for formal delegation being preferred to centralization. For example, if $\bar{q}_A < \bar{q}_P$ or $v^{Dunce}(q_A^-) \leq v < v^{Eunce}(q_A^-)$, then there does not exist an empowerment equilibrium even though the principal strictly prefers its outcome. The bottleneck is the agent's strategic silence, as in the baseline model.

G Continuous Execution Decision (for Online Appendix)

In this appendix, we consider the environment where the agent's execution decision is continuous rather than binary. Our results in the baseline model are demonstrated in this extension.

G.1 Preliminaries

Suppose that the execution level is continuous: $e \in [0, 1]$ associated with the agent's cost function is $C(e) = \bar{c}e^2/2$, where $\bar{c} > 0$ is the marginal cost of execution. Let $\bar{v} \equiv b/\bar{c}$ be the intrinsic incentive (the ratio of marginal benefit to cost in execution). The probability of success (i.e., $x = 1$) is defined by

$$\text{Prob}(x = 1 \mid s, d, e) \equiv \begin{cases} e & \text{if } s = d, \\ 0 & \text{otherwise.} \end{cases} \tag{G.1}$$

The remaining setup is identical to that of the baseline model. The modified setup is referred to as the *continuous execution model.* We make the following parametric assumption. Define $\eta_0 \equiv q_P(1 - q_A)/[q_P(1 - q_A) + (1 - q_P)q_A]$ and $\eta_1 \equiv q_P q_A/[q_P q_A + (1 - q_P)(1 - q_A)]$.

Assumption G.1. *The following condition holds:*

$$\frac{1}{\eta_0} \le \bar{v} < \frac{1}{\eta_1}. \tag{G.2}$$

Intuitively, it requires that the marginal cost of execution is neither sufficiently large nor small compared with the agent's benefit of success, which corresponds to $v_0^C \le v < v_1^C$ in the baseline model. We will revisit the role of this assumption later.

G.2 Centralization and Formal Delegation

G.2.1 Centralization

Under centralization, by the same procedure as in the proof of Lemma 1, it is shown that the optimal equilibrium satisfies $d^C(\theta_P) = \theta_P$ for any θ_P. The agent chooses the execution level to maximize

$$\text{Prob}(s = d \mid \theta_A, d)eb - \frac{\bar{c}e^2}{2}, \tag{G.3}$$

where his confidence is

$$\text{Prob}(s = d \mid \theta_A, d) = \begin{cases} \eta_0 & \text{if } d = \theta_A, \\ \eta_1 & \text{if } d \neq \theta_A. \end{cases} \tag{G.4}$$

By Assumption G.1, when $d = \theta_A$, the first derivative with respect to e satisfies

$$\eta_0 b - \bar{c}e \geq \eta_0 b - \bar{c} \geq 0 \tag{G.5}$$

for all $e \in [0, 1]$, implying that the equilibrium execution level is $e^C = 1$. When $d \neq \theta_A$, the first order condition implies that the equilibrium execution level satisfies

$$\eta_1 b - \bar{c}e^C = 0 \iff e^C = \eta_1 \bar{v} (< 1). \tag{G.6}$$

The principal's payoff is then

$$U^{Ccont}(\bar{v}) = (q_P q_A + q_P(1 - q_A)\eta_1 \bar{v})\, B. \tag{G.7}$$

G.2.2 The Value of Formal Delegation

Under formal delegation, as in the baseline model, it is optimal that the agent chooses the project consistently with his signal. Given that the agent chooses $d = \theta_A$, the agent's confidence is equal to $\text{Prob}(s = d \mid \theta_A, d) = q_A$. As the agent chooses e to maximize (G.3), the first order condition implies

$$q_A b - \bar{c} e^D \geq 0 \iff e^D = \min\{q_A \bar{v}, 1\} = \begin{cases} q_A \bar{v} & \text{if } q_A b - \bar{c} < 0, \\ 1 & \text{if } q_A b - \bar{c} \geq 0. \end{cases} \tag{G.8}$$

The principal's payoff is then

$$U^{Dcont}(\bar{v}) = q_A \min\{q_A \bar{v}, 1\} B. \tag{G.9}$$

The value of formal delegation in the continuous execution model is characterized as follows.

Proposition G.1. *Consider the continuous execution model, and suppose that Assumption G.1 holds. Then, $U^{Dcont}(\bar{v}) > U^{Ccont}(\bar{v})$ if and only if $q_A > \tilde{q}_A^{cont}$ and*

$$\frac{q_P q_A}{q_A^2 - q_P(1 - q_A)\eta_1} < \bar{v} < \min\left\{\frac{q_A(1 - q_P)}{q_P(1 - q_A)\eta_1}, \frac{1}{\eta_1}\right\}. \tag{G.10}$$

Proof (Proposition G.1)**.** First, suppose $\bar{v} \geq 1/q_A$ so that $\min\{q_A \bar{v}, 1\} = 1$. Then,

$$U^{Dcont}(\bar{v}) > U^{Ccont}(\bar{v}) \iff \bar{v} < \frac{q_A(1 - q_P)}{q_P(1 - q_A)\eta_1}. \tag{G.11}$$

As $1/q_A > 1/\eta_0$, given Assumption G.1, $U^{Dcont}(\bar{v}) > U^{Ccont}(\bar{v})$ if and only if

$$\bar{v} \in L_0 \equiv \left[\frac{1}{q_A}, \min\left\{\frac{q_A(1 - q_P)}{q_P(1 - q_A)\eta_1}, \frac{1}{\eta_1}\right\}\right). \tag{G.12}$$

Note that $q_A(1-q_P)/[q_P(1-q_A)\eta_1] \le 1/\eta_1$ is equivalent to $q_A \le q_P$. When $q_A > q_P$, L_0 is non-empty if and only if $1/q_A < 1/\eta_1$, which always holds. When $q_A \le q_P$, L_0 is non-empty if and only if $1/q_A < q_A(1-q_P)/[q_P(1-q_A)\eta_1]$, which is equivalent to

$$G_0(q_A) \equiv -(2q_P-1)(1-q_P)q_A^3 - q_P(2q_P-1)q_A^2 + 2q_P^2 q_A - q_P^2 > 0. \tag{G.13}$$

Note that for $q_A \ge 1/2$, G_0 satisfies $\partial^2 G_0/\partial q_A^2 = -6(2q_P-1)(1-q_P)q_A - 2q_P(2q_P-1) < 0$ and is then concave. As $G_0(q_A = 1/2) = -(1+q_P)(2q_P-1)/8 < 0$ and $G_0(q_A = q_P) = (1-q_P)^2 q_P^2(2q_P-1) > 0$, we see that there exists $\tilde{q}_A^{cont} \in (1/2, q_P)$, which is the second greatest root of $G_0(q_A) = 0$, such that $G_0(q_A) > 0$ if and only if $q_A \in (\tilde{q}_A^{cont}, q_P]$. In summary, given $\bar{v} \ge 1/q_A$, formal delegation is strictly preferred if and only if $q_A > \tilde{q}_A^{cont}$ and $\bar{v} \in L_0$.

Second, suppose $\bar{v} < 1/q_A$ so that $\min\{q_A\bar{v}, 1\} = q_A\bar{v}$. Then,

$$U^{Dcont}(\bar{v}) > U^{Ccont}(\bar{v}) \iff q_P q_A < [q_A^2 - q_P(1-q_A)\eta_1]\bar{v}. \tag{G.14}$$

Obviously, this does not hold if $G_1 \equiv q_A^2 - q_P(1-q_A)\eta_1 \le 0$. Note that

$$\begin{aligned} G_1 > 0 \iff & \bar{G}_1 \equiv [q_P(1-q_A) + (1-q_P)q_A]G_1 > 0 \\ \iff & -(2q_P-1)q_A^3 + (1-q_P)q_P q_A^2 + 2q_P^2 q_A - q_P^2 > 0. \end{aligned} \tag{G.15}$$

Given $\bar{G}_1 > 0$, (G.14) is equivalent to $\bar{v} > q_A q_P/G_1$. As $1/\eta_0 < \min\{1/\eta_1, 1/q_A\}$, given Assumption G.1, $U^{Dcont}(\bar{v}) > U^{Ccont}(\bar{v})$ if and only if $G_1 > 0$ and

$$\bar{v} \in L_1 \equiv \left(\frac{q_P q_A}{G_1}, \min\left\{\frac{1}{\eta_1}, \frac{1}{q_A}\right\}\right). \tag{G.16}$$

Recall that

$$\frac{1}{\eta_1} \leq \frac{1}{q_A} \iff q_P \geq \hat{q}_P(q_A) \equiv \frac{q_A^2}{q_A^2 + (1-q_A)^2}. \tag{G.17}$$

Suppose $q_P \geq \hat{q}_P(q_A)$. Then, L_1 is non-empty if and only if

$$\frac{q_P q_A}{G_1} < \frac{1}{\eta_1} \iff (1-q_A)q_P^2 + (2q_A - 1)q_A^2 q_P - q_A^3 < 0. \tag{G.18}$$

Note that the derivative of the left-hand side with respect to q_P is positive for $q_A > 1/2$. Then, for all $q_P \geq \hat{q}_P(q_A)$,

$$\begin{aligned} &(1-q_A)q_P^2 + (2q_A - 1)q_A^2 q_P - q_A^3 \\ \geq\ &(1-q_A)\left[\frac{q_A^2}{q_A^2 + (1-q_A)^2}\right]^2 + (2q_A-1)q_A^2\left[\frac{q_A^2}{q_A^2+(1-q_A)^2}\right] - q_A^3 \\ =\ &\frac{q_A^3(1-q_A)^2(2q_A-1)}{(2q_A^2 - 2q_A + 1)^2} > 0, \end{aligned} \tag{G.19}$$

which contradicts $q_P q_A / G_1 < 1/\eta_1$. Then, we must have $q_P < \hat{q}_P(q_A)$, and L_1 is non-empty if and only if

$$\frac{q_P q_A}{G_1} < \frac{1}{q_A} \iff G_0(q_A) > 0. \tag{G.20}$$

As we have seen, G_0 is concave for $q_A > 1/2$ and the second greatest root of $G_0(q_A) = 0$, denoted by $\tilde{q}_A^{cont}$, satisfies $\tilde{q}_A^{cont} \in (1/2, q_P)$. Furthermore, since $G_0(q_A = 1) = (1-q_P)^2 > 0$, we see that $G_0(q_A) > 0$ if and only if $q_A > \tilde{q}_A^{cont}$. Note also that since

$$\bar{G}_1 - G_0(q_A) = q_P q_A^2[q_P(1-q_A) + (1-q_P)q_A] > 0, \tag{G.21}$$

given $G_0(q_A) \geq 0$, $\bar{G}_1 > 0$ and $G_1 > 0$ must hold. Note furthermore that $q_P < \hat{q}_P(q_A)$ is equivalent to

$$q_A > \tilde{\tilde{q}}_A^{cont} \equiv \frac{q_P - \sqrt{q_P(1-q_P)}}{(2q_P - 1)}, \tag{G.22}$$

where $\tilde{\tilde{q}}_A^{cont} \in (1/2, q_P)$. Furthermore, as G_0 is concave and $G_0(\tilde{\tilde{q}}_A^{cont}) < 0$, $\tilde{\tilde{q}}_A^{cont} < \tilde{q}_A^{cont}$ hold. In summary, given $\bar{v} < 1/q_A$, formal delegation is strictly preferred if and only if $q_A > \max\{\tilde{q}_A^{cont}, \tilde{\tilde{q}}_A^{cont}\} = \tilde{q}_A^{cont}$ and $\bar{v} \in L_1$. The above argument is summarized in the following proposition. ■

Intuitively, formal delegation is strictly preferred if and only if the agent's signal is so precise that he can choose the promising project sufficiently likely and the intrinsic incentive is so moderate that the impact of the demotivating effect under disagreement is greater than that of the motivating effect under consensus. When, for example, $q_A \in (\tilde{q}_A^{cont}, q_P)$ and (G.10) hold, formal delegation is strictly better than centralization even though the principal's signal is more precise, as in the baseline model. This is because the optimal execution level under consensus is on the boundary (i.e., $e = 1$) because of Assumption G.1. The boundary solution under consensus implies that the execution level should be higher than 1 if there is no upper bound in e. In words, the motivating effect by consensus is limited. As the advantage under centralization is discounted, formal delegation could be optimal even though $q_A < q_P$, as in the baseline model.

G.3 Non-credibility of Empowerment

Hereinafter, we assume the conditions in Proposition G.1 hold and investigate whether there exists an empowerment equilibrium in the ACE procedure. We say that a strategy profile (or an equilibrium) constitutes empowerment if (i) $m^*(\theta_A) = \theta_A$ for each θ_A, (ii) $d^*(\theta_P, m \neq \phi) = d$ for each θ_P, and (iii) $e^*(\theta_A, m = \theta_A, d = m) = \min\{q_A\bar{v}, 1\}$ for each θ_A. A necessary condition for credible empowerment is as follows.

Proposition G.2. *Consider the continuous execution model with Assumption G.1, and suppose that* $q_A > \tilde{q}_A^{cont}$ *and (G.10). Then, there exists an empowerment equilibrium only if* $q_A \geq q_P$.

Proof (Proposition G.2)**.** Suppose that there exists an empowerment equilibrium $\mathcal{E}^*$. On the empowerment equilibrium, the agent's expected payoff is the same as the payoff under formal delegation, that is,

$$V^{*cont}(\theta_A, m = \theta_A) = q_A \min\{q_A \bar{v}, 1\} b - \frac{\bar{c}(\min\{q_A \bar{v}, 1\})^2}{2}. \tag{G.23}$$

If the agent deviates to $m = \phi$, then the project choice and the execution level are the same as the outcome under centralization because of Requirement 1. Hence, the agent's expected payoff is

$$\begin{aligned} V^{*cont}(\theta_A, m = \phi) = {} & [q_p q_A + q_P(1 - q_A)\eta_1 \bar{v}] b \\ & - [q_P q_A + (1 - q_P)(1 - q_A)] \frac{\bar{c}}{2} - [q_P(1 - q_A) + (1 - q_P) q_A] \frac{\bar{c}(\eta_1 \bar{v})^2}{2}. \end{aligned} \tag{G.24}$$

The deviation payoff is strictly greater than the equilibrium payoff if and only if

$$\begin{aligned} & \bar{c} \left\{ [q_p q_A + q_P(1 - q_A)\eta_1 \bar{v}] \bar{v} - [q_P q_A + (1 - q_P)(1 - q_A)] \frac{1}{2} - [q_P(1 - q_A) + (1 - q_P) q_A] \frac{(\eta_1 \bar{v})^2}{2} \right\} \\ > {} & \bar{c} \left[q_A \min\{q_A \bar{v}, 1\} \bar{v} - \frac{(\min\{q_A \bar{v}, 1\})^2}{2} \right]. \end{aligned} \tag{G.25}$$

When $q_A\bar{v} \geq 1$, (G.25) is

$$
\begin{aligned}
&q_P^2(1-q_A)^2\bar{v}^2 - 2(1-q_P)q_A[q_P(1-q_A)+(1-q_P)q_A]\bar{v} + [q_P(1-q_A)+(1-q_P)q_A]^2 > 0\\
&\iff \{(1-q_P)q_A\bar{v} - [q_P(1-q_A)+(1-q_P)q_A]\}^2 + [q_P^2(1-q_A)^2 - (1-q_P)^2q_A^2]\bar{v}^2 > 0,
\end{aligned}
\tag{G.26}
$$

which clearly holds if $q_A < q_P$. That is, the agent never deviates only when $q_A \geq q_P$.

Likewise, when $q_A\bar{v} < 1$, (G.25) is equivalent to

$$G_2(\bar{v}) \equiv -G_1\bar{v}^2 + 2q_Pq_A\bar{v} - [1-q_P(1-q_A)-(1-q_P)q_A] > 0. \tag{G.27}$$

As $G_1 = q_A^2 - q_P(1-q_A)\eta_1 > 0$ when $q_A > \tilde{q}_A^{cont}$, $\partial G_2/\partial\bar{v} = -2G_1(\bar{v} - q_Pq_A/G_1) < 0$ for $\bar{v} \in L_1$. Then, G_2 is positive for all $\bar{v} \in L_1$ if $G_2(\bar{v} = 1/q_A) > 0$; that is,

$$G_2\left(\bar{v} = \frac{1}{q_A}\right) = \frac{G_3(q_A)}{q_P(1-q_A)+(1-q_P)q_A} > 0 \iff G_3(q_A) > 0, \tag{G.28}$$

where

$$G_3(q_A) \equiv (2q_P-1)^2q_A^2 - 2(2q_P-1)^2q_A + 2(2q_P-1)q_P - \frac{2q_P^2}{q_A} + \frac{q_P^2}{q_A^2}. \tag{G.29}$$

Note that

$$\frac{\partial G_3}{\partial q_A} = -\frac{2(1-q_A)[q_A^3(2q_P-1)^2+q_P^2]}{q_A^3} < 0, \tag{G.30}$$

implying that G_3 is decreasing in $q_A \in (1/2, 1)$. Furthermore, $G_3(q_A = q_P) = (1-q_P)^2(2q_P-1)^2 > 0$. Then, for $q_A < q_P$, G_2 is positive for all $\bar{v} \in L_1$. Therefore, if $q_A < q_P$, then the agent strictly prefers $m = \phi$ to $m = \theta_A$. ■

Proposition G.2 implies that, as in the baseline model, the condition for credible empowerment is more demanding than the superiority of formal delegation. Specifically, as $\tilde{q}_A^{cont} < q_P$, the gap between formal and informal delegation appears when $q_A \in (\tilde{q}_A^{cont}, q_P)$ and $\bar{v}$ satisfies (G.10). The mechanism behind non-credible empowerment is the agent's strategic silence to learn the principal's information, which is identical to that of the baseline model. Hence, to deter strategic silence, it is necessary that the agent has more precise information.

G.4 Remarks

We have the following remarks on this extension. First, Assumption G.1 plays a key role for our argument. As mentioned above, this assumption generates the asymmetry between consensus and disagreement in the sense that the optimal execution level under disagreement is given by the interior solution (i.e., $e^C = \eta_1 \bar{v}$), whereas it is given by the boundary solution under consensus (i.e., $e^C = 1$). The difference of the interior and boundary solutions reflects the idea that whereas the reduction in execution level under disagreement is fully considered, the increase under consensus is limited. As the advantage under centralization is discounted, the superiority of formal delegation when $q_A < q_P$ appears. However, as long as $q_A < q_P$, empowerment is prevented since the agent has an incentive to be silent in order to obtain the principal's signal.

Once Assumption G.1 is relaxed, the superiority of formal delegation and the gap between formal and informal delegation may not appear. For example, suppose that $q_P < \hat{q}_P(q_A)$, $\bar{v} < 1/\eta_0$, and $\bar{c} = 1$, which guarantees that the optimal execution levels are interior both under consensus and disagreement. Since the parties' expected payoffs are calculated as in Table G.1, the necessary and sufficient condition for formal delegation being strictly preferred

	Formal Delegation	Centralization
Principal	$q_A^2 bB$	$q_P^2 \left(\frac{q_A^2}{q_P q_A + (1-q_P)(1-q_A)} + \frac{(1-q_A)^2}{q_P(1-q_P)+(1-q_P)q_A} \right) bB$
Agent	$\frac{1}{2} q_A^2 b^2$	$\frac{1}{2} q_P^2 \left(\frac{q_A^2}{q_P q_A + (1-q_P)(1-q_A)} + \frac{(1-q_A)^2}{q_P(1-q_P)+(1-q_P)q_A} \right) b^2$

Table G.1: Parties' Expected Payoffs without Assumption G.1

is

$$\left(\frac{q_A}{q_P}\right)^2 > \frac{q_A^2}{q_P q_A + (1-q_P)(1-q_A)} + \frac{(1-q_A)^2}{q_P(1-q_A)+(1-q_P)q_A}, \tag{G.31}$$

which is never satisfied when $q_A < q_P$. Furthermore, as long as (G.31) holds, since $q_A \geq q_P$, there exists an empowerment equilibrium, implying that when formal delegation is preferred, its outcome is always implemented informally.

The intuition behind the disappearance of the gap between formal and informal delegation is as follows. Recall that the gap appears when the parties conflict on the preferred procedure; that is, the principal prefers formal delegation, whereas the agent prefers centralization. This conflict is resolved when the optimal execution level under consensus is also interior. Contrary to the case of the corner solution, the motivating effect is fully taken into account, which enhances the advantage of centralization for the principal. Accordingly, the parties agree on the preferred project.[50] This exercise implies that the asymmetry between the motivating and demotivating effects is relevant for the non-credibility of empowerment.

Second, instead of Assumption G.1, introducing fixed costs for a positive level of execution may restore the non-credibility of empowerment. For example, suppose that the cost function is given by $C(e) = c + e^\gamma/\gamma$ for $e > 0$ and 0 otherwise, where $c > 0$ and $\gamma > 1$. If fixed cost c is not sufficiently small, then the agent chooses $e^C = 0$ under disagreement, whereas the optimal execution level under consensus is given by an interior solution, which induces the region where

[50]We observe from Table G.1 that the principal strictly prefers formal delegation to centralization if and only if the agent does, too.

formal delegation is strictly preferred even when $q_A < q_P$. As a result, desirable empowerment could be non-credible due to strategic silence.[51]

Finally, as an analogy of those observations, we conjecture that our argument in the baseline model still holds when the cost function is concave in e because the optimal execution levels would be at the boundaries. Such a setup seems reasonable when execution (e.g., investment) exhibits economies of scale.

H Incentive Contracts (for Online Appendix)

In this appendix, we demonstrate that strategic silence may emerge even if incentive contracts are available.

H.1 Preliminaries

We assume that, as in Zábojník (2002), before the parties learn the private signal, the principal may offers an incentive contract specifying monetary transfers contingent on the outcome x. The agent is protected by limited liability so that the transfers from the principal to the agent must be non-negative. Without loss of generality, the incentive contract specifies no transfer for failure ($x = 0$) and $w \geq 0$ for success ($x = 1$). Given transfers $w \geq 0$, the *ex post* payoffs are then expressed as $(B - w)x$ for the principal and $(b + w)x - ce$ for the agent. The principal specifies w to maximize her expected payoff on the optimal equilibrium. Let $r \equiv B/c > 0$ be the ratio of the principal's return to the execution cost from the promising project. The remaining setup is identical to that of the baseline model. The modified setup is referred to as the *incentive-contract model*.

[51] The details are available upon request.

H.2 Centralization and Formal Delegation

H.2.1 Centralization

Under centralization, by the same procedure as in the proof of Lemma 1, it is shown that the optimal equilibrium satisfies $d^C(\theta_P) = \theta_P$ for any θ_P. The agent executes the project if and only if

$$\text{Prob}(s = d \mid \theta_A, d = \theta_P)(b + w) - c \geq 0 \iff w \geq c\left(\frac{1}{\text{Prob}(s = d \mid \theta_A, d = \theta_P)} - v\right), \quad \text{(H.1)}$$

where $\text{Prob}(s = d \mid \theta_A, d = \theta_P)$ satisfies (2) in the body of the paper. The optimal equilibrium under centralization is characterized by the principal's payoff U^{CIC} and incentive contracts w^C, illustrated in the v-r diagram, as in Figure H.1.

Proposition H.1. *Consider the incentive-contract model. The principal's ex ante expected payoff and the optimal incentive contract under centralization are as follows:*

$$(U^{CIC}(v,r), w^C) = \begin{cases} (q_P c r, 0) & \text{if } v \geq v_1^C, \\ (q_P c(r + v - v_1^C), c(v_1^C - v)) & \text{if } \max\{v_1^C - (1-q_A)r, v_0^C\} \leq v < v_1^C \\ & \quad \text{or } v_2^C - r \leq v < v_0^C, \\ (q_P q_A c r, 0) & \text{if } v_0^C \leq v < v_1^C - (1-q_A)r, \\ (q_P q_A c(r + v - v_0^C), c(v_0^C - v)) & \text{if } v_0^C - r \leq v < \min\{v_0^C, v_2^C - r\}, \\ (0,0) & \text{if } v < v_0^C - r. \end{cases} \quad \text{(H.2)}$$

Proof (Proposition H.1)**.** Suppose first $w \geq c(v_1^C - v)$. As (H.1) is satisfied for any θ_P and θ_A, the agent chooses $e = 1$ for any θ_A and d. Then, the principal's expected payoff is $q_P(B - w)$. As the payoff is decreasing in w, given $w \geq c(v_1^C - v)$, the principal's payoff is maximized at $w = \max\{c(v_1^C - v), 0\}$, whereby her payoff is $q_P c(r - \max\{v_1^C - v, 0\})$.

Suppose next $c(v_0^C - v) \leq w < c(v_1^C - v)$, where this is true only when $v < v_1^C$. As (H.1) is satisfied only when $\theta_P = \theta_A$, the agent chooses $e = 1$ only for $\theta_A = d = \theta_P$. Then, the principal's expected payoff is $q_P q_A(B - w)$. As the payoff is decreasing in w, given $c(v_1^C - v) > w \geq c(v_0^C - v)$, the principal's payoff is maximized at $w = \max\{c(v_0^C - v), 0\}$, whereby her payoff is $q_P q_A c(r - \max\{v_0^C - v, 0\})$.

Suppose finally $w < c(v_0^C - v)$, where this is true only when $v < v_0^C$. As (H.1) is never satisfied, the agent chooses $e = 0$ for any θ_A and d. Then, the principal's expected payoff is 0.

By comparing these payoffs, we obtain the principal's optimal payoff as follows. First, suppose $v \geq v_1^C$. Then, as $q_P c(r - \max\{v_1^C - v, 0\}) = q_P cr > \max\{q_P q_A c(r - \max\{v_0^C - v, 0\}), 0\}$, the principal's optimal payoff is $q_P cr$ and the incentive contract satisfies $w = 0$. Second, suppose $v_0^C \leq v < v_1^C$. Note that $q_P c(r - \max\{v_1^C - v, 0\}) = q_P c(r - v_1^C + v)$, $q_P q_A c(r - \max\{v_0^C - v, 0\}) = q_P q_A cr$, and

$$q_P c(r - v_1^C + v) \geq q_P q_A cr \iff (1 - q_A)r + v \geq v_1^C. \tag{H.3}$$

Then, when $(1 - q_A)r + v \geq v_1^C$, the principal's optimal payoff is $q_P c(r - v_1^C + v)$ and the incentive contract satisfies $w = c(v_1^C - v)$. Conversely, when $(1 - q_A)r + v < v_1^C$, the principal's optimal payoff is $q_P q_A cr$ and the incentive contract satisfies $w = 0$. Third, suppose $v < v_0^C$. Note that $q_P c(r - \max\{v_1^C - v, 0\}) = q_P c(r - v_1^C + v)$, $q_P q_A c(r - \max\{v_0^C - v, 0\}) = q_P q_A c(r - v_0^C + v)$, and

$$\begin{aligned} & q_P c(r - v_1^C + v) \geq q_P q_A c(r - v_0^C + v) \\ \iff & r + v \geq v_2^C \equiv v_1^C + \frac{q_A}{1 - q_A}(v_1^C - v_0^C) = 1 + \frac{(1 - q_P)[2q_A - 1 + q_A(1 - q_A)]}{q_P(1 - q_A)^2}. \end{aligned} \tag{H.4}$$

Then, when $r + v \geq v_2^C$, as $q_P c(r - v_1^C + v) > q_P c(r - v_2^C + v) \geq 0$, the principal's optimal payoff is $q_P c(r - v_1^C + v)$ and the incentive contract satisfies $w = c(v_1^C - v)$. When $v_0^C \leq r + v < v_2^C$,

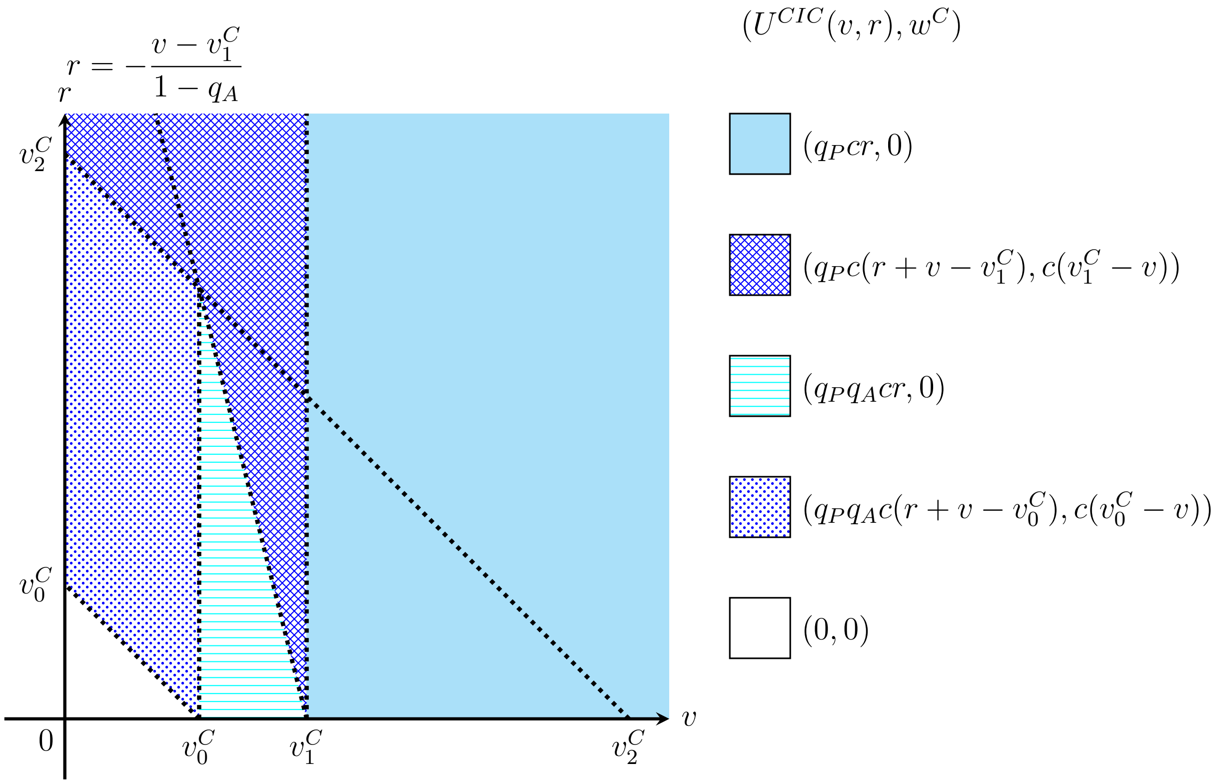

Figure H.1: The Principal's Payoff and the Incentive Contract under Centralization

as $q_P q_A c(r - v_0^C + v) \geq 0$, the principal's optimal payoff is $q_P q_A c(r - v_0^C + v)$, and the incentive contract satisfies $w = c(v_0^C - v)$. When $r + v < v_0^C$, as $q_P c(r - v_1^C + v) < q_P c(r - v_0^C + v) < 0$, the principal's optimal payoff is 0, and the incentive contract satisfies $w = 0$. ■

H.2.2 The Value of Formal Delegation

Under formal delegation, given that the agent chooses $d = \theta_A$, the agent's confidence is equal to $\text{Prob}(s = d \mid \theta_A, d = \theta_A) = q_A$. The agent executes the project if and only if

$$\text{Prob}(s = d \mid \theta_A, d = \theta_A)(b + w) - c \geq 0 \iff w \geq c\left(v^D - v\right). \tag{H.5}$$

As in centralization, the optimal equilibrium under formal delegation is characterized by the principal's payoff U^{DIC} and incentive contract w^D, illustrated in the v-r diagram, as in Figure H.2.

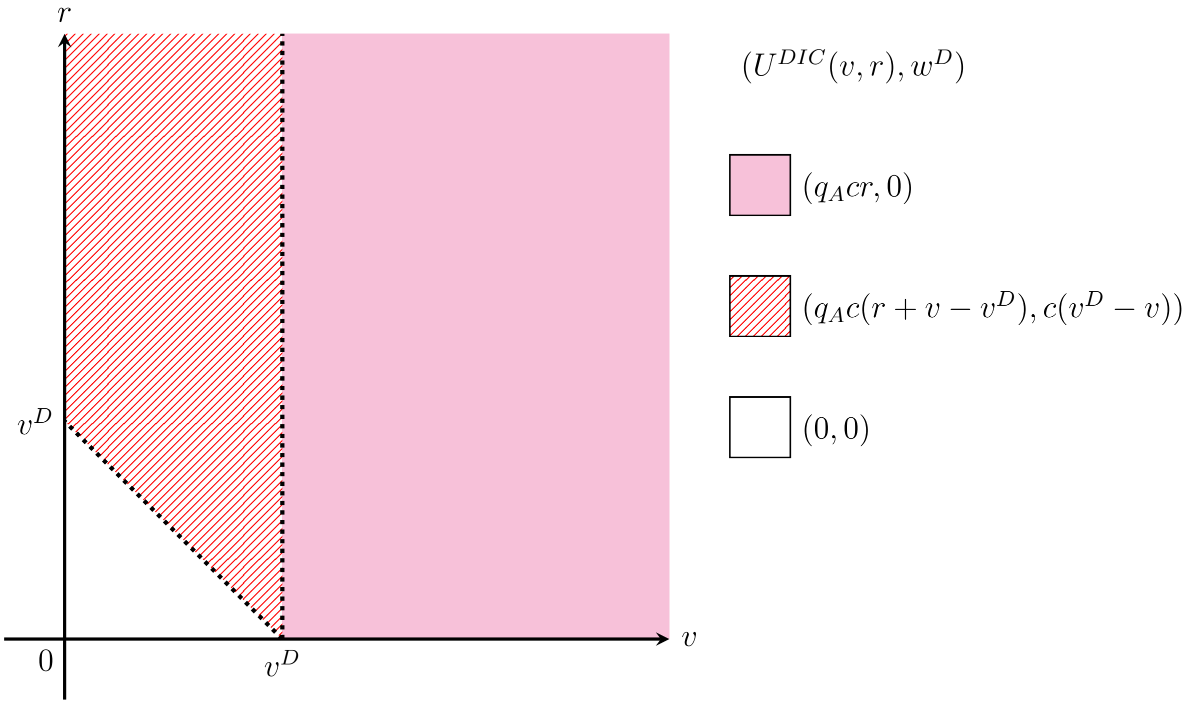

Figure H.2: The Principal's Payoff and the Incentive Contract under Delegation

Proposition H.2. *Consider the incentive-contract model. The principal's ex ante expected payoff and the optimal incentive contract under formal delegation are as follows:*

$$(U^{DIC}(v,r), w^D) = \begin{cases} (q_A cr, 0) & \text{if } v \geq v^D, \\ (q_A c(r+v-v^D), c(v^D-v)) & \text{if } v^D - r \leq v < v^D, \\ (0,0) & \text{if } v < v^D - r. \end{cases} \tag{H.6}$$

Proof (Proposition H.2)**.** Suppose first $w \geq c(v^D - v)$. As (H.5) is satisfied for any θ_A, the agent chooses $e = 1$ for any θ_A. Then, the principal's expected payoff is $q_A(B - w)$. As the payoff is decreasing in w, given $w \geq c(v^D - v)$, the principal's payoff is maximized at $w = \max\{c(v^D - v), 0\}$, whereby her payoff is $q_A c(r - \max\{v^D - v, 0\})$. Suppose next $w < c(v^D - v)$, where this is true only when $v < v^D$. As (H.5) is never satisfied, the agent chooses $e = 0$ for any θ_A. Then, the principal's expected payoff is 0. By comparing these payoffs, the statement is immediately derived. ■

We now derive the condition under which delegation is strictly preferred. Note that as

$U^{CIC}(v,r) \geq 0$ for any $(v,r) \in \mathbb{R}^2_{++}$, formal delegation is strictly preferred only when $v+r \geq v^D$. Then, in what follows, we focus on cases in which $v+r \geq v^D$. Note also that given $v+r \geq v^D$, (H.6) implies $U^{DIC}(v,r) = q_A c(r + \min\{v - v^D, 0\})$. First, suppose $v^D \geq v_1^C$, or equivalently $q_P \geq \hat{q}_P(q_A) \equiv q_A^2/(q_A^2 + (1-q_A^2))(> q_A)$. The value of formal delegation never appears in this case as shown in the following lemma.

Lemma H.1. *Consider the incentive contract model, and suppose that $q_P \geq \hat{q}_P(q_A)$. Then, $U^{CIC}(v,r) > U^{DIC}(v,r)$ holds for any (v,r).*

Proof (Lemma H.1)**.** For $v \geq v_1^C$, since $q_P > q_A$, (H.2) and (H.6) imply

$$
\begin{aligned}
U^{CIC}(v,r) - U^{DIC}(v,r) &= q_P cr - q_A c(r + \min\{v - v^D, 0\}) \\
&\geq (q_P - q_A)cr > 0. && \text{(H.7)}
\end{aligned}
$$

For $v \in [v_0^C, v_1^C)$ and $v \geq v_1^C - (1-q_A)r$, since $q_P > q_A$ and $v < v_1^C \leq v^D$,

$$
\begin{aligned}
U^{CIC}(v,r) - U^{DIC}(v,r) &= q_P c(r + v - v_1^C) - q_A c(r + \min\{v - v^D, 0\}) \\
&= q_P c(r + v - v_1^C) - q_A c(r + v - v^D) \\
&> q_P c(r + v - v_1^C) - q_P c(r + v - v^D) \\
&= q_P c(v^D - v_1^C) \geq 0. && \text{(H.8)}
\end{aligned}
$$

For $v \in [v_0^C, v_1^C)$ and $v < v_1^C - (1-q_A)r$, since $q_P > q_A$ and $v^D \geq v_1^C$,

$$
\begin{aligned}
U^{CIC}(v,r) - U^{DIC}(v,r) &= q_P q_A cr - q_A c(r + v - v^D) \\
&> q_P q_A cr - q_A c[r + v_1^C - (1-q_A)r - v^D] \\
&= q_A c[(q_P - q_A)r + v^D - v_1^C] \geq 0. && \text{(H.9)}
\end{aligned}
$$

For $v < v_0^C$ and $v \geq v_2^C - r$, since $q_P > q_A$ and $v < v_0^C < v_1^C \leq v^D$, $U^{CIC}(v,r) - U^{DIC}(v,r) > 0$ by the same procedure as (H.8). For $v < v_0^C$ and $v < v_2^C - r$, since $q_P > q_A$ and $v^D \geq v_1^C$,

$$\begin{aligned} U^{CIC}(v,r) - U^{DIC}(v,r) &= q_P q_A c(r + v - v_0^C) - q_A c(r + v - v^D) \\ &= q_A c[-(1 - q_P)(r + v) - q_P v_0^C + v^D] \\ &> q_A c[-(1 - q_P)v_2^C - q_P v_0^C + v_1^C] \\ &= q_A c \left[\frac{(1 - q_P)(2q_A - 1)(q_P - q_A)}{q_P q_A (1 - q_A)^2} \right] \geq 0, \end{aligned} \tag{H.10}$$

which completes the proof. ■

Next, suppose $1/q_P < v^D < v_1^C$, or equivalently $q_A < q_P < \hat{q}_P(q_A)$. Comparison between (H.2) and (H.6) derives the value of formal delegation in this case as follows. For $v \geq v_1^C$, since $q_P > q_A$, $U^{CIC}(v,r) - U^{DIC}(v,r) > 0$ by the same procedure as (H.7). For $v \in [v^D, v_1^C)$ and $v \geq v_1^C - (1 - q_A)r$,

$$U^{CIC}(v,r) - U^{DIC}(v,r) = q_P c(r + v - v_1^C) - q_A cr. \tag{H.11}$$

Then, formal delegation is strictly preferred if $v \in [v^D, v_0^C)$ and $r \in [(v_1^C - v)/(1 - q_A), q_P(v_1^C - v)/(q_P - q_A))$. For $v \in [v^D, v_1^C)$ and $v < v_1^C - (1 - q_A)r$, since $v \geq v^D > v_0^C$,

$$U^{CIC}(v,r) - U^{DIC}(v,r) = q_P q_A cr - q_A cr = q_A cr(q_P - 1) < 0, \tag{H.12}$$

implying that formal delegation is strictly preferred. For $v \in [v_0^C, v^D)$ and $v \geq v_1^C - (1 - q_A)r$,

$$\begin{aligned} U^{CIC}(v,r) - U^{DIC}(v,r) &= q_P c(r + v - v_1^C) - q_A c(r + v - v^D) \\ &= c[(q_P - q_A)(r + v) - q_P v_1^C + q_A v^D]. \end{aligned} \tag{H.13}$$

Then, formal delegation is strictly preferred if $v \in [v_0^C, v^D)$ and $r \in [(v_1^C - v)/(1 - q_A), -v + (q_P v_1^C - q_A v^D)/(q_P - q_A))$. For $v \in [v_0^C, v^D)$ and $v < v_1^C - (1 - q_A)r$,

$$U^{CIC}(v, r) - U^{DIC}(v, r) = q_P q_A cr - q_A c(r + v - v^D) = q_A c[-(1 - q_P)r - v + v^D]. \quad \text{(H.14)}$$

Then, formal delegation is strictly preferred if $v \in [v_0^C, v^D)$ and $r \in ((v - v^D)/(1 - q_P), (v_1^C - v)/(1 - q_A))$. For $v < v_0^C$ and $v \geq v_2^C - r$, since $v_0^C < v^D$, by the same procedure as (H.13), $U^{CIC}(v, r) - U^{DIC}(v, r) = c[(q_P - q_A)(r + v) - q_P v_1^C + q_A v^D]$. Then, formal delegation is strictly preferred if $v < v_0^C$ and $r \in [-v + v_2^C, -v + (q_P v_1^C - q_A v^D)/(q_P - q_A))$. For $v < v_0^C$ and $v < v_2^C - r$,

$$\begin{aligned} U^{CIC}(v, r) - U^{DIC}(v, r) &= q_P q_A c(r + v - v_0^C) - q_A c(r + v - v^D) \\ &= (1 - q_P) q_A c[-(r + v) + v^E]. \end{aligned} \quad \text{(H.15)}$$

Then, formal delegation is strictly preferred if $v < v_0^C$ and $r \in (-v + v^E, -v + v_2^C)$.

In summary, the necessary and sufficient condition for strictly preferred formal delegation when $q_P \in (q_A, \hat{q}_P(q_A))$ is either

$$v \in [v^D, v_1^C) \text{ and } r < \frac{q_P(v_1^C - v)}{q_P - q_A}, \quad \text{(H.16)}$$

$$v \in [v_0^C, v^D) \text{ and } r \in \left(\frac{v^D - v}{1 - q_P}, \frac{q_P v_1^C - q_A v^D}{q_P - q_A} - v\right), \text{ or} \quad \text{(H.17)}$$

$$v < v_0^C \text{ and } r \in \left(v^E - v, \frac{q_P v_1^C - q_A v^D}{q_P - q_A} - v\right). \quad \text{(H.18)}$$

Now, define

$$\tilde{q}_P^{IC}(q_A) \equiv \frac{q_A[2q_A - 1 + q_A(1 - q_A)]}{2q_A - 1} - \sqrt{\frac{(1 - q_A)^3 q_A[2q_A - 1 + q_A(1 - q_A)]}{(2q_A - 1)^2}}. \quad \text{(H.19)}$$

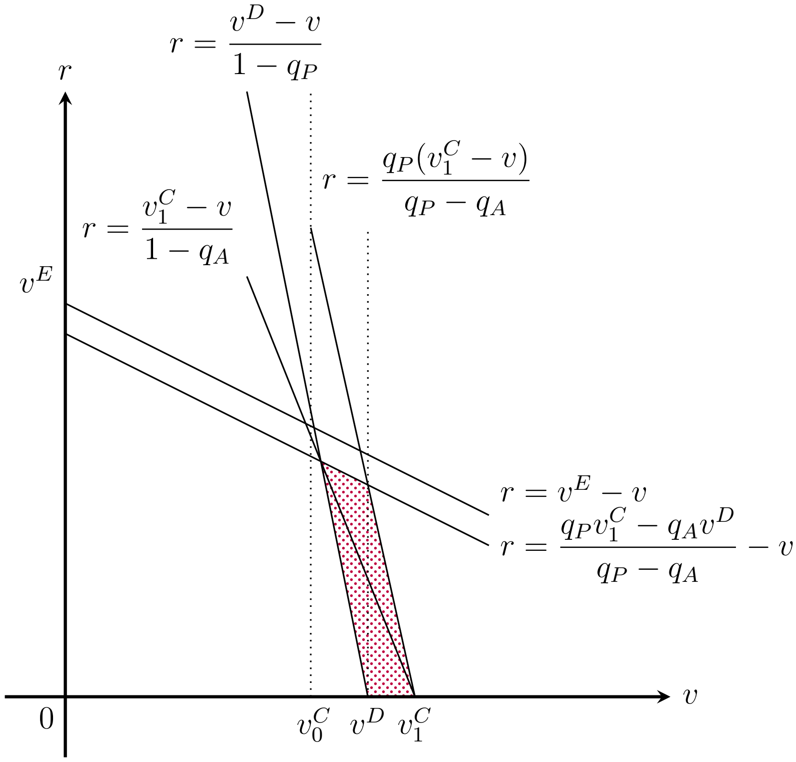

Figure H.3: Value of Delegation for $q_P \in \left[\tilde{q}_P^{IC}(q_A), \hat{q}_P(q_A)\right)$

Note that $q_P \geq \tilde{q}_P^{IC}(q_A)$ is equivalent to

$$\frac{v^D - v_0^C}{1 - q_P} \geq \frac{v_1^C - v_0^C}{1 - q_A}. \tag{H.20}$$

Furthermore, it is possible to check $q_A < \tilde{q}_P^{IC}(q_A) < \hat{q}_P(q_A)$ for any $q_A \in (1/2, 1)$. The condition for desirable formal delegation can be rewritten as follows, which is denoted in v-r diagrams as in Figures H.3 and H.4.[52]

[52]In Figure H.3, line $r = (v_1^C - v)/(1 - q_A)$ intersects with $r = (v^D - v)/(1 - q_P)$ and $r = (q_P v_1^C - q_A v^D)/(q_P - q_A) - v$ at $v = [(1 - q_A)v^D - (1 - q_P)v_1^C]/(q_P - q_A)$. Furthermore, lines $r = (q_P v_1^C - q_A v^D)/(q_P - q_A) - v$ and $r = q_P(v_1^C - v)/(q_P - q_A)$ intersect at $v = v^D$.

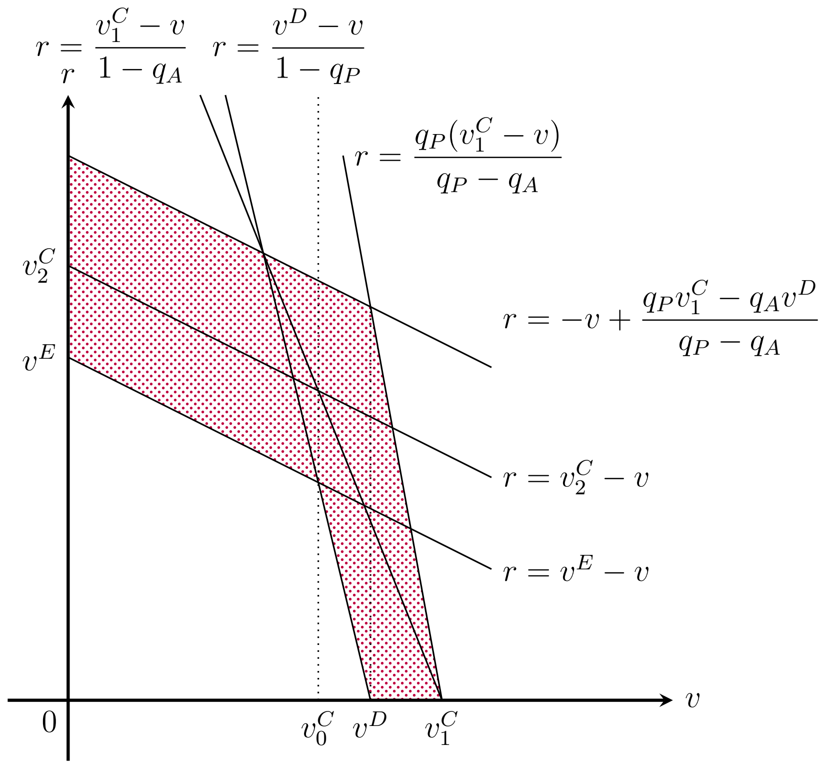

Figure H.4: Value of Delegation for $q_P \in \left(q_A, \tilde{q}_P^{IC}(q_A)\right)$

Lemma H.2. *Consider the incentive contract model.*

1. *Suppose that* $q_P \in \left[\tilde{q}_P^{IC}(q_A), \hat{q}_P(q_P)\right)$. *Then,* $U^{CIC}(v,r) < U^{DIC}(v,r)$ *holds if and only if the following holds:*

$$v \in \left(v^D - (1-q_P)r, \min\left\{v_1^C - \left(1 - \frac{q_A}{q_P}\right)r, \frac{q_P v_1^C - q_A v^D}{q_P - q_A} - r\right\}\right). \tag{H.21}$$

2. *Suppose that* $q_P \in \left(q_A, \tilde{q}_P^{IC}(q_A)\right)$. *Then,* $U^{CIC}(v,r) < U^{DIC}(v,r)$ *holds if and only if the following holds:*

$$v \in \left(\min\left\{v^D - (1-q_P)r, v^E - r\right\}, \min\left\{v_1^C - \left(1 - \frac{q_A}{q_P}\right)r, \frac{q_P v_1^C - q_A v^D}{q_P - q_A} - r\right\}\right). \tag{H.22}$$

Proof (Lemma H.2)**.** 1. We show that when $q_P \in \left[\tilde{q}_P^{IC}(q_A), \hat{q}_P(q_A)\right)$, either (H.16), (H.17), or

(H.18) holds if and only if (H.21) holds. To show the necessity, note that since

$$\frac{v^D - v_0^C}{1 - q_P} - \frac{v_1^C - v_0^C}{1 - q_A} = v^E - v_2^C = v_2^C - \frac{q_P v_1^C - q_A v^D}{q_P - q_A}, \tag{H.23}$$

(H.20) yields

$$v^E \geq v_2^C \geq \frac{q_P v_1^C - q_A v^D}{q_P - q_A}, \tag{H.24}$$

implying that (H.18) never holds because the r-region is not well defined. Suppose that (H.16) holds, or equivalently

$$v^D \leq v < v_1^C - \left(1 - \frac{q_A}{q_P}\right) r \tag{H.25}$$

holds. Given (H.25), since $q_P > q_A$,

$$\begin{aligned} q_P v_1^C - q_A v^D - (q_P - q_A)(r + v) &> q_P v_1^C - q_A v^D - (q_P - q_A)\left(\frac{v_1^C - v}{1 - q_A/q_P} + v\right) \\ &= q_A(v - v^D) \geq 0, \end{aligned} \tag{H.26}$$

implying $v < (q_P v_1^C - q_A v^D)/(q_P - q_A) - r$. Then, (H.21) holds. Suppose that (H.17) holds, or equivalently

$$v^D - (1 - q_P)r < v < \min\left\{v^D, \frac{q_P v_1^C - q_A v^D}{q_P - q_A} - r\right\} \tag{H.27}$$

holds. Given (H.27),

$$v_1^C - \left(1 - \frac{q_A}{q_P}\right) r > v_1^C - \left(1 - \frac{q_A}{q_P}\right)\left(\frac{q_P v_1^C - q_A v^D}{q_P - q_A} - v\right)$$
$$= \frac{q_A(v^D - v)}{q_P} + v > v, \tag{H.28}$$

implying (H.21).

To show the sufficiency, suppose that (H.21) holds. First, it is confirmed that $v \geq v_0^C$ must hold. Note that (H.21) implies $(v^D - v)/(1 - q_P) < r < (q_P v_1^C - q_A v^D)/(q_P - q_A) - v$. Then,

$$\frac{q_P v_1^C - q_A v^D}{q_P - q_A} - v - \frac{v^D - v}{1 - q_P} > 0 \iff v > \frac{(1 - q_A)v^D - (1 - q_P)v_1^C}{q_P - q_A}. \tag{H.29}$$

This implies $v \geq v_0^C$ since

$$\frac{(1 - q_A)v^D - (1 - q_P)v_1^C}{q_P - q_A} - v_0^C = \frac{(1 - q_P)(1 - q_A)}{q_P - q_A}\left(\frac{v^D - v_0^C}{1 - q_P} - \frac{v_1^C - v_0^C}{1 - q_A}\right) \geq 0, \tag{H.30}$$

where the last inequality is due to (H.20). If $v \geq v^D$, then (H.25) holds, which is equivalent to (H.16). Likewise, if $v \in [v_0^C, v^D)$, then (H.27) holds, which is equivalent to (H.17).

2. We show that when $q_P \in (q_A, \tilde{q}_P^{IC}(q_A))$, either (H.16), (H.17), or (H.18) holds if and only if (H.22) holds. To show the necessity, suppose first that (H.16) holds, implying that (H.25) holds. By the same argument above, $v < (q_P v_1^C - q_A v^D)/(q_P - q_A) - r$. As $\min\{v^D - (1 - q_P)r, v^E - r\} \leq v^D - (1 - q_P)r \leq v^D \leq v$, (H.22) holds. Second, suppose that (H.17) holds, implying that (H.27) holds. By the same argument above, (H.28) holds. As $\min\{v^D - (1 - q_P)r, v^E - r\} \leq v^D - (1 - q_P)r < v$, (H.22) holds. Finally, suppose that (H.18) holds, implying

$$v^E - r < v < \min\left\{\frac{q_P v_1^C - q_A v^D}{q_P - q_A} - r, v_0^C\right\}. \tag{H.31}$$

As $v < (q_P v_1^C - q_A v^D)/(q_P - q_A) - r$, we can again apply (H.28), implying $v < v_1^C - (1 - q_A/q_P)r$. As $\min\{v^D - (1 - q_P)r, v^E - r\} \leq v^E - r < v$, (H.22) holds.

To show the sufficiency, suppose that (H.22) holds. If $v \geq v^D$, then it is obvious to see that (H.25) and then (H.16) hold. Next, suppose that $v \in [v_0^C, v^D)$. In this case, it is confirmed that $v > v^D - (1 - q_P)r$ as follows. As $v \geq \max\{\min\{v^D - (1 - q_P)r, v^E - r\}, v_0^C\}$, it is enough to show $\max\{\min\{v^D - (1 - q_P)r, v^E - r\}, v_0^C\} \geq v^D - (1 - q_P)r$, which holds if either $v^D - (1 - q_P)r \leq v^E - r$ or $v_0^C \geq v^D - (1 - q_P)r$. When $v^D - (1 - q_P)r > v^E - r$, as we obtain $r > (v^E - v^D)/q_P$,

$$v_0^C - [v^D - (1 - q_P)r] > v_0^C - \left[v^D - (1 - q_P)\left(\frac{v^E - v^D}{q_P}\right)\right] = 0, \tag{H.32}$$

implying either $v^D - (1 - q_P)r \leq v^E - r$ or $v_0^C \geq v^D - (1 - q_P)r$. As a result, (H.27) holds, which is equivalent to (H.17) holding. Finally, suppose that $v < v_0^C$. It is confirmed that $v > v^E - r$ as follows. As $v > \min\{v^D - (1 - q_P)r, v^E - r\}$ holds by (H.22), it is sufficient to show $v^D - (1 - q_P)r \geq v^E - r$, or equivalently $r \geq (v^E - v^D)/q_P$. Suppose to the contrary $r < (v^E - v^D)/q_P$. However, it implies that

$$\begin{aligned} v_0^C > v &> v^D - (1 - q_P)r \\ &> v^D - (1 - q_P)\left(\frac{v^E - v^D}{q_P}\right) = v_0^C, \end{aligned} \tag{H.33}$$

which is a contradiction. Then, (H.22) is rewritten as

$$v \in \left(v^E - r, \min\left\{v^D - \left(1 - \frac{q_A}{q_P}\right)r, \frac{q_P v_1^C - q_A v^D}{q_P - q_A}\right\}\right), \tag{H.34}$$

which induces (H.18). ■

Finally, suppose $v^D \leq 1/q_P$, or equivalently $q_P \leq q_A$. The value of formal delegation is characterized as follows. For $v \geq v_1^C$,

$$U^{CIC}(v,r) - U^{DIC}(v,r) = cr(q_P - q_A) \leq 0. \tag{H.35}$$

Then, formal delegation is strictly preferred if $q_P < q_A$. For $v \in [v^D, v_1^C)$, we have

$$U^{CIC}(v,r) - U^{DIC}(v,r) < cr(q_P - q_A) \leq 0, \tag{H.36}$$

implying that formal delegation is strictly preferred. For $v \in [v_0^C, v^D)$ and $v \geq v_1^C - (1-q_A)r$,

$$\begin{aligned} U^{CIC}(v,r) - U^{DIC}(v,r) &= q_P c(r + v - v_1^C) - q_A c(r + v - v^D) \\ &= c\left[(q_P - q_A)(r+v) - (q_P v_1^C - q_A v^D)\right]. \end{aligned} \tag{H.37}$$

As $q_P \leq q_A$ and $q_P v_1^C - q_A v^D = (1-q_P)(2q_A - 1)/(1-q_A) > 0$, (H.37) is negative. Then, formal delegation is strictly preferred. For $v \in [v_0^C, v^D)$ and $v < v_1^C - (1-q_A)r$, by the same procedure as (H.14), $U^{CIC}(v,r) - U^{DIC}(v,r) < 0$ if and only if $v > v^D - (1-q_P)r$. Note that $v_1^C - (1-q_A)r > v^D - (1-q_P)r$ holds because $q_P \leq q_A$ and $v_1^C > v^D$. Then, formal delegation is strictly preferred if $v \in [v_0^C, v^D)$ and $r \in ((v^D - v)/(1-q_P), (v_1^C - v)/(1-q_P))$. For $v < v_0^C$ and $v \geq v_2^C - r$, by the same procedure as (H.37), $U^{CIC}(v,r) - U^{DIC}(v,r) < 0$. Then, formal delegation is strictly preferred. For $v < v_0^C$ and $v < v_2^C - r$, by the same procedure as (H.15), $U^{CIC}(v,r) - U^{DIC}(v,r) < 0$ if and only if $v > v^E - r$. Note that $v_2^C > v^E$ because $q_P \leq q_A < \tilde{q}_A^{IC}(q_A)$. Then, formal delegation is strictly preferred if $v < v_0^C$ and $r \in (-v + v^E, -v + v_2^C)$.

In summary, the necessary and sufficient condition for strictly preferred formal delegation when $q_P \leq q_A$ is either one of the following holds:

$$v \geq v_1^C \text{ and } q_P \neq q_A, \tag{H.38}$$

$$v \in [v^D, v_1^C), \tag{H.39}$$

$$v \in [v_0^C, v^D) \text{ and } r > (v^D - v)/(1 - q_P), \text{ or} \tag{H.40}$$

$$v < v_0^C \text{ and } r > v^E - v. \tag{H.41}$$

As in the previous case, the above condition can be rewritten as follows.

Lemma H.3. *Consider the incentive contract model, and suppose that $q_P \leq q_A$. Then, $U^{CIC}(v, r) < U^{DIC}(v, r)$ holds if and only if the following holds:*

$$r > \min\left\{\frac{v^D - v}{1 - q_P}, v^E - v\right\} \tag{H.42}$$

and either (i) $q_P < q_A$ or (ii) $v < v_1^C$.

Proof (Lemma H.3)**.** We now show that given $q_P \leq q_A$, either (H.38), (H.39), (H.40), or (H.41) holds if and only if (H.42) holds and either $q_P < q_A$ or $v < v_1^C$. The necessity is straightforward given that $v^E - v \leq (v^D - v)/(1 - q_P)$ if and only if $v \leq v_0^C$ and $\min\{v^E - v, (v^D - v)/(1 - q_P)\} \leq 0$ for $v \geq v^D$.

To show the sufficiency, suppose that (H.42) holds and either $q_P < q_A$ or $v < v_1^C$. If $v \geq v_1^C$, then (H.38) holds because $q_P < q_A$ makes (H.42) unrestrictive. If $v \in [v^D, v_1^C)$, then (H.42) is not restrictive, inducing (H.39). If $v \in [v_0^C, v^D)$, then (H.42) is rewritten as $r > (v^D - v)/(1 - q_P)$, implying (H.40). Finally, if $v < v_0^C$, then (H.42) is written as $r > v^E - v$, inducing (H.41). ■

Figure H.5 illustrates v-r diagrams, where formal delegation is strictly preferred when $q_P <$

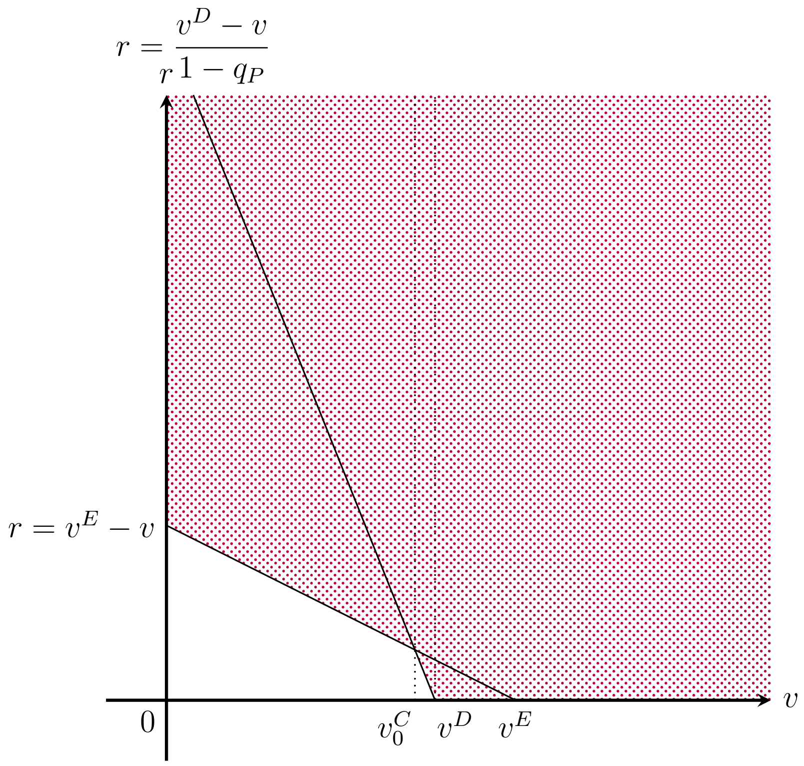

Figure H.5: Value of Delegation for $q_P < q_A$

q_A in the shaded region.[53] As a corollary of Lemmas H.1, H.2, and H.3, we have the following proposition.

Proposition H.3. *Consider the incentive contract model.* $U^{CIC}(v,r) < U^{DIC}(v,r)$ *holds if and only if one of the following holds:*

1. $q_P \in \left[\tilde{q}_P^{IC}(q_A), \hat{q}_P(q_A)\right)$ *and (H.21);*

2. $q_P \in \left(q_A, \tilde{q}_P^{IC}(q_A)\right)$ *and (H.22);*

3. $q_P = q_A$, $v < v_1^C$, *and (H.42); or*

4. $q_P < q_A$ *and (H.42).*

Zábojník (2002, Proposition 2) demonstrates that there exists a parameter region such that formal delegation is strictly preferred. Our proposition refines his result in that we comprehensively characterize such parameter regions. In particular, Zábojník (2002) makes a parametric

[53]In Figure H.5, line $r = v^E - v$ intersects with $r = (v^D - v)/(1 - q_P)$ at $v = v_0^C$.

assumption, which implies (H.42) given $q_A > q_P$. Then, as argued by Proposition 2 in Zábojník (2002), in his setup, the principal always prefers formal delegation to centralization whenever the agent's signal is more precise.

H.3 Non-credibility of Empowerment

Hereinafter, we assume that the conditions in Proposition H.2 hold and incentive contracts are available in the ACE procedure. In this section, we consider two kinds of empowerment. First, we are interested in whether the outcome on the optimal equilibrium under formal delegation can be supported on the ACE procedure. We say that a strategy profile constitutes *exact empowerment* if the principal offers incentive contract w^D and the strategy constitutes empowerment. Second, even though the exact same outcome on the optimal equilibrium under formal delegation cannot be supported, the principal may still be able to offer an incentive contract that induces the project choice based on the agent's report and motivates his execution. We say that a strategy profile constitutes *weak empowerment* if the strategy constitutes empowerment (in the sense of the baseline ACE model). The corresponding equilibria that satisfy Requirement 1 are called an *exact empowerment equilibrium* and a *weak empowerment equilibrium*, respectively. Recall that we focus on the parameter region such that $v + r \geq v^D$.

H.3.1 Exact Empowerment

First, we investigate whether there exists an exact empowerment equilibrium. We can show that the characterization of exact empowerment equilibria is identical to that of empowerment equilibria in the baseline model.

Proposition H.4. *Consider the incentive contract model, and suppose that $U^{CIC}(v,r) < U^{DIC}(v,r)$. Then, there is an exact empowerment equilibrium if and only if $q_P \leq q_A$ and $v \geq v^E$.*

Proof (Proposition H.4)**.** To show the necessity, suppose that there exists an exact empowerment equilibrium with transfer w^*. On the exact empowerment equilibrium, the agent sends message $m^*(\theta_A) = \theta_A$. Then, his expected payoff and the optimal incentive contract under formal delegation satisfy

$$\left(V^{*IC}(\theta_A, m = \theta_A), w^*\right) = (q_A(b + w^*) - c, w^*) = \begin{cases} (q_A c(v-1), 0) & \text{if } v \geq v^D, \\ (0, c(v^D - v)) & \text{if } v \in [v^D - r, v^D). \end{cases} \tag{H.43}$$

We now check the agent's incentive to deviate to $m = \phi$. For $v \geq v^D$, as no incentive transfer is paid to the agent even after the project succeeds, the agent's expected payoff after $m = \phi$ is the same as that of the baseline model. Then, as shown in Proposition 3, the agent prefers not to deviate if and only if $q_P \leq q_A$ and $v \leq v^E$. For $v \in [v^D - r, v^D)$, as the transfer is $w^* = c(v^D - v)$, the agent executes the project if and only if

$$c(v^D - v) \geq c\left(\frac{1}{\text{Prob}(s = d \mid \theta_A, \theta_P)} - v\right) \iff v^D \geq \frac{1}{\text{Prob}(s = d \mid \theta_A, \theta_P)}. \tag{H.44}$$

As $\text{Prob}(s = d \mid \theta_A, \theta_P)$ after deviating to $m = \phi$ satisfies (2) in the body of the paper, the agent executes the project under consensus (i.e., $\theta_P = \theta_A$) if and only if $v^D \geq v_0^C$, which is always true, and under disagreement (i.e., $\theta_P \neq \theta_A$) if and only if $v^D \geq v_1^C$. As formal delegation is strictly preferred only when $v^D < v_1^C$, the agent executes the project if and only if there is consensus. Then, the agent's payoff from deviation is

$$q_P q_A(b + w^*) - (q_P q_A + (1 - q_P)(1 - q_A))\, c = (2q_P - 1)(1 - q_A)c, \tag{H.45}$$

which is strictly greater than the equilibrium payoff $V^{*IC}(\theta_A, m = \theta_A) = 0$. Then, the agent always prefers to deviate.

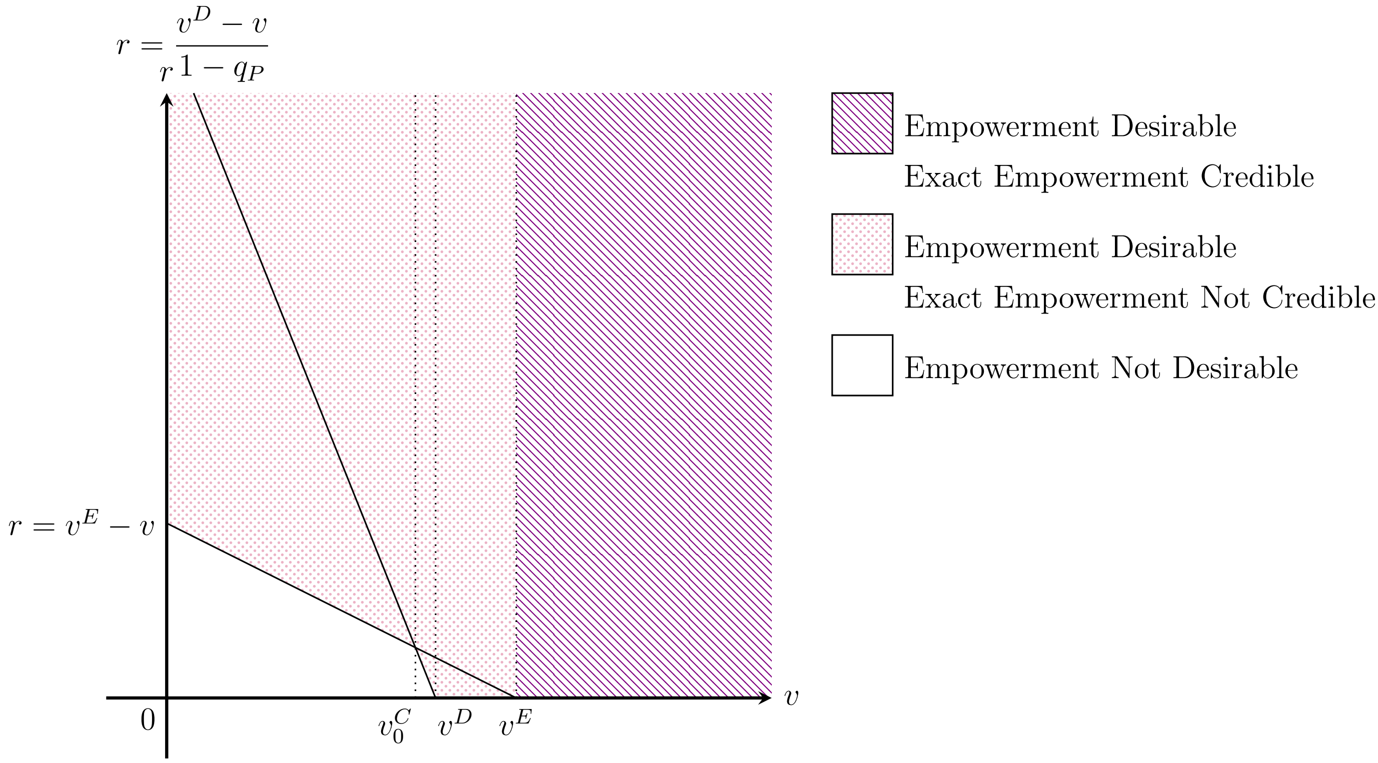

Figure H.6: Credibility of Exact Empowerment for $q_P < q_A$

To show the sufficiency, suppose that $q_P \leq q_A$ and $v \geq v^E$. By Proposition 3, there exists an empowerment equilibrium in the baseline model. Note that it is an exact empowerment equilibrium with incentive contract $w^* = 0$. ■

Figure H.6 illustrates v-r diagrams with $q_P < q_A$. Given that the incentive contract is optimal under formal delegation, there exists an exact empowerment equilibrium only in the dark-shaded region. In the light-shaded region, exact empowerment cannot be supported though formal delegation is strictly preferred to centralization.[54]

It is worthwhile to remark that the condition for credible exact empowerment is identical to that characterized in Proposition 3 even though incentive contracts are available. In words, incentive contracts do not help support exact empowerment at all. The intuition is as follows. For $v \geq v^D$, as monetary incentives are redundant for execution, the incentive problem that the agent faces is identical to that of the baseline model, implying the same condition. For

[54]When $q_P = q_A$, there is an exact empowerment equilibrium if and only if $v \geq v^E = v_1^C$. However, as mentioned in Proposition H.2, formal delegation is not strictly preferred in this region.

$v \in [v^D - r, v^D)$, the optimal bonus w^* is determined to induce the agent to be indifferent between $e = 1$ and 0. Hence, his expected payoff is zero, which is strictly worse than the payoff from strategic silence.

H.3.2 Existence of Weak Empowerment Equilibria

As shown in Proposition H.2, incentive contracts are neutral toward implementing the exact expected payoff under formal delegation. This is because optimal bonus w^* is designed only for incentivizing execution but not disclosing information. In words, to prevent strategic silence, the principal must provide more rents to the agent. Given that observation, a weak empowerment equilibrium as a "second-best" outcome is characterized as follows.

Proposition H.5. *Consider the incentive contract model. There exists a weak empowerment equilibrium if and only if $q_P \leq q_A$ and either one of the following holds:*

1. $v < v_1^C$ *and* $w \in \big[\max\{c(v^E - v), 0\}, c(v_1^C - v)\big)$, *or*

2. $w \geq \max\{c(v_1^C - v), 0\}$.

Proof (Proposition H.5)**.** To show the necessity, suppose that there exists weak empowerment equilibrium with incentive contract w^*. The principal's expected payoff on the weak empowerment equilibrium is $q_A(B - w^*)$. As her payoff can be at least zero by offering $w^* = 0$, $w^* \leq B$ is one of the necessary conditions. Furthermore, note that the agent's expected payoff on the weak empowerment equilibrium with bonus w is $q_A(b + w^*) - c$. Given the message $m^*(\theta_A) = \theta_A$ and the principal's choice $d = \theta_A$, the agent executes the project if and only if

$$q_A(b + w^*) - c \geq 0 \iff w^* \geq c(v^D - v). \tag{H.46}$$

Suppose that the agent deviates to $m = \phi$. If the principal chooses $d = \theta_P = \theta_A$, then the agent's expected payoff by executing the project is

$$\frac{q_P q_A}{q_P q_A + (1-q_P)(1-q_A)}(b+w^*) - c, \tag{H.47}$$

while his payoff without execution is 0. Therefore, his expected payoff given $d = \theta_P = \theta_A$ is

$$\max\left\{\frac{q_P q_A}{q_P q_A + (1-q_P)(1-q_A)}(b+w^*) - c, 0\right\} \tag{H.48}$$

Similarly, his expected payoff given $d = \theta_P \neq \theta_A$ is

$$\max\left\{\frac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A}(b+w^*) - c, 0\right\} \tag{H.49}$$

Hence, the agent does not deviate to $m = \phi$ if and only if

$$\begin{aligned}
& q_A(b+w^*) - c \\
& \geq [q_P q_A + (1-q_P)(1-q_A)] \max\left\{\frac{q_P q_A}{q_P q_A + (1-q_P)(1-q_A)}(b+w^*) - c, 0\right\} \\
& \quad + [q_P(1-q_A) + (1-q_P)q_A] \max\left\{\frac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A}(b+w^*) - c, 0\right\} \\
\iff & q_A\left(v + \frac{w^*}{c}\right) - 1 \geq q_P q_A \max\left\{\left(v + \frac{w^*}{c}\right) - v_0^C, 0\right\} + q_P(1-q_A) \max\left\{\left(v + \frac{w^*}{c}\right) - v_1^C, 0\right\}.
\end{aligned} \tag{H.50}$$

Note that (H.46) and $0 \leq w^* \leq B$ can be jointly expressed as

$$\max\{c(v^D - v), 0\} \leq w^* \leq B. \tag{H.51}$$

Therefore, incentive contract w^* must satisfy (H.50) and (H.51).

Recall that the conditions in Proposition H.2 imply $v_1^C > v^D$. First, consider the case where

$w^* \in [\max\{c(v^D - v), 0\}, c(v_1^C - v))$, which requires $v < v_1^C$. (H.50) is transformed to

$$q_A\left(v + \frac{w^*}{c}\right) - 1 \geq q_P q_A\left[\left(v + \frac{w^*}{c}\right) - v_0^C\right] \iff w^* \geq c(v^E - v). \tag{H.52}$$

As $v^E > v^D$, such w^* satisfies all the constraints if and only if $w^* \in [\max\{c(v^E - v), 0\}, c(v_1^C - v))$, which requires $v^E < v_1^C$ or, equivalently, $q_P < q_A$.

Next, consider the case where $w^* \geq \max\{c(v_1^C - v), 0\}$. (H.50) is transformed to

$$\begin{aligned} &q_A\left(v + \frac{w^*}{c}\right) - 1 \geq q_P q_A\left[\left(v + \frac{w^*}{c}\right) - v_0^C\right] + q_P(1 - q_A)\left[\left(v + \frac{w^*}{c}\right) - v_1^C\right] \\ \iff &(q_A - q_P)\left(v + \frac{w^*}{c}\right) \geq 0. \end{aligned} \tag{H.53}$$

As $w^* \geq 0$, if $q_A < q_P$, then (H.53) never holds. By contrast, if $q_A \geq q_P$, (H.53) holds for any $w^* \geq \max\{c(v_1^C - v), 0\}$.

To show the sufficiency, suppose that $q_P \leq q_A$ and either Conditions 1 or 2 in the statement hold. Then, by replacing B and b with $B - w$ and $b + w$, respectively, the same argument used in the proof of Proposition 3 shows that the weak empowerment strategy constitutes a PBE satisfying Requirement 1. ■

Propositions 3 and H.5 emphasize that signal precision is crucial for the prevalence of strategic silence. Recall from Proposition 3 that $q_P \leq q_A$ and $v \geq v^E$ are necessary to prevent strategic silence when incentive contracts are unavailable. When incentive contracts are available, the condition that $q_P \leq q_A$ is still required for the empowerment equilibrium though the intrinsic incentive does not need to be high (i.e., $v \geq v^E$ is not required). This is because the transfer does not directly control the agent's incentives for disclosure because it only depends on whether the project succeeds. Even if the agent is strategically silent, the transfer is paid as long as the project succeeds. Although paying an incentive transfer may motivate the execution of the chosen project, strategic silence cannot be prevented especially when the principal has more precise information.[55]

H.3.3 Optimal Weak Empowerment Equilibria

We now characterize the optimal weak empowerment equilibrium given $q_P \leq q_A$. The optimal weak empowerment equilibrium specifies w to maximize the principal's payoff $q_A(B-w)$ subject to (H.50) and (H.51), which are characterized in Proposition H.5. As the principal's payoff is decreasing in w, it is enough to find the minimum w that satisfies the conditions in Proposition H.5. Let w^{E*} represent the optimal transfer. The optimal weak empowerment equilibrium is characterized as follows, illustrated in the v-r diagram as in Figure H.7.

Proposition H.6. *Consider the incentive-contract model. The principal's ex ante expected payoff and the incentive contract on the optimal weak empowerment equilibrium are as follows:*

$$\big(U^{*IC}(v,r), w^{E*}\big) = \begin{cases} (q_A cr, 0) & \text{if } v \geq v^E, \\ \big(q_A c(r + v - v^E), c(v^E - v)\big) & \text{if } v \in [v^E - r, v^E). \end{cases} \tag{H.54}$$

Proof (Proposition H.6)**.** When $v < v_1^C$, a weak empowerment equilibrium is supported for $w \geq \max\{c(v^E - v), 0\}$ by Proposition H.5-1. Then, the optimal weak empowerment equilibrium satisfies $w^{E*} = \max\{c(v^E - v), 0\}$, and the principal's optimal payoff is $q_A c[r - \max\{v^E - v, 0\}]$. When $v > v_1^C$, a weak empowerment equilibrium is supported for $w \geq \max\{c(v_1^C - v), 0\} = 0$ by Proposition H.5-2. Then, the optimal weak empowerment equilibrium satisfies $w^{E*} = 0$, and the principal's optimal payoff is $q_A cr$. Note that if the principal's payoff is not greater than zero, then the principal should implement another equilibrium without execution rather than a weak empowerment equilibrium. Hence, for $v < v^E - r$, the weak empowerment equilibrium is not optimal for the principal. ■

[55] We conjecture that if message-contingent contracts are available, then strategic silence can be avoided even if $q_P > q_A$.

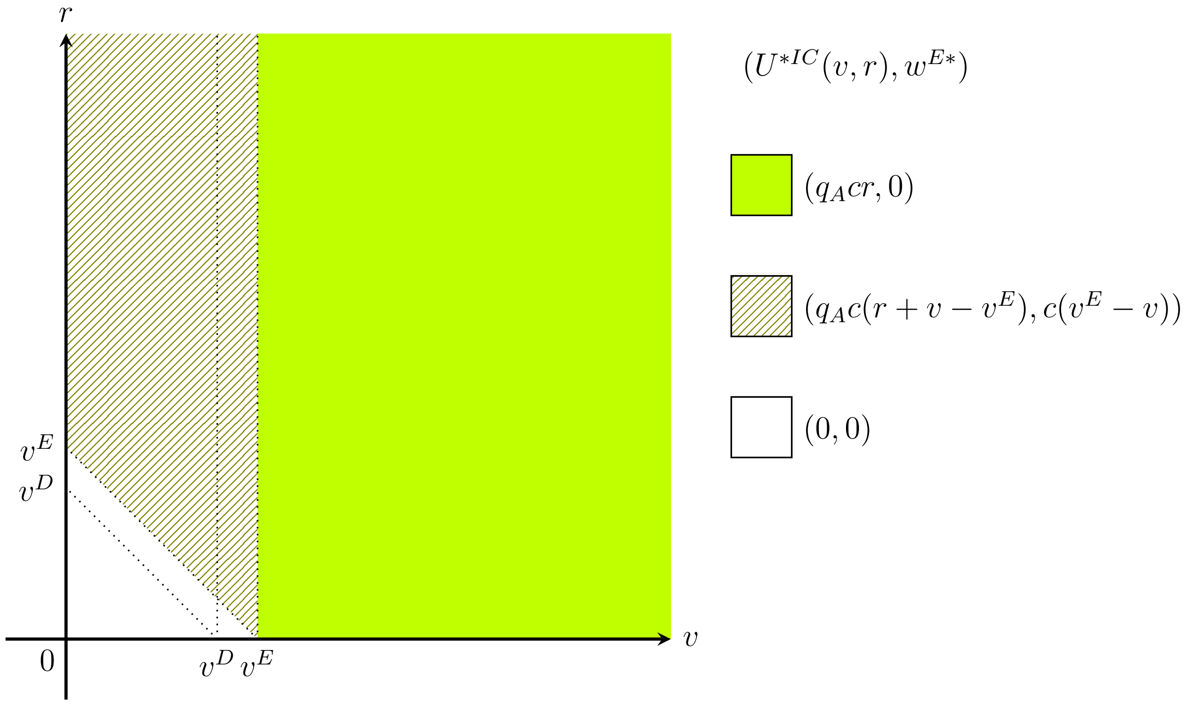

Figure H.7: Optimal Weak Empowerment Equilibria for $q_P \leq q_A$

Given $q_P \leq q_A$, we now derive the condition under which the optimal weak empowerment equilibrium is strictly preferred to centralization. For $v \geq v^E$, as $U^{*IC}(v,r) = U^{DIC}(v,r)$, the optimal weak empowerment equilibrium is strictly preferred to centralization if and only if formal delegation is strictly preferred to centralization as in Proposition H.2. For $v \in [v_0^C, v^E)$ and $v \geq v_1^C - (1-q_A)r$,

$$\begin{aligned} U^{CIC}(v,r) - U^{*IC}(v,r) &= q_P c(r+v-v_1^C) - q_A c(r+v-v^E) \\ &= c[(q_P - q_A)(r+v) - q_P v_1^C + q_A v^E] \\ &= -c(q_A - q_P)\left[r + v + \frac{q_P}{1-q_P} + \frac{q_A}{1-q_A}\right], \end{aligned} \tag{H.55}$$

which is negative if and only if $q_P < q_A$. For $v \in [v_0^C, v^E)$ and $v < v_1^C - (1-q_A)r$,

$$U^{CIC}(v,r) - U^{*IC}(v,r) = q_P q_A cr - q_A c(r+v-v^E) = q_A c[-(1-q_P)r - v + v^E], \tag{H.56}$$

which is negative if and only if $v > v^E - (1-q_P)r$. As $q_P \leq q_A$, $v_1^C \geq v^E$ holds, implying that $v_1^C - (1-q_A)r \geq v^E - (1-q_P)r$. Then, the optimal weak empowerment equilibrium is strictly preferred if and only if $q_P < q_A$ and $v \in (v^E - (1-q_P)r, v_1^C - (1-q_A)r)$. For $v < v_0^C$ and $v \geq v_2^C - r$, by the same procedure as (H.55), $U^{CIC}(v,r) - U^{*IC}(v,r) < 0$ if and only if $q_P < q_A$. For $v < v_0^C$ and $v < v_2^C - r$,

$$\begin{aligned} U^{CIC}(v,r) - U^{*IC}(v,r) &= q_P q_A c(r + v - v_0^C) - q_A c(r + v - v^E) \\ &= q_A c[-(1-q_P)(r+v) - q_P v_0^C + v^E], \end{aligned} \tag{H.57}$$

which is negative if and only if $v > (v^E - q_P v_0^C)/(1-q_P) - r$. Note that since $q_P \leq q_A$, $v_2^C \geq (v^E - q_P v_0^C)/(1-q_P)$ holds with equality for $q_P = q_A$. Then, the optimal weak empowerment equilibrium is strictly preferred if and only if $v \in ((v^E - q_P v_0^C)/(1-q_P) - r, v_2^C - r)$ and $q_P < q_A$.

In summary, the optimal weak empowerment equilibrium is strictly preferred to centralization if and only if $q_P < q_A$ and either one of the following hold:

$$v \geq v^E, \tag{H.58}$$

$$v \in [v_0^C, v^E) \text{ and } r > \frac{v^E - v}{1-q_P}, \text{ or} \tag{H.59}$$

$$v < v_0^C \text{ and } r > \frac{v^E - q_P v_0^C}{1-q_P} - v. \tag{H.60}$$

The above conditions can be rewritten as follows.

Proposition H.7. *Consider the incentive contract model. There exists the optimal weak empowerment equilibrium that is strictly preferred to centralization if and only if $q_P < q_A$ and the following hold:*

$$r > \min\left\{\frac{v^E - q_P v_0^C}{1-q_P} - v, \frac{v^E - v}{1-q_P}\right\} \tag{H.61}$$

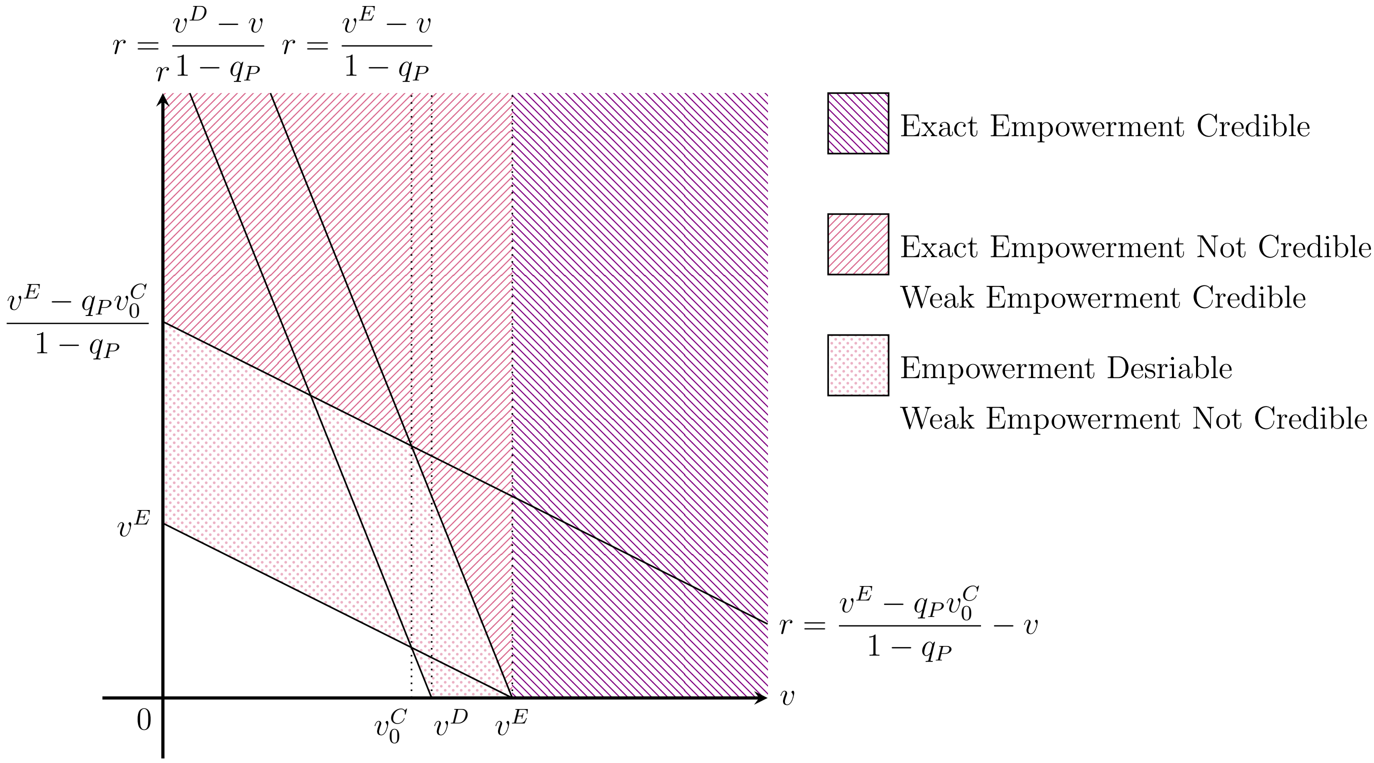

Figure H.8: Credibility of Weak Empowerment for $q_P < q_A$

Proof (Proposition H.7)**.** The necessity is confirmed as follows. When (H.58) holds, (H.61) holds since the right-hand side of (H.61) is less than zero. Likewise, (H.59) or (H.60) implies (H.61). To show the sufficiency, suppose that (H.61) holds. If $v \geq v^E$, then (H.61) is not restrictive, implying that (H.58) holds. Note that

$$\min\left\{\frac{v^E - q_P v_0^C}{1-q_P} - v, \frac{v^E - v}{1-q_P}\right\} = \begin{cases} \dfrac{v^E - v}{1-q_P} & \text{if } v \geq v_0^C, \\ \dfrac{v^E - q_P v_0^C}{1-q_P} - v & \text{if } v \leq v_0^C. \end{cases} \tag{H.62}$$

Then, (H.61) implies (H.59) for $v \in [v_0^C, v^E)$ and (H.60) for $v < v_0^C$. ■

Figure H.8 illustrates v-r diagrams, where $q_P < q_A$ and (H.61) is satisfied in the shaded region. As already seen in Figure H.6, exact empowerment is not credible for $v < v^E$. In such regions, if r is sufficiently high, there still exists an appropriate incentive contract such that empowerment is better for the principal than centralization. Nevertheless, with Proposition H.4, the principal's payoff must be lower than in the case of formal delegation because the principal must leave more rent to the agent to incentivize voluntary disclosure. Furthermore, if both v and r are sufficiently low, as in the lightest shaded region of Figure H.8, then even there is no weak empowerment equilibrium though empowerment is desirable. This means that strategic silence may emerge even when the agent's signal is more precise than the principal's and incentive contracts are available.

I Mediation Mechanisms (for Online Appendix)

We have thus far focused on (formal/informal) delegation to resolve the demotivating problem under centralization. Theoretically, we might consider more general procedures other than delegation. This appendix investigates *mediation mechanisms* (e.g., Forge, 1986; Myerson, 1986) and discusses whether the availability of mediators is helpful for the principal.[56] If the answer is negative, then focusing on formal delegation, as in the body of the paper, is not loss of generality. We show that the impact of mediation mechanisms is limited as long as formal delegation is strictly preferred to centralization. In that sense, we claim that the argument in the body of the paper is robust with respect to the availability of mediators.

I.1 Preliminaries

We introduce a nonstrategic mediator into the baseline model and consider the following procedure. First, each party simultaneously sends message $m_i \in M(\theta_i) \equiv \{\theta_i, \phi\}$ about his/her signal to the mediator. Let $m \equiv (m_P, m_A) \in M^2 \equiv \{1, -1, \phi\}^2$ represent a report profile. Second, the mediator recommends the project choice and the execution decision to the agent given report m. Let $r \in R \equiv \{r_{10}, r_{11}, r_{-10}, r_{-11}\}$ represent the recommendation to the agent, where r_{ij} denotes the recommendation of project $d = i$ and execution decision $e = j$. Let $d(r) \in D$ and $e(r) \in E$ represent the project choice and the execution decision recommended

[56] See, for example, Bergemann and Morris (2016) and Sugaya and Wolitzky (2021) for the recent developments.

by r, respectively (i.e., $d(r_{ij}) = i$ and $e(r_{ij}) = j$). Finally, after receiving recommendation r, the agent chooses both the project and the execution decision. The remaining setup is identical to the baseline model. The modified setup is referred to as the *mediation-mechanism* model. Hereinafter, to clarify the argument, we assume $q_P < \hat{q}_P(q_A)$, where formal delegation may be strictly preferred to centralization. Formally, the above procedure is represented by a *mediation rule* $\psi : M^2 \to \Delta(R)$ satisfying the parties' incentive-compatibility conditions. While we assume that the nonstrategic mediator commits to mediation rule ψ, the parties' behaviors are not enforced by the mechanism. Hence, to implement the outcome suggested by the mediation rule, each party must prefer to disclose the signal and to obey the recommendation. The mediation rule satisfying the above properties is referred to as a *mediated-delegation mechanism*.

Definition I.1. *A mediation rule ψ is a mediated-delegation mechanism if it satisfies the following conditions.*

1. *A-disclosure: For any $\theta_A \in \Theta$,*

$$\sum_{\theta_P \in \Theta} \sum_{s \in S} \sum_{r \in R} \left[bx\left(s, d(r), e(r)\right) - ce(r)\right] \psi(r \mid \theta_P, \theta_A) \text{Prob}(s \mid \theta_P, \theta_A) \text{Prob}(\theta_P \mid \theta_A)$$
$$\geq \sum_{\theta_P \in \Theta} \sum_{s \in S} \sum_{r \in R} \left[bx\left(s, d(r), e(r)\right) - ce(r)\right] \psi(r \mid \theta_P, \phi) \text{Prob}(s \mid \theta_P, \theta_A) \text{Prob}(\theta_P \mid \theta_A). \tag{I.1}$$

2. *P-disclosure: For any $\theta_P \in \Theta$,*

$$\sum_{\theta_A \in \Theta} \sum_{s \in S} \sum_{r \in R} Bx\left(s, d(r), e(r)\right) \psi(r \mid \theta_P, \theta_A) \text{Prob}(s \mid \theta_P, \theta_A) \text{Prob}(\theta_A \mid \theta_P)$$
$$\geq \sum_{\theta_A \in \Theta} \sum_{s \in S} \sum_{r \in R} Bx\left(s, d(r), e(r)\right) \psi(r \mid \phi, \theta_A) \text{Prob}(s \mid \theta_P, \theta_A) \text{Prob}(\theta_A \mid \theta_P). \tag{I.2}$$

3. *Obedience: For any $\theta_A \in \Theta$, $m_A \in M(\theta_A)$, $r \in \bigcup_{m_P \in M} \text{supp}\left(\psi(m_P, m_A)\right)$, $d \in D$, and*

$e \in E$,

$$\sum_{\theta_P \in \Theta} \sum_{s \in S} [bx\,(s, d(r), e(r)) - ce(r)]\,\mathrm{Prob}(s \mid \theta_P, \theta_A)\nu(\theta_P \mid \theta_A, m_A, r)$$

$$\geq \sum_{\theta_P \in \Theta} \sum_{s \in S} [bx\,(s, d, e) - ce]\,\mathrm{Prob}(s \mid \theta_P, \theta_A)\nu(\theta_P \mid \theta_A, m_A, r). \tag{I.3}$$

4. Consistency: There exists the agent's belief $\nu : \Theta \times M \times R \to \Delta(\Theta)$ that is derived by ψ and the parties' disclosure using Bayes' rule whenever it is possible.

Given mediated-delegation mechanism ψ, the principal's *ex ante* expected payoff U^ψ is defined as follows:

$$U^\psi \equiv \sum_{\theta_P \in \Theta} \sum_{\theta_A \in \Theta} \sum_{s \in S} \sum_{r \in R} Bx\,(s, d(r), e(r))\,\psi(r \mid \theta_P, \theta_A)\mathrm{Prob}(s \mid \theta_P, \theta_A)\mathrm{Prob}(\theta_A \mid \theta_P)\mathrm{Prob}(\theta_P). \tag{I.4}$$

For easy exposition, we define $U^\psi(\theta_P)$ and $U^\psi(\theta_P, \theta_A)$ as follows:

$$U^\psi(\theta_P) \equiv \sum_{\theta_A \in \Theta} \sum_{s \in S} \sum_{r \in R} Bx\,(s, d(r), e(r))\,\psi(r \mid \theta_P, \theta_A)\mathrm{Prob}(s \mid \theta_P, \theta_A)\mathrm{Prob}(\theta_A \mid \theta_P), \tag{I.5}$$

$$U^\psi(\theta_P, \theta_A) \equiv \sum_{s \in S} \sum_{r \in R} Bx\,(s, d(r), e(r))\,\psi(r \mid \theta_P, \theta_A)\mathrm{Prob}(s \mid \theta_P, \theta_A). \tag{I.6}$$

Note that, by the symmetry between $\theta_P = 1$ and -1,

$$\begin{aligned} U^\psi &= U^\psi(\theta_P) \\ &= U^\psi(\theta_P, \theta_A = 1)\mathrm{Prob}(\theta_A = 1 \mid \theta_P) + U^\psi(\theta_P, \theta_A = -1)\mathrm{Prob}(\theta_A = -1 \mid \theta_P) \end{aligned} \tag{I.7}$$

holds for each θ_P.

I.2 Mediated-Delegation Mechanisms

In this subsection, we demonstrate the effectiveness of mediated-delegation mechanisms. First, we show that mediated-delegation mechanisms outperform formal delegation when formal delegation is strictly preferred to centralization. Specifically, when $q_P < q_A$ and $v \geq v_D$, formal delegation achieves the *ex ante* best outcome for the principal. Furthermore, when $q_P \in [q_A, \hat{q}_P(q_A))$ and $v \in [v^D, v_1^C)$, mediated-delegation mechanisms do not exist. Second, when centralization is strictly preferred to formal delegation, mediated-delegation mechanisms might exist and outperform formal delegation and centralization.

I.2.1 Case 1: Formal Delegation Outperforms Centralization

First, we consider the case where formal delegation is strictly preferred to centralization. By Proposition 2-3, it is either (i) $q_P < q_A$ and $v \geq v^D$ or (ii) $q_P \in [q_A, \hat{q}_P(q_A))$ and $v \in [v^D, v_1^C)$. First, we observe that, in Case (i), there is no room for improvement by introducing mediators because formal delegation achieves the best outcome for the principal.

Lemma I.1. *Consider the mediation-mechanism model. Suppose that $q_P < q_A$ and $v \geq v^D$ and mediated-delegation mechanism ψ exists. Then, $U^D(v) \geq U^\psi(v)$ holds.*

Proof (Lemma I.1)**.** This statement is straightforward from the observation that, under formal delegation, the project is chosen based on the more precise signal and the chosen project is executed for certain. ■

Furthermore, in Case (ii), there exists no mediated-delegation mechanism, as shown below.

Lemma I.2. *Consider the mediation-mechanism model, and suppose that $q_P \in [q_A, \hat{q}_P(q_A))$ and $v \in [v^D, v_1^C)$. Then, there exists no mediated-delegation mechanism.*

Proof (Lemma I.2)**.** Suppose, in contrast, that there exists mediated-delegation mechanism ψ in this parameter range. We first show the following two claims.

Claim I.1. $\bigcup_{\theta_P \in \Theta} \operatorname{supp}\left(\psi(m_P = \theta_P, m_A = \phi)\right) \subseteq \{r_{10}, r_{-10}\}$.

Proof (Claim I.1)**.** Suppose, in contrast, that $\psi(r = r_{11} \mid m_P = 1, m_A = \phi) > 0$ without loss of generality. Note that since mediation rule ψ is a mediated-delegation mechanism, the obedience condition implies that choosing $d = 1$ and $e = 1$ is optimal after receiving recommendation $r = r_{11}$. Now, the agent's consistent posterior when $\theta_A = -1$, $m_A = \phi$, and $r = r_{11}$ satisfies

$$0 \leq \nu\left(\theta_P = -1 \mid \theta_A = -1, m_A = \phi, r = r_{11}\right) < 1. \tag{I.8}$$

Hence, by Bayes' rule, the confidence given $\theta_A = -1$, $m_A = \phi$, $r = r_{11}$, and $d = 1$ satisfies the following:

$$v_1^C \leq \frac{1}{\text{Prob}\left(s = d = 1 \mid \theta_A = -1, m_A = \phi, r = r_{11}, d = 1\right)} < \bar{v}_1. \tag{I.9}$$

As $v < v_1^C$, (I.9) implies that

$$\begin{aligned} v &< \frac{1}{\text{Prob}\left(s = d = 1 \mid \theta_A = -1, m_A = \phi, r = r_{11}, d = 1\right)} \\ &\iff \text{Prob}\left(s = d = 1 \mid \theta_A = -1, m_A = \phi, r = r_{11}, d = 1\right) b - c < 0. \end{aligned} \tag{I.10}$$

However, it implies that the agent disobeys the recommendation because $e = 0$ is optimal given $\theta_A = -1$, $m_A = \phi$, $r = r_{11}$, and $d = 1$, which is a contradiction. Thus, $\psi(r = r_{11} \mid m_P = \theta_P, m_A = \phi) = 0$ must hold for each θ_P. By the similar argument used above, we insist that mediated-delegation mechanism ψ must satisfy $\psi(r = r_{-11} \mid m_P = \theta_P, m_A = \phi) = 0$ also must hold for each θ_P. ■

Let $\rho_1 \equiv \psi(r = r_{10} \mid \theta_P = 1, m_A = \phi) \geq 0$ and $\rho_{-1} \equiv \psi(r = r_{10} \mid \theta_P = -1, m_A = \phi) \geq 0$.

Claim I.2. $\rho_1 < \rho_{-1}$.

Proof (Claim I.2)**.** Suppose that the agent with $\theta_A = 1$ receives recommendation $r = r_{10}$ after sending message $m_A = \phi$. By Claim I.1, the agent's consistent posterior is as follows:

$$\begin{aligned}
&\nu(\theta_P = 1 \mid \theta_A = 1, m_A = \phi, r = r_{10}) \\
&\quad = \frac{\rho_1[q_P q_A + (1-q_P)(1-q_A)]}{\rho_1[q_P q_A + (1-q_P)(1-q_A)] + \rho_{-1}[q_P(1-q_A) + (1-q_P)q_A]}. \qquad \text{(I.11)}
\end{aligned}$$

Then, the confidence given $d = 1$ is

$$\begin{aligned}
&\text{Prob}(s = d = 1 \mid \theta_A = 1, m_A = \phi, r = r_{10}) \\
&\quad = \frac{q_A[\rho_1 q_P + \rho_{-1}(1-q_P)]}{\rho_1[q_P q_A + (1-q_P)(1-q_A)] + \rho_{-1}[q_P(1-q_A) + (1-q_P)q_A]}. \qquad \text{(I.12)}
\end{aligned}$$

As the agent obeys recommendation $r = r_{10}$,

$$\begin{aligned}
&\text{Prob}(s = d = 1 \mid \theta_A = 1, m_A = \phi, r = r_{10})b - c < 0 \\
&\iff v < 1 + \frac{(1-q_A)[\rho_1(1-q_P) + \rho_{-1}q_P]}{q_A[\rho_1 q_P + \rho_{-1}(1-q_P)]} \qquad \text{(I.13)}
\end{aligned}$$

must hold.[57] Furthermore, as $v \geq v^D$, (I.13) implies

$$v^D < 1 + \frac{(1-q_A)[\rho_1(1-q_P) + \rho_{-1}q_P]}{q_A[\rho_1 q_P + \rho_{-1}(1-q_P)]} \iff \rho_1 < \rho_{-1}. \qquad \text{(I.14)}$$

■

Now, suppose that the agent with $\theta_A = -1$ receives recommendation $r = r_{10}$ after sending

[57] (I.13) must hold with strict inequality because we adopt the tie-breaking rule that the agent chooses $e = 1$ if $e = 1$ and 0 are indifferent.

message $m_A = \phi$. Since the agent's consistent posterior is

$$\nu(\theta_P = -1 \mid \theta_A = -1, m_A = \phi, r = r_{10})$$
$$= \frac{\rho_{-1}[q_P q_A + (1-q_P)(1-q_A)]}{\rho_1[q_P(1-q_A) + (1-q_P)q_A] + \rho_{-1}[q_P q_A + (1-q_P)(1-q_A)]}, \tag{I.15}$$

the confidence given $d = -1$ is

$$\text{Prob}(s = d = -1 \mid \theta_A = -1, m_A = \phi, r = r_{10})$$
$$= \frac{q_A[\rho_{-1}q_P + \rho_1(1-q_P)]}{\rho_1[q_P(1-q_A) + (1-q_P)q_A] + \rho_{-1}[q_P q_A + (1-q_P)(1-q_A)]}. \tag{I.16}$$

By Claim I.2, $\rho_1 < \rho_{-1}$ holds, which is equivalent to

$$v^D > 1 + \frac{(1-q_A)[\rho_1 q_P + \rho_{-1}(1-q_P)]}{q_A[\rho_{-1}q_P + \rho_1(1-q_P)]}. \tag{I.17}$$

However, by $v \geq v^D$ and (I.17), the agent given $\theta_A = -1$, $m_A = \phi$, and $r = r_{10}$ obtains positive payoff if he chooses $d = -1$ and $e = 1$, whereas his payoff is 0 from obeying the recommendation, which is a contradiction. Therefore, there exists no mediated-delegation mechanism in this parameter range. ■

It is impossible to construct mediated-delegation mechanisms because recommendations after $m_A = \phi$ must simultaneously satisfy the obedience conditions for both $\theta_A = 1$ and -1. Suppose, for example, that recommendation r after $m_A = \phi$ reveals that $\theta_P = 1$. Since this is good news for the agent with $\theta_A = 1$, it is necessary to satisfy the obedience condition that r recommends to choose $d = 1$ and $e = 1$ (i.e., $r = r_{11}$). Note that the agent with $\theta_A = -1$ may also receive the same recommendation after sending $m_A = \phi$. However, since the recommendation is bad news for the agent with $\theta_A = -1$, he prefers to deviate from the recommendation. Likewise, in the parameter range of Lemma I.2, when recommendation r

does not reveal any information about θ_P, it is necessary to satisfy the obedience condition that r recommends to choose $d = \theta_A$ and $e = 1$. However, recommendation $r = r_{11}$ (resp. r_{-11}) induces type $\theta_A = -1$ (resp. 1) to disobey the recommendation. The obedience condition after the agent conceals his signal limits the implementability of mediated-delegation mechanisms.

Combining Lemmas I.1 and I.2, we conclude that mediated-delegation mechanisms are useless when formal delegation is strictly preferred to centralization.

Proposition I.1. *Consider the mediation-mechanism model, and suppose that* $U^C(v) < U^D(v)$*. Then, there exists no mediated-delegation mechanism that is strictly better than formal delegation.*

The analysis so far justifies formal delegation as a benchmark for resolving the demotivating problem. When authority can be formally delegated to the agent, the principal's payoff cannot be strictly better off by mediation. We then conclude that focusing on (unmediated) formal delegation as our benchmark is not a loss of generality.

I.2.2 Case 2: Centralization Outperforms Formal Delegation

Next, we consider the case where centralization is preferred to formal delegation (although it is not the main scope of the body of the paper). Proposition 2-3 implies that it is either (i) $q_P > q_A$ and $v \geq v_1^C$ or (ii) $v \in [v_0^C, \min\{v^D, v_1^C\})$. It is straightforward that there is no room for improvements by mediated-delegation mechanisms in Case (i) because centralization achieves the best outcome in the sense that the project is chosen based on a more precise signal and it is executed for certain. However, in Case (ii), there exists a mediated-delegation mechanism dominating unmediated centralization/delegation.

Define mediation rule ψ^* as follows:

$$\psi^*(r \mid m_P, m_A) \equiv \begin{cases} 1 & \text{if } [m_P = 1, m_A = 1, r = r_{11}] \text{ or } [m_P = -1, m_A = -1, r = r_{-11}], \\ \rho^* & \text{if } [m_P = -1, m_A = 1, r = r_{11}] \text{ or } [m_P = 1, m_A = -1, r = r_{-11}], \\ 1 - \rho^* & \text{if } [m_P = -1, m_A = 1, r = r_{10}] \text{ or } [m_P = 1, m_A = -1, r = r_{-10}], \\ 1/2 & \text{if } [m_A = \phi, r = r_{10}] \text{ or } [m_A = \phi, r = r_{-10}], \\ 1 & \text{if } [m_P = \phi, m_A = 1, r = r_{10}] \text{ or } [m_P = \phi, m_A = -1, r = r_{-10}], \end{cases} \tag{I.18}$$

where

$$\rho^* \equiv \frac{q_P q_A (v-1) - (1-q_P)(1-q_A)}{q_P(1-q_A) - (1-q_P) q_A (v-1)}. \tag{I.19}$$

Intuitively, mediation rule ψ^* induces the semi-separation of events, as denoted in Figure I.1 heuristically. Suppose, for instance, that both parties disclose the signals and $\theta_A = 1$. When the parties' signals coincide (i.e., $\theta_P = \theta_A = 1$), the mediator sends recommendation $r = r_{11}$ for certain. Contrary, when the signals disagree (i.e., $\theta_P = -1$ and $\theta_A = 1$), the mediator sends recommendation $r = r_{11}$ with probability ρ^* and $r = r_{10}$ with the remaining probability.[58] In words, the agent recognizes that the signals disagree when she recommends not to execute whereas he is not certain whether the signals coincide when execution is recommended. Randomization probability ρ^* is determined so that the agent is indifferent between $e = 1$ and 0 given the recommended project. If the agent conceals his signal, then the mediator recommends $r = r_{10}$ and r_{-10} equally likely irrelevant to the principal's message. If the principal conceals her signal whereas the agent discloses, then the mediator recommends $r = r_{\theta_A 0}$ for certain. We can show that mediation rule ψ^* is a mediated-delegation mechanism that weakly outperforms centralization.

[58]Note that $\rho^* \in [0, 1)$ because $v \in [v_0^C, v^D)$.

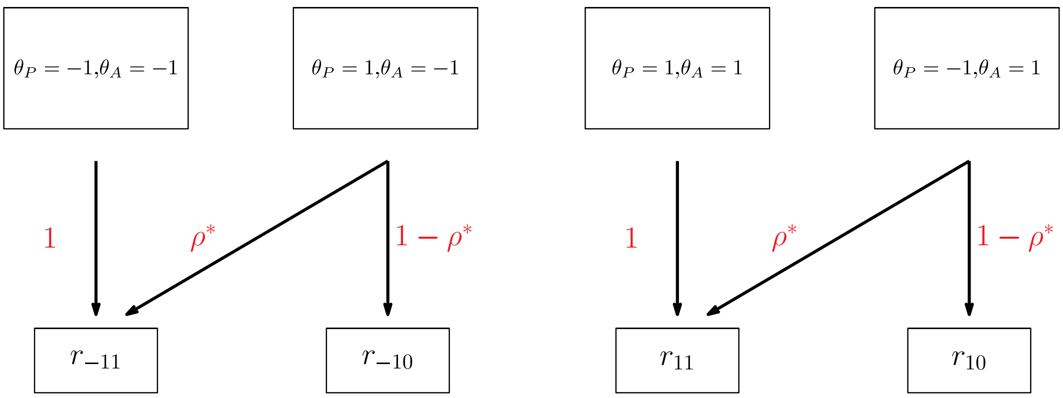

Figure I.1: Mediation rule ψ^*

Proposition I.2. *Consider the mediation-mechanism model and suppose that $v \in [v_0^C, \min\{v^D, v_1^C\})$.*

1. *Mediation rule ψ^* is an optimal mediated-delegation mechanism.*

2. *$U^{\psi^*}(v) = [q_P q_A + (1-q_P)q_A\rho]\, B \geq U^C(v) = q_P q_A B$, where the equality holds for $v = v_0^C$.*

Proof (Proposition I.2)**.** 1. (Existence) The agent's obedience conditions are checked as follows. Without loss of generality, $\theta_A = 1$ is assumed. First, suppose that $m_A = 1$. Then, $\bigcup_{m_P \in M} \text{supp}(\psi^*(m_P, m_A = 1)) = \{r_{11}, r_{10}\}$. Given $\theta_A = 1$, $m_A = 1$, and $r = r_{10}$, the agent's consistent posterior is $\nu^*(\theta_P = 1 \mid \theta_A = 1, m_A = 1, r = r_{10}) = 0$. Hence, the agent's confidence is

$$\text{Prob}(s = d \mid \theta_A = 1, m_A = 1, r = r_{10}) = \begin{cases} \dfrac{(1-q_P)q_A}{q_P(1-q_A) + (1-q_P)q_A} & \text{if } d = 1, \\[2ex] \dfrac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A} & \text{if } d = -1. \end{cases} \tag{I.20}$$

As $v < \min\{v_1^C, v^E\}$ implied by $v < \min\{v^D, v_1^C\}$, $e = 0$ is optimal whatever the chosen project is, implying that obeying $r = r_{10}$ is optimal. Given $\theta_A = 1$, $m_A = 1$, and $r = r_{11}$, the agent's consistent posterior is

$$\nu^*(\theta_P = 1 \mid \theta_A = 1, m_A = 1, r = r_{11}) = \frac{q_P q_A + (1-q_P)(1-q_A)}{1 - (1-\rho^*)[q_P(1-q_A) + (1-q_P)q_A]}. \tag{I.21}$$

Hence, the confidence given $d = 1$ is

$$\text{Prob}(s = d = 1 \mid \theta_A = 1, m_A = 1, r = r_{11}) = \frac{q_A[q_P + \rho^*(1 - q_P)]}{1 - (1 - \rho^*)[q_P(1 - q_A) + (1 - q_P)q_A]}. \quad \text{(I.22)}$$

It implies that $e = 1$ is optimal given $d = 1$ if and only if

$$\begin{aligned} &\left(\frac{q_A[q_P + \rho^*(1 - q_P)]}{1 - (1 - \rho^*)[q_P(1 - q_A) + (1 - q_P)q_A]}\right) b - c \\ &\iff \rho^* \leq \frac{q_P q_A(v - 1) - (1 - q_P)(1 - q_A)}{q_P(1 - q_A) - (1 - q_P)q_A(v - 1)}, \end{aligned} \quad \text{(I.23)}$$

which is satisfied by the definition of ρ^*. Likewise, the agent's expected payoff from $d = -1$ and $e = 1$ is

$$\left(\frac{(1 - q_P)(1 - q_A) + \rho^* q_P(1 - q_A)}{1 - (1 - \rho^*)[q_P(1 - q_A) + (1 - q_P)q_A]}\right) b - c. \quad \text{(I.24)}$$

Hence, obeying recommendation $r = r_{11}$ is a best response if and only if

$$\begin{aligned} &q_P q_A + \rho^*(1 - q_P)q_A \geq (1 - q_P)(1 - q_A) + \rho^* q_P(1 - q_A) \\ &\iff \rho^*(q_A - q_P) \geq 1 - q_P - q_A. \end{aligned} \quad \text{(I.25)}$$

As the right-hand side of (I.25) is negative, (I.25) holds if $q_P \leq q_A$. If $q_P > q_A$, then (I.25) is equivalent to

$$\rho^* \leq \frac{q_P + q_A - 1}{q_P - q_A}. \quad \text{(I.26)}$$

Note that the right-hand side of (I.26) is greater than 1, implying that (I.26) is satisfied. Thus, given $\theta_A = 1$, $m_A = 1$, and $r = r_{11}$, obeying the recommendation is optimal.

Second, suppose that $m_A = \phi$, implying that $\bigcup_{m_P \in M} \text{supp}(\psi^*(m_P, m_A = \phi)) = \{r_{10}, r_{-10}\}$.

Given $\theta_A = 1$, $m_A = \phi$, and $r = r_{10}$, the agent's posterior is $\nu^*(\theta_P = 1 \mid \theta_A = 1, m_A = \phi, r = r_{10}) = q_P q_A + (1 - q_P)(1 - q_A)$, implying that the confidence given $d = 1$ is $\text{Prob}(s = d = 1 \mid \theta_A = 1, m_A = \phi, r = r_{10}) = q_A$. As $v < v^D$, $e = 0$ is optimal given $d = 1$. Likewise, the confidence given $d = -1$ is $\text{Prob}(s = d = -1 \mid \theta_A = 1, m_A = \phi, r = r_{10}) = 1 - q_A$, implying that $e = 0$ is optimal given $d = -1$ because $v < v^D < \bar{v}_0 = 1/(1 - q_A)$. Thus, given $\theta_A = 1$, $m_A = \phi$, and $r = r_{10}$, obeying the recommendation is optimal. By the similar argument, given $\theta_A = 1$, $m_A = \phi$, and $r = r_{-10}$, obeying the recommendation is also optimal.

The P-disclosure conditions are checked as follows. The principal's expected payoff from $m_P = \theta_P$ is $q_A[q_P + \rho^*(1 - q_P)]B > 0$. Now, suppose that the principal deviates to $m_P = \phi$. Note that the agent never executes projects, whatever the chosen one is on the path after $m_A = \phi$, implying that the principal's expected payoff from $m_P = \phi$ is 0. Therefore, the P-disclosure conditions are satisfied.

The A-disclosure conditions are checked as follows. The agent's expected payoff from $m_A = \theta_A$ is $q_A[q_P + \rho^*(1 - q_P)]b - [1 - (1 - \rho^*)q_P(1 - q_A) + (1 - q_P)q_A]c$. Now, suppose that the agent deviates to $m_A = \phi$, implying recommendations $r = r_{10}$ and r_{-10} with equally likely. As the agent obeys each recommendation as shown above, his expected payoff from $m_A = \phi$ is 0. Note that, by definition of ρ^*,

$$q_A[q_P + \rho^*(1 - q_P)]b - [1 - (1 - \rho^*)q_P(1 - q_A) + (1 - q_P)q_A]c = 0 \tag{I.27}$$

holds, implying that $m_A = \theta_A$ is optimal. Therefore, the A-disclosure conditions are satisfied. Thus, we conclude that mediation rule ψ^* is a mediated-delegation mechanism.

(Optimality) Suppose, in contrast, that there exists mediated-delegation mechanism ψ' such that $U^{\psi'} > U^{\psi^*} = q_A[q_P + \rho^*(1-q_P)]B$. Note that

$$U^{\psi'} > U^{\psi^*} \iff \Big[U^{\psi'}(\theta_P = 1, \theta_A = 1) - U^{\psi^*}(\theta_P = 1, \theta_A = 1)\Big] \operatorname{Prob}(\theta_A = 1 \mid \theta_P = 1)$$
$$+ \Big[U^{\psi'}(\theta_P = 1, \theta_A = -1) - U^{\psi^*}(\theta_P = 1, \theta_A = -1)\Big] \operatorname{Prob}(\theta_A = -1 \mid \theta_P = 1) > 0. \tag{I.28}$$

Note that, by the construction of mediation rule ψ^*, we have $U^{\psi'}(\theta_P = 1, \theta_A = 1) \leq U^{\psi^*}(\theta_P = 1, \theta_A = 1)$. Hence, it is necessary to hold the following for satisfying (I.28):

$$U^{\psi'}(\theta_P = 1, \theta_A = -1) > U^{\psi^*}(\theta_P = 1, \theta_A = -1). \tag{I.29}$$

Claim I.3. $r_{11} \notin \operatorname{supp}(\psi'(m_P = 1, m_A = -1))$.

Proof (Claim I.3)**.** Suppose, in contrast, that $\psi'(r = r_{11} \mid m_P = 1, m_A = -1) > 0$. Note that the agent's confidence given $\theta_A = -1$, $m_A = -1$, and $r = r_{11}$ satisfies

$$\frac{(1-q_P)(1-q_A)}{q_P q_A + (1-q_P)(1-q_A)} < \operatorname{Prob}(s = d = 1 \mid \theta_A = -1, m_A = -1, r = r_{11})$$
$$\leq \frac{q_P(1-q_A)}{q_P(1-q_A) + (1-q_P)q_A}. \tag{I.30}$$

However, as $v < v_1^C$, $e = 0$ is optimal given $d = 1$, which is a contradiction. ■

Claim I.3 implies that $r_{-11} \in \operatorname{supp}(\psi'(m_P = 1, m_A = -1))$; otherwise, $U^{\psi'}(\theta_P = 1, \theta_A = -1) = 0$ because $\operatorname{supp}(\psi'(m_P = 1, m_A = -1)) \subseteq \{r_{10}, r_{-10}\}$ and mediation rule ψ' satisfies the obedience condition, which violates (I.29). Again, as $v < v^E$ implied by $v < \min\{v^D, v_1^C\}$, $r_{-11} \in \operatorname{supp}(\psi'(m_P = -1, m_A = -1))$ must hold; otherwise, the agent with $\theta_A = -1$, $m_A = -1$, $r = r_{-11}$ chooses $e = 0$ given $d = -1$ because $\nu'(\theta_P = -1 \mid \theta_A = -1, m_A = -1, r = r_{-11}) = 0$, which is a contradiction to that mediation rule ψ' satisfies the obedience condition.

Define $\rho_1 \equiv \psi'(r = r_{-11} \mid m_P = 1, m_A = -1) > 0$ and $\rho_{-1} \equiv \psi'(r = r_{-11} \mid m_P = -1, m_A =$

$-1) > 0$, respectively. Furthermore, define

$$I(\rho_1, \rho_{-1}) \equiv \nu'(\theta_P = -1 \mid \theta_A = -1, m_A = -1, r = r_{-11})$$
$$= \frac{\rho_{-1}[q_P q_A + (1-q_P)(1-q_A)]}{\rho_{-1}[q_P q_A + (1-q_P)(1-q_A)] + \rho_1[q_P(1-q_A) + (1-q_P)q_A]}. \tag{I.31}$$

Note that the following holds: (i) $I(\rho^*, 1) = \nu^*(\theta_P = -1 \mid \theta_A = -1, m_A = -1, r = r_{-11})$, (ii) $\partial I/\partial \rho_1 < 0$, and (iii) $\partial I/\partial \rho_{-1} > 0$. Since the agent with type $\theta_A = -1$ is indifferent between $e = 1$ and 0 when he receives recommendation $r = r_{-11}$ after sending message $m_A = -1$ under mediated-delegation mechanism ψ^* and mediation rule ψ' satisfies the obeying condition, $I(\rho_1, \rho_{-1}) \geq \nu^*(\theta_P = -1 \mid \theta_A = -1, m_A = -1, r = r_{-11})$ must hold. Furthermore, it is necessary for holding (I.29) that $\rho_1 > \rho^*$. However, the observations (i) to (iii) mentioned above imply that

$$I(\rho_1, \rho_{-1}) < I(\rho^*, 1) = \nu^*(\theta_P = -1 \mid \theta_A = -1, m_A = -1, r = r_{-11}) \tag{I.32}$$

holds for any $\rho_{-1} \in (0, 1]$, which is a contradiction. Therefore, mediated-delegation mechanism ψ' does not exist.

2. It is straightforward from the first part of this proof. ■

We have the following remarks. First, mediated-delegation mechanisms exist when $q_P < \hat{q}_P(q_A)$ and $v \in [v_0^C, v^D)$, which is a sharp contrast to the case of $q_P < \hat{q}_P(q_A)$ and $v \in [v^D, v_1^C)$. Although the bottleneck under $m_A = \phi$ is still relevant in this parameter range, it can be avoided if recommendations after $m_A = \phi$ never reveal any information about the principal's signal (e.g., $\psi^*(r = r_{10} \mid m_P = \theta_P, m_A = \phi) = \psi^*(r = r_{-10} \mid m_P = \theta_P, m_A = \phi) = 1/2$ for each θ_P). After receiving recommendation $r = r_{10}$, the agent chooses $e = 0$, whatever the chosen project is, because $v < v^D < \bar{v}_0 = 1/(1 - q_A)$. In words, because the agent's execution decision to each project is symmetric in the above sense, it is optimal for each θ_A to obey recommendation $r = r_{10}$. Note that when $v \geq v^D$, the agent's execution decision is asymmetric (i.e., without additional information about θ_P, the agent executes the project if and only if the chosen project is consistent with his signal), which makes this trick fails to work well.

Second, mediated-delegation mechanism ψ^* makes the principal better off than centralization and formal delegation. This is because mediation rules ψ^* can induce execution even when the signals disagree. In particular, by appropriately randomizing the recommendation, the "bad news" of signal disagreement is partially pooling with the "good news" of signal agreement. As a result, the agent does not recognize the bad news with positive probability, inducing execution more likely. Intuitively, as mediation rule ψ^* tailors the agent's posterior belief about θ_P so that the conflict over the project choice is partially resolved, it outperforms unmediated centralization and formal delegation.

Third, even if we consider *mediated-centralization mechanisms* in which the mediator recommends the project choice to the principal rather than the agent as alternative mediation mechanisms, our argument in this section does not change. Specifically, focusing on formal delegation as a benchmark for resolving the demotivating problem is not a loss of generality.[59]

J Total Surplus (for Online Appendix)

In this appendix, we consider a PBE that maximizes the expected total surplus. Here, the total surplus is defined as the sum of the principal's and agent's payoffs. For notational simplicity, let $B^+ \equiv B + b$. Throughout this appendix, we impose the following assumption, which is satisfied if the principal's benefit from executing the promising project B is sufficiently large.

[59] As the obedience conditions are different from those under the mediated-delegation mechanisms, there are gaps between mediated-delegation and centralization mechanisms. The detail is available upon request.

Assumption J.1. *The following condition holds:*

$$\frac{B^+}{c} > \max\left\{v^E, \frac{1}{q_P}\right\}. \tag{J.1}$$

Consider first equilibria under centralization. The analysis can proceed similarly to Appendix A.1.1. First, as the equilibrium condition does not change from the baseline model, there exists a PBE such that $d^C(\theta_P) = \theta_P$ for each θ_P and e^C satisfies (A.2). The total surplus on the equilibrium is calculated as

$$W^C(v) = \begin{cases} q_P B^+ - c & \text{if } v \geq v_1^C, \\ q_P q_A B^+ - [q_P q_A + (1-q_P)(1-q_A)]c & \text{if } v_0^C \leq v < v_1^C, \\ 0 & \text{if } v < v_0^C. \end{cases} \tag{J.2}$$

Note that there exist other equilibria. We will later verify that the other equilibria do not yield a total surplus larger than $W^C(v)$ or the maximum total surplus achieved under formal delegation.

Next, consider equilibria under formal delegation. By the similar procedure to the proof of Lemma 5, the equilibrium that maximizes the total surplus under formal delegation satisfies $d^D(\theta_A) = \theta_A$ for each θ_A and $e = 1$ if and only if $v \geq v^D$. Then, the maximum total surplus under formal delegation is

$$W^D(v) = \begin{cases} q_A B^+ - c & \text{if } v \geq v^D, \\ 0 & \text{if } v < v^D. \end{cases} \tag{J.3}$$

Owing to Assumption J.1, the value of formal delegation measured by the total surplus is essentially equivalent to that of the baseline model, as shown below.[60]

[60]By combining Proposition J.1 with the observations in Appendix I, we argue that mediation mechanisms

Proposition J.1. *Suppose that Assumption J.1 holds. Then,* $W^D(v) > W^C(v)$ *if and only if* $U^D(v) > U^C(v)$*.*

Proof (Proposition J.1)**.** The comparison between (J.2) and (J.3) and Proposition 2-3 immediately derives the statement. ■

Finally, we confirm that there is no PBE that yields a total surplus larger than $\max\{W^C(v), W^D(v)\}$. As demonstrated in Appendix A.1.1, under centralization, there are two other kinds of equilibria such that (i) for some $\tilde{d} \in D$, $d^C(\theta_P) = \tilde{d}$, and (ii) $d^C(\theta_P) = -\theta_P$ for each θ_P. Similar to Tables 1 to 4, Tables J.1 to J.6 summarize the comparison of the total surplus. In each table, it is possible to confirm that $\max\{W^C(v), W^D(v)\}$ in the second row is not less than the total surplus in the third row. Then, there is no other equilibrium under centralization that yields a larger total surplus.

Corollary J.1. *Suppose that Assumption J.1 holds.*

1. *Suppose that* $U^C(v) \geq U^D(v)$*. Then, the maximum total surplus under centralization is* $W^C(v)$ *and not less than* $W^D(v)$*.*

2. *Suppose that* $U^C(v) < U^D(v)$*. Then, the maximum total surplus under delegation is* $W^D(v)$ *and not less than* $W^C(v)$*.*

Proof (Corollary J.1)**.** By Proposition J.1, $U^C(v) < U^D(v)$ holds if and only if $W^C(v) < W^D(v)$ holds. Then, the optimality is immediately derived from Tables J.1 to J.6. ■

Corollary J.1 implies that empowerment in the ACE model may be desirable in terms of the total surplus when $U^C(v) < U^D(v)$. Nevertheless, as we have already checked, for $v < v^E$ or $q_A < q_P$, there is no empowerment equilibrium because of the agent's deviation incentive to be silent strategically. Therefore, strategic silence may be an obstacle to the improvement of the total surplus.

are weakly dominated by formal delegation when $W^C(v) < W^D(v)$.

	$\max\{W^C(v), W^D(v)\}$	$d^C(\theta_P) = \tilde{d}$
$v \geq \bar{v}_0$	$q_A B^+ - c$	$B^+/2 - c$
$v^D \leq v < \bar{v}_0$		$q_A B^+/2 - c/2$
$v_0^C \leq v < v^D$	$q_P q_A B^+ - [q_P q_A + (1-q_P)(1-q_A)]c$	0
$v < v_0^C$	0	

Table J.1: Comparison of Total Surplus: $q_P < q_A$

	$\max\{W^C(v), W^D(v)\}$	$d^C(\theta_P) = \tilde{d}$
$v \geq \bar{v}_0$	$q_P B^+ - c$	$B^+/2 - c$
$v_1^C \leq v < \bar{v}_0$		$q_A B^+/2 - c/2$
$v^D \leq v < v_1^C$	$q_A B^+ - c$	
$v_0^C \leq v < v^D$	$q_P q_A B^+ - [q_P q_A + (1-q_P)(1-q_A)]c$	0
$v < v_0^C$	0	

Table J.2: Comparison of Total Surplus: $q_A \leq q_P < \hat{q}_P(q_A)$

	$\max\{W^C(v), W^D(v)\}$	$d^C(\theta_P) = \tilde{d}$
$v \geq \bar{v}_0$		$B^+/2 - c$
$v^D \leq v < \bar{v}_0$	$q_P B^+ - c$	$q_A B^+/2 - c/2$
$v_1^C \leq v < v^D$		
$v_0^C \leq v < v_1^C$	$q_P q_A B^+ - [q_P q_A + (1-q_P)(1-q_A)]c$	0
$v < v_0^C$	0	

Table J.3: Comparison of Total Surplus: $q_P \geq \hat{q}_P(q_A)$

	$\max\{W^C(v), W^D(v)\}$	$d^C(\theta_P) = -\theta_P$
$v \geq \bar{v}_1$	$q_A B^+ - c$	$(1 - q_P)B^+ - c$
$v^D \leq v < \bar{v}_1$		$(1 - q_P)q_A B^+ - [q_P(1 - q_A) + (1 - q_P)q_A]c$
$v^E \leq v < v_1^C$	$q_P q_A B^+ - [q_P q_A + (1 - q_P)(1 - q_A)]c$	
$v_0^C \leq v < v^E$		0
$v < v_0^C$	0	

Table J.4: Comparison of Total Surplus: $q_P < q_A$

	$\max\{W^C(v), W^D(v)\}$	$d^C(\theta_P) = -\theta_P$
$v \geq \bar{v}_1$	$q_P B^+ - c$	$(1 - q_P)B^+ - c$
$v^E \leq v < \bar{v}_1$		$(1 - q_P)q_A B^+ - [q_P(1 - q_A) + (1 - q_P)q_A]c$
$v_1^C \leq v < v^E$		0
$v^D \leq v < v_1^C$	$q_A B^+ - c$	
$v_0^C \leq v < v^D$	$q_P q_A B^+ - [q_P q_A + (1 - q_P)(1 - q_A)]c$	
$v < v_0^C$	0	

Table J.5: Comparison of Total Surplus: $q_A \leq q_P < \hat{q}_P(q_A)$

	$\max\{W^C(v), W^D(v)\}$	$d^C(\theta_P) = -\theta_P$
$v \geq \bar{v}_1$	$q_P B^+ - c$	$(1 - q_P)B^+ - c$
$v^E \leq v < \bar{v}_1$		$(1 - q_P)q_A B^+ - [q_P(1 - q_A) + (1 - q_P)q_A]c$
$v_1^C \leq v < v^E$		0
$v_0^C \leq v < v_1^C$	$q_P q_A B^+ - [q_P q_A + (1 - q_P)(1 - q_A)]c$	
$v < v_0^C$	0	

Table J.6: Comparison of Total Surplus: $q_P \geq \hat{q}_P(q_A)$