Credibility, efficiency and the structure of authority *

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Abstract

In many economic settings it is optimal to endow individuals with high abilities, rather than those with low abilities, with decision-making power. Yet there is rich empirical evidence showing that many of those in charge of decisions are not necessarily the most talented. We offer a novel rationale for why choosing a decision maker with low ability might be welfare-optimal. In a setting with two-sided information acquisition where the players disagree only when uninformed, we show that a high-ability principal optimally delegates authority to a low-ability agent because the latter not only exerts higher effort than under centralized decision-making, but also follows the principal's advice when uninformed himself. As a result, the principal does not lose any real authority.

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JEL codes: D82, D83, M52.

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1 Introduction

In many economic settings, in particular those modeled as principal-agent problems, it is optimal to endow high-ability agents, rather than low ability ones, with decision-making power. Yet there is rich evidence showing that decision-making positions are often occupied by poorly qualified personnel,[1] and even so when the candidates were known in advance to not be particularly well-suited for the jobs.[2] For instance, in organizational contexts, even in developed countries where a wide range of candidates' screening procedures is available, management exhibits large variation in their expertise to perform core tasks (Bloom and Van Reenen, 2007).[3]

In this paper we show how granting decision rights to a less able player can be compatible with efficient organizational design. Specifically, in a setting where the principal and the agent differ in their abilities to access information necessary for successful decision-making, we show that a high-ability principal sometimes benefits from credibly delegating decision rights to a lower ability agent. The key element for such an equilibrium to exist is that – given the initial common prior – the players disagree over an optimal action ex-ante, i.e. without any acquired information. If, however, the players become informed, then they agree on the optimal action, i.e. information resolves the initial conflict. Under delegation a low-ability agent who is in charge of decision-making follows the principal's advice, in form of cheap talk, only if he believes that *on average* the principal recommends an action that is in the agent's best interest. Hence, the principal is persuasive only if she is sufficiently likely to be informed as in this case her advice is more likely to be based on obtained information rather than just on her preferences. As we discuss below, this finding resonates with the empirical literature on how trust within organizations affects information production and sharing, and that trust is rooted in the belief that the other party is sufficiently "skilled".

More broadly, we connect to the literature on how human capital affects organizational design[4] (Bloom, Sadun, and Van Reenen, 2012; Caroli and Van Reenen, 2001) and how credibility acts as a determinant of organizational design, in particular the credibility of communication (e.g. Dessein (2002), Alonso, Dessein, and Matouschek (2008), Rantakari (2008)) and the question of trust within organizations (Baker, Gibbons, and Murphy, 1999). Similar to the above-mentioned papers, we follow the incomplete contracting approach assuming that infor-

[1] The presence of untalented decision makers in organizations does not only happen in developing countries, in particular in the context of family-owned firms (Caselli and Gennaioli, 2013) or transition environments where posts are allocated to often untalented political insiders (e.g. Barberis, Boycko, Shleifer, and Tsukanova (1996)), but also in the context of market economies (Caselli and Gennaioli, 2008). For example, Campbell, Baldwin, Johnson, Chapman, Upton, and Walton (2001) uncovered substantial gaps in qualifications of organizational decision makers: a finding that was also recognized in subsequent reports (e.g. Learning, for Education, and Britain)(SSDA) (2004)).

[2] In a political economy context, Mattozzi and Merlo (2015) discuss many examples where important political offices in mature democracies were being held by persons with "mediocre" backgrounds.

[3] See also the discussion in Sadun, Bloom, and Van Reenen (2017).

[4] Important empirical studies of delegation include Acemoglu, Aghion, Lelarge, Van Reenen, and Zilibotti (2007), Guadalupe and Wulf (2010), Bloom, Garicano, Sadun, and Van Reenen (2014) and Aghion, Bloom, Lucking, Sadun, and Van Reenen (2017).

mation is soft and the principal is only able to commit to the allocation of decision rights.

Before discussing our main results, we briefly sketch our model. We consider a principal-agent framework with two-sided information acquisition where the players are differentially *efficient* in obtaining information. The organizational decision refers to the choice between one of the two actions, a or b, and there is an unobserved underlying state which is either $\mathcal{A}$ or $\mathcal{B}$. The players' preferences are such that, given the common prior, there is disagreement over the optimal action. Conditional on the state, however, both prefer to match the action to the state. The initial disagreement comes from a difference in preferences: the players disagree on the relative gain from making the right decision in different states. Transfers are ruled out but at the beginning of the game, the principal can either credibly delegate the formal authority over the choice of action to the agent or retain decision-making power. After decision rights are allocated, both players simultaneously exert efforts. Under *centralisation*, the agent communicates to the principal who then chooses the action. Under *delegation*, the principal communicates to the agent who then chooses the action. Information is soft (Crawford and Sobel, 1982) and the only distinction between the principal and the agent is that the former decides on the decision rights. Players simultaneously exert effort to obtain a perfectly revealing signal about the state and higher effort makes a signal more likely.

In the paper, we first characterize equilibria under both delegation and centralization, and then we deal with the question of optimal authority allocation for the principal. On the one hand, delegation can raise the value of information for the agent who exerts more effort compared to centralisation. On the other hand, under delegation an uninformed agent may take his ex-ante preferred biased action which is bad for the principal.

We first show that there is no truthful communication under any organizational form. Under the payoff structure in our setup, there is no incentive to lie upon successful information acquisition. However, there is always an incentive to lie upon the lack of successful information acquisition, as conditional on no additional information the players disagree over the optimal action. Intuitively, after the information acquisition efforts have been exerted, an uninformed player will always recommend the decision maker to switch towards his ex-ante preferred action, anticipating that his recommendation may only be influential if the decision maker is not informed. Hence, the only influential communication (i.e. communication that has an effect on the decision maker's action) involves pooling resulting in noisy recommendation.

Our second main result shows the existence of influential equilibria under both delegation and centralisation. In this type of equilibrium, the actual decision maker follows a *credible* recommendation by the other player (adviser) when uninformed, provided that the adviser exerts sufficiently high effort. Additionally, the decision maker follows his own signal whenever he has successfully learned the state, in which case again he chooses the mutually optimal project.

To better understand the mechanism, consider the case of delegation. If the principal exerts effort, there is a positive probability that she receives a signal. The signal either reveals that the optimal action is the one ex ante preferred by the agent (say, action a), or the one ex ante preferred by the principal (say, action b). With some probability, the principal does not receive any signal. Suppose that the principal reveals when the optimal action is a and sends an alternative message otherwise. Upon receiving the latter, the agent is uncertain whether the principal learned that the optimal action is b (in which case the players agree), or if the principal is uninformed. In the latter case, if the agent himself is uninformed, the players disagree on the action choice. However, whenever the principal is sufficiently efficient in information acquisition, her recommendation is credible enough to switch the action of an uninformed agent towards action b. Specifically, the agent assigns a sufficiently high posterior belief to the principal being informed. In this case the principal retains real authority in the form of a recommendation. We call this type of equilibrium *influential*. As efforts are substitutes in this setup, the more inefficient the agent is, the more effort the principal exerts, and the more likely it is that this equilibrium arises.[5]

The existence of an influential equilibrium under centralisation is similar: if the agent is sufficiently efficient compared to the principal, he makes a recommendation which the principal follows whenever uninformed. Similarly, when the principal is indeed informed, she always takes the mutually optimal action. The above results resonate with empirical findings that under delegation management is still involved in consultations with the worker (Katayama, Meagher, and Wait, 2018) and that centralisation is more likely to arise the less the employee trusts the management (Meagher and Wait, 2018).[6] In line with the above results, the leader-member exchange (LMX) theory suggests that managers delegate more often, while at the same time consulting their subordinates, when there is a relationship of strong mutual trust (Yukl and Fu, 1999). The study of interaction between trust, information transmission and production has a longer tradition in the business and psychology literature[7] where trust, or openness to being persuaded, stems from the "belief that the other [party] is capable and skilled" (Collins and Smith, 2006), it means the other party has the *ability* to act in a persuasive way (Deutsch, 1960; Mayer, Davis, and Schoorman, 1995; Mayer and Gavin, 2005). However, to our best knowledge this literature has not explored yet a mechanism of how the ability to persuade organizational decision makers is affected by the organizational design and the underlying abilities of the players.

Finally, our third group of results studies the optimality of the organizational structure. We show that as long as the principal is sufficiently efficient to make an influential recommendation

[5]Substitutability of efforts leads to moral hazard à la Holmstrom (1982). Dewatripont and Tirole (2005) study communication combining moral hazard in teams with lack of congruence between a sender and a receiver. Their story is different, however, as they study how the mutual efforts of sender and receiver endogenously determine the verifiability of the sender's information.

[6]How trust affects organizational decision structure is further explored in Bloom et al. (2012).

[7]Garrett, Hoitash, and Prawitt (2014) find that intra-organizational trust between managers and their subordinates leads to a more informative financial reporting. That trust induces a better production and a more truthful dissemination of information is also shown in Mayer and Gavin (2005) and Roberts and O'Reilly III (1974).

under delegation, the principal does not lose any authority by delegating. When an influential equilibrium under delegation exists, the agent is sufficiently inefficient and hence unable to produce a credible recommendation himself. The key ingredients are the relative efficiencies of the players. Even if the agent is less efficient relative to the principal, he exerts some effort under delegation whereas under centralisation, an inefficient agent who cannot influence the final decision would not exert any effort.[8] On the other hand, under delegation the uninformed agent follows the principal's recommendation while overruling the principal if and only if informed in which case he chooses the mutually optimal action. The reason for the agent's effort under delegation is to overrule an uninformed principal who wrongly recommends her ex-ante preferred action. This possibility induces the agent to exert effort although he follows the principal's recommendation whenever unable to obtain an informative signal.

The above result on no loss of authority from delegation when an influential equilibrium exists is also important as it renders delegation credible in our setup. Baker et al. (1999) argue that as the principal is the ultimate stakeholder, granting authority might not be credible and delegation can be revoked if the agent wants to make a decision against the principal's interest. In our setting, however, when influential equilibrium under delegation exists, the principal would never want to revoke authority as the agent only ever overrules the principal when he is informed, in which case he is taking the optimal decision for the principal. Hence, when the principal is sufficiently efficient, the credibility of her recommendation also translates into the credibility of delegation even if it is not contracted upon.

When the principal is relatively inefficient, under delegation her recommendation is never credible and hence she would stop exerting any effort. Hence, it is optimal to centralise for a sufficiently inefficient principal if the agent can be influential under centralisation (with the exception of the case when the principal does find it optimal not to exert any effort hence prefers to delegate and play the babbling equilibrium). Indeed, our results show that for mutual effort and communication, the relatively inefficient party must be allocated decision-making power whenever an influential equilibrium does exist. We show that this is also the welfare optimal organizational structure. This is due to the fact that for influential communication to happen, the party who isn't taking the decision must be putting in sufficiently high effort. Given the equilibrium efforts are substitutes, this will be more likely to happen if the decision maker is putting in less effort. When influential equilibrium doesn't exist, i.e. babbling is unique under centralisation or delegation, then the tradeoff faced by delegation is that between losing authority and inducing effort.

We extend to study the verifiable information version of our game. First, the efforts and payoffs under centralisation in the verifiable information game are identical to those of the influential equilibrium under delegation in our main model. Second, the same one to one correspondence holds for delegation in the verifiable information game and the influential equilibrium

[8] Although we assume that parameters are such that the informative equilibria under delegation and centralisation do not exist simultaneously, this turns out to be an easy condition that holds under most parameters.

under centralisation in our main model. These results suggest that the verifiable information outcomes can be replicated with soft information but only under certain parameters (in this case when influential equilibrium exists) and under a different organizational structure.[9]

We also extend our model to consider sequential information acquisition where a player exerts effort and communicates to the decision maker who then exerts effort and chooses a project. The sequentiality of information acquisition changes communication incentives allowing for truthful communication, specifically if the decision maker is sufficiently efficient. This creates an incentive to reveal the absence of a signal by the first-mover in order to incentivize effort by the follower. As we show, under certain conditions influential equilibria do exist under centralisation and delegation, and each organizational structure is optimal under the conditions which are qualitatively similar to the case of simultaneous information acquisition. The additional dimension here is that the first-mover will shift some of the effort burden to the follower. However, free-riding in terms of effort is limited since the first-mover also anticipates that the decision maker may also not successfully acquire information and therefore exert higher effort. Similar to the case of simultaneous effort provision, the first-mover has to be sufficiently efficient in order for her recommendation to be followed by an uninformed decision maker. Complication arises due to the additional dimension that the first-mover is more likely to be truthful to a more efficient second mover whom he trusts will exert sufficient effort into information acquisition.

This article is structured as follows. Section 2 presents the setup, Section 3 characterizes the outcomes of the game and Section 4 studies the optimal organizational arrangements. Section 5 discusses welfare. Section 6 studies extensions to general preferences, verifiable information and sequential information acquisition. Section 7 concludes. In the remainder of this section we relate this article to the existing literature.

Discussion of the Literature: Our paper is related to the literature on delegation. In Aghion and Tirole (1997) verifiable information is acquired and shared between a principal and an agent and the transfer of the actual decision-power to the agent motivates him to invest in information. The trade-off is between providing incentives through delegation and loss of decision-making power. The conflict of interest is different to our model: in Aghion and Tirole (1997) the players disagree on the project choice when both are informed and hence the principal always loses some decision-making power from delegation as the agent whenever informed can overrule an informed principal to select his preferred project. The agent exerts more effort under delegation given that whenever he is informed, he overrules the principal.

[9] A comparison of the outcomes under different assumptions of verifiability of information is useful for comparing our setup to the relevant literature. For example, Aghion and Tirole (1997) soft information is equivalent to hard information as there are no incentives to lie, whereas for example, Newman and Novoselov (2009) focuses exclusively on hard information where again lying is not an issue. In the context where a principal could choose whether to invest in making information verifiable our analysis shows when such investment could be optimal and when it can be irrelevant, as the verifiable information outcome can be sometimes achieved when information is not verifiable.

On the contrary, in our setup with influential equilibrium under delegation, the agent works harder under delegation than under centralisation and never overrules the principal unless when informed, hence the principal does not lose any decision-making power.

While in Aghion and Tirole (1997) the principal would benefit from the lack of conflict, the presence of conflict can benefit the principal in Rantakari (2012) and Che and Kartik (2009). In Rantakari (2012), under delegation the agent diverts effort away from the tasks that is important for the principal towards the task important for himself. Che and Kartik (2009) consider a disclosure game where the agent and the principal conflict due to differing priors over the distribution of the state while conditional on the state their preferences are aligned. In these papers, the agent is the only one who can acquire a noisy signal.

Newman and Novoselov (2009) study the consequences of hard information on allocation of authority in a setting where both the principal and the agent agree on the best action when informed. The conflict of interest is similar to how we model it. There is a crucial difference which is that in their setup information is verifiable and therefore the question of credibility of communication does not arise. In contrast, in our setup the advice of the principal under delegation is only credible when the principal is efficient enough that her message is more likely to be based on acquired information as opposed to ex-ante bias. Deimen and Szalay (2016) study a communication game where there are multiple issues on which agent has the choice to learn about: either the issue which is important for the agent or the one which is important for the principal. They show that centralisation is dominant over delegation as in that case, the agent learns about what matters to the principal in order to be credible. In their setup, only the agent can acquire information.

There is a rich literature exploring the rationale for delegation within organizations[10] when contracts are incomplete (Grossman and Hart, 1986; Hart and Moore, 1990) as otherwise the allocation of authority is irrelevant.[11] Some of the literature assumes that the employees are already endowed with information and explores the trade-off between the quality of communication and the loss of decision power (Dessein, 2002; Harris and Raviv, 2005). If the information is dispersed between multiple employees, the setting of coordinated adaptation with exogenous information (Alonso et al., 2008; Rantakari, 2008) suggests that the principal prefers to centralize whenever the conflict of interest within an organization is substantial and coordination is sufficiently important. In a similar framework Liu and Migrow (2018) show that a large coordination motive can support delegation if the information is endogenous and the principal is unable to commit to decision rules. Different to our paper, in the above papers the principal is unable to obtain information directly hence has to rely only on her subordinates. In addition, in all these papers the loss of authority from delegation is present whenever the principal faces a biased agent.

[10]See Gibbons, Matouschek, and Roberts (2013) and Garicano and Rayo (2016) for excellent overviews of the literature.

[11]In the setting where the allocation of authority is irrelevant, Holmström (1984) and Alonso and Matouschek (2008) explore which decisions are attainable via constrained delegation.

We further connect to the literature on costly information acquisition before cheap talk, starting with Austen-Smith (1994) who models uncertainty about expert's information acquisition cost. Some of the recent contributions to strategic communication with information acquisition include Pei (2015), Argenziano, Severinov, and Squintani (2016), Deimen and Szalay (2016) and Hidir (2018). Pei (2015) adds information acquisition to the setup of Crawford and Sobel (1982) and shows that an expert truthfully transmits all the information he acquires, while Argenziano et al. (2016) show that communication-based organization does better than delegation. Deimen and Szalay (2016) consider a setup where the expert can choose on which issues to gather information and show that communication dominates delegation. Hidir (2018) studies a setup where investment into information acts as a way to signal a sender's type when the sender's bias is unknown. Our setup is different in that in all of these papers consider the agent as the one acquiring information.

Finally, we connect to the literature on the loyalty-competence trade-off mostly studied in the political economy context where a leader concerned with preservation of their power might choose an incompetent adviser (Egorov and Sonin, 2011). Empirically, Besley, Folke, Persson, and Rickne (2017) show the presence of this trade-off in the selection process of politicians by the party leaders in Sweden.[12] In an organizational setting, Prendergast and Topel (1996) use a similar loyalty-competence trade-off to model favoritism. Specifically, they introduce principal's preferences for particular types of agents. If the principal values her power to influence the agent, she may optimally choose low-ability agents. Even though we explore a similar theme of the principal's reliance on less competent agents, our setup is very different from the above papers.

2 Model

An organization consists of a principal (she, P) and an agent (he, A). An organizational decision concerns the choice of one of the two actions, $\theta \in \{a, b\}$, and there is an unobserved state $\omega \in \{\mathcal{A}, \mathcal{B}\}$ with the common prior $Pr(\omega = \mathcal{A}) = p$. In each state the payoff from action b is zero for both the principal and agent, while the payoffs from action a differ depending on the state. When the state is $\mathcal{A}$, the payoffs of the agent and the principal from action a are respectively βw and $(1-\beta)w$. When the state is $\mathcal{B}$, the payoffs of the agent and the principal from action a are respectively $-(1-\beta)w$ and $-\beta w$. Hence, in the state $\mathcal{A}$, action a and in state $\mathcal{B}$, action b is the mutually optimal action. We assume $1-\beta < p < \beta$ which ensures that at the beginning of the game, i.e. before any information is acquired, the agent's optimal action is a while the principal's optimal action is b.[13] Hence, $\beta \in (1/2, 1]$ defines the bias which

[12] See also Mattozzi and Merlo (2015) for the discussion of the selection of "mediocre" players in the context of political parties.

[13] With other words, we model an ex ante conflict of interest where the uninformed agent prefers project a to b: $p\beta w > (1-p)(1-\beta)w$, and the uninformed principal prefers project b to a: $(1-p)\beta w > p(1-\beta)w$.

is identical for both players but points towards different actions for each player. Information about the state resolves the initial conflict of interest over the optimal action. As we discuss in the extension, our results hold for general payoff structures provided that there is a mutually optimal action conditional on the state, and that given the prior there is a disagreement due to differing preferences, i.e. due to differences in the loss of making a wrong decision in the corresponding states.

As what matters for information acquisition and decision-making is the difference in payoffs of choosing the right and the wrong action conditional on the state, we interpret the decision as the one between a risky action and a safe action (the status quo) by normalizing the payoff from the safe action b to zero in either state, and varying the payoff from the risky action a depending on the underlying state. We so assume that the agent has a larger inclination towards the risky action than the principal and so the principal has a bias towards the status quo.

Remark: The type of conflict we model reflects a common feature in organizations when the central management is averse to adopting risky projects as the managerial performance is often measured by short-term fluctuations of the company's value (Aghion, Van Reenen, and Zingales, 2013; Porter, 1992). In contrast, local division managers might not face immediate evaluations as the central management does, and so are more inclined to adopt riskier projects.[14]

Each player can acquire a costly state-dependent signal. We assume success-enhancing effort as in Green and Stokey (1980) where exerting effort $e_i \in [0, 1]$ for $i = P, A$ results in the arrival of a perfectly revealing signal $s_i = \omega$ with probability e_i at a cost $\frac{e_i^2}{2}c_i$, whereas with probability $1 - e_i$ no signal arrives. The signal is non-verifiable.

We follow the incomplete contracting approach (Grossman and Hart, 1986; Hart and Moore, 1990) and assume that the principal is unable to commit to transfers (or choice functions) based on reports. However, at the beginning of the game the principal can choose, and commit to an allocation of decision rights. The principal either chooses centralisation (principal authority) or delegation (agent authority). Under both structures, first, both players simultaneously and privately invest effort in order to acquire signals. Under centralisation, the agent sends a cheap talk message to the principal who, then, chooses an action. Under delegation, after efforts are exerted, the principal sends a cheap talk message to the agent who, then, chooses an action. The timing of the game is summarized in Figure 1.

The message space M available to each player is countable and arbitrarily large, and we denote by $m_i \in M$ a message sent by player i, which as we will find in equilibrium will consist of recommending one of the two actions, hence $i \in \{a, b\}$.

[14] Acharya and Subramanian (2009) and Azoulay, Graff Zivin, and Manso (2011) show that optimal organizational contracts indeed tolerate risk-taking by the employees.

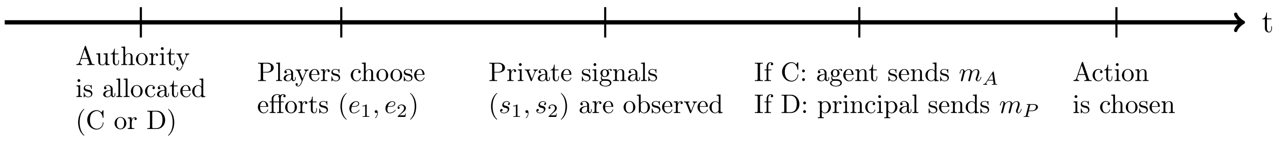


Figure 1: Timing of Events

3 The outcomes of the game

Throughout the paper we maintain the following assumption on the costs of information acquisition which ensures that both player's efforts are always less than or equal to 1:

Assumption 1 The following holds throughout the paper:

$c_A \geq (1-p)(1-\beta)w$ and $c_P \geq p(1-\beta)w$.

Our first proposition shows that the players never communicate all of their information truthfully, regardless of the allocation of authority.

Proposition 1: *There is no truthful communication equilibrium under either centralisation or delegation.*

To understand why a player cannot reveal his signal truthfully to the decision maker, note that this player may only influence the decision if the decision maker is indeed uninformed. Consider the case of delegation and assume by contradiction that there is a truthtelling equilibrium. If the principal truthfully reveals to the agent that she is uninformed, the agent chooses action a when he is also uninformed. If, however, he is informed, he chooses the mutually optimal action no matter what the principal recommends. Then, if the agent expects the principal to be truthful, the uninformed principal will deviate and recommend action b. The agent understands the principal's strategy and therefore, given the ex-ante conflict of interest, truthful communication cannot happen in equilibrium under delegation. For the case of centralisation the argument is similar.

Next, we characterize the types of equilibria under delegation and centralisation before we proceed with the characterization of the optimal organizational structure.

3.1 Delegation

Delegation here indicates that the decision-making power is allocated to the agent. As we show below, there are two possible equilibria under delegation. We call the first equilibrium

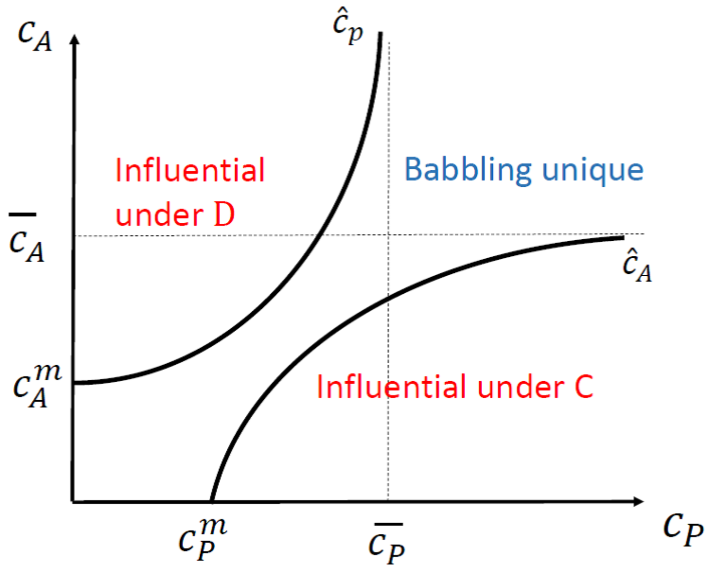


Figure 2: Characterisation of equilibria

influential as in this equilibrium the principal exerts effort and the agent follows the principal's recommendation whenever he himself is uninformed. This happens if and only if the principal is sufficiently more efficient in information acquisition than the agent, and hence in equilibrium she exerts high enough effort to make her recommendation credible. If not, a *babbling* equilibrium is the unique one, in which the uninformed agent always chooses action a regardless of what the principal says. In that case, as the principal can never influence the agent's decision, she exerts no effort at all.

3.1.1 Influential equilibrium under delegation

Here we characterize the equilibrium in which the principal exerts effort and, after observing her signal, sends a recommendation to the agent who follows it when uninformed.

The principal's communication strategy consists of sending one of the two signal-contingent messages, m_a and m_b. If she learns that the state is $\mathcal{A}$, she sends message m_a to the agent, who then follows her recommendation. If she learns that the state is $\mathcal{B}$ or does not learn anything, she recommends action b by sending the message m_b. Thus, upon receiving m_b the uninformed agent does not know whether the principal is uninformed or genuinely informed that the state is $\mathcal{B}$. As we show below, the agent's posterior probability assigned to the state $\mathcal{B}$ should be high enough such that he optimally follows the principal's recommendation and chooses action b upon receiving m_b.

To understand the incentives behind this strategy profile, we first consider the agent's optimal choice. Whenever informed, the agent chooses a mutually optimal action regardless of the principal's message. Whenever the uninformed agent receives m_a, the agent is sure of the state and he chooses action a. If, however, the uninformed agent receives m_b, he assigns a posterior probability $\tilde{p} = \frac{1-p}{1-e_P p}$ to the state $\mathcal{A}$ and so the posterior:

$$1 - \tilde{p} = \frac{p(1-e_P)}{1-pe_P} \tag{3.1}$$

to the state $\mathcal{B}$. Therefore, the uninformed agent follows the recommendation if

$$(1-\tilde{p})(1-\beta)w \geq \tilde{p}\beta w$$

or

$$e_P \geq \frac{\beta + p - 1}{\beta p}. \tag{3.2}$$

Hence, in this case the principal's equilibrium effort is high enough to induce a sufficiently high posterior belief of the agent in favor of the state $\mathcal{B}$. Note that the RHS of 3.2 increases in β and p. This is because a higher β (and/or p) increases the attractiveness of choosing an ex-ante preferred action a by the uninformed agent, and therefore the principal is required to exert higher effort in order to persuade the uninformed agent to switch his action.

Anticipating the principal's equilibrium effort and hence his own response to the principal's communication strategy, at the effort stage the agent chooses e_A to maximize

$$e_A p\beta w + (1-e_P) - \frac{e_A^2}{2}c_A.$$

The above expected payoff reflects the fact that, conditional on obtaining an informative signal – which happens with probability e_A – the agent chooses the optimal action. With the complementary probability $1 - e_A$ the agent is uninformed. In this case he either receives a truthful recommendation from the principal to choose action a that yields the payoff βw, or a "noisy" recommendation (which the agent follows) to choose action b that yields the payoff 0. As the above objective is concave in the agent's effort, the first-order approach results in the agent's best response

$$e_A = \frac{(1-e_P)p\beta w}{c_A}.$$

The principal's problem at the effort stage is to choose the effort e_P that maximizes

$$e_P p(1-\beta)w + (1-e_P)[e_A p(1-\beta)w] - \frac{e_P^2}{2}c_P,$$

which results in

$$e_P = \frac{(1-e_A)(1-\beta)pw}{c_P}.$$

Solving both player's best responses at the effort stage, we obtain

$$e_A = \frac{p\beta w(c_P - (1-\beta)pw)}{c_A c_P - (1-\beta)p^2 w^2 \beta}$$

and

$$e_P = \frac{p(1-\beta)w(c_A - p\beta w)}{c_A c_P - (1-\beta)p^2 w^2 \beta}.$$

Using the principal's optimal effort we rewrite the condition 3.2 to get the condition for the existence of a persuasive recommendation (and therefore of an influential equilibrium) in terms of the principal and agent's cost:

$$c_P \leq \frac{p^2(1-\beta)\beta w}{p+\beta-1}\Big(1 - \frac{(1-p)(1-\beta)w}{c_A}\Big) := \hat{c}_P. \tag{3.3}$$

Intuitively, the principal has to be sufficiently efficient, and therefore exert high enough effort in equilibrium, in order to influence an uninformed agent to follow her recommendation b. As equilibrium efforts are substitutes, a less efficient agent induces the principal to exert more effort in equilibrium which in turn makes her more credible.

Note that the constraint 3.3 relaxes as c_A increases. This is due to the strategic substitutability of the effort levels: a less efficient agent exerts less equilibrium effort, which induces the principal to exert more effort for any given level of the principal's efficiency. Therefore for the principal to be able to persuade an agent, it must be the case that the principal is sufficiently more efficient than the agent. Indeed, the inefficiency of the agent provides credibility to the principal in equilibrium.

Finally, note that the RHS of 3.3 converges continuously to the limit

$$\bar{c}_P = \frac{p^2(1-\beta)\beta w}{p+\beta-1}$$

as $c_A \to \infty$. Intuitively, even if an agent becomes very inefficient, there is some finite upper bound on the principal's cost to make her recommendation influential.

In addition, if we replace the minimum value of c_P which is $(1-\beta)pw$ into $\hat{c}_P$, we get the minimum c_A for which this type of equilibrium can exist:

$$c_A \geq \beta p w.$$

3.1.2 Babbling equilibrium under delegation

Suppose, next, that $c_P > \hat{c}_P$ meaning that the principal is not efficient enough to be able to make an influential recommendation under delegation, i.e. induce an uninformed agent to choose action b. Although the principal's recommendation will be credible when he recommends action a, this is what the uninformed agent would choose anyway. Hence, given that the principal can never affect the agent's decision, and the effort is costly, she exerts no effort at all, $e_P = 0$. The agent therefore maximizes:

$$p\beta w - (1 - e_A)(1 - \beta)(1 - p)w - \frac{e_A^2}{2} c_P$$

over his effort choice leading to:

$$e_A = \frac{(1 - \beta)(1 - p)w}{c_A}.$$

Thus, the agent exerts more effort the higher is the probability of acquiring a signal which would switch his decision to b, and the higher is his payoff from rightly doing that. We call this equilibrium *babbling under delegation* as there is no informative communication at all. As it is characteristic for a cheap talk game, this equilibrium also exists for values $c_P \leq \hat{c}_P$ under delegation while for $c_P > \hat{c}_P$, it arises as the unique equilibrium.

3.2 Centralisation

We now consider the organizational structure in which the principal keeps decision-making power. As with delegation, there are two possible outcomes: the influential one in which the principal follows the agent's recommendation whenever she is uninformed, and the babbling one where the principal chooses action b whenever uninformed and hence the agent exerts no effort at all.

3.2.1 Influential equilibrium under centralisation

Consider a strategy profile in which the agent provides a recommendation to the principal, and the principal always follows it when she is uninformed. The agent's communication strategy consists of two signal-contingent messages. If the agent receives a signal indicating that the optimal action is b, he sends the message m_b to the principal. In all other instances he sends the message m_a, recommending action a. Thus, upon receiving the second message the principal cannot distinguish whether the agent is uninformed or is genuinely informed that the optimal action is a. The question then is, when will the principal follow the recommendation, i.e. choose action a when uninformed herself?

Given the agent's equilibrium effort e_A, the principal's posterior upon receiving m_a that the state is $\mathcal{A}$, is $\bar{p} = \frac{p}{1 - e_A(1-p)}$. Thus, an uninformed principal will follow the agent's recommendation if

$$\bar{p}(1 - \beta)w \geq (1 - \bar{p})\beta w$$

resulting in

$$e_A \geq \frac{\beta - p}{(1-p)\beta}. \tag{3.4}$$

Intuitively, the principal rubberstamps the agent's recommendation if she expects the agent to exert sufficient effort, i.e. her posterior assigns a sufficient probability to the agent being informed, compared to the probability of him having failed to obtain a signal. Notice the parallel to 3.2: in both cases the player who communicates must be expected to exert sufficiently high effort for the decision maker to believe that the recommendation is more likely to be based on information rather than on the ex-ante preference.

At the effort stage the agent chooses e_A to maximize

$$p\beta w] - (1-e_A)(1-e_P)(1-p)(1-\beta)w - \frac{e_A^2}{2}c_A$$

resulting in

$$e_A = \frac{(1-p)(1-\beta)w(1-e_P)}{c_A}.$$

Similarly, the principal chooses e_P to maximize her expected payoff

$$p(1-\beta)w - (1-e_A)(1-e_P)(1-p)\beta w - \frac{e_P^2}{2}c_P$$

resulting in

$$e_P = \frac{(1-p)\beta w(1-e_A)}{c_P}.$$

Using the players' best responses at the effort stage, we obtain the optimal effort choices:

$$e_P = \frac{(1-p)\beta w[c_A - (1-p)(1-\beta)w]}{c_A c_P - (1-p)^2\beta(1-\beta)w^2}, \text{ and}$$

$$e_A = \frac{(1-p)(1-\beta)w(c_P - (1-p)\beta w)}{c_A c_P - (1-p)^2\beta(1-\beta)w^2}.$$

Finally, for the agent's message to be influential, using the equilibrium efforts, the condition becomes

$$c_A \leq \frac{(1-p)^2(1-\beta)\beta w}{(\beta - p)}\left(1 - \frac{pw(1-\beta)}{c_P}\right) = \hat{c}_A. \tag{3.5}$$

Thus, for the agent to be credible, his cost of information acquisition has to be sufficiently low. In particular, the agent has to be sufficiently more efficient than the principal. As equilibrium efforts are substitutes, a less efficient principal induces the agent to exert more effort in equilibrium which in turn makes him more credible. As $c_P \to \infty$, we get the maximum c_A for which influential equilibrium under centralisation can exist:

$$\bar{c}_A = \frac{(1-p)^2(1-\beta)\beta w}{\beta - p}.$$

Thus, even if the principal is very inefficient, there is an upper bound on the agent's cost of effort for the equilibrium message to be influential.

In addition, when we replace the minimum value of c_A which is $(1-\beta)(1-p)w$ into $\hat{c}_A$, we get the minimum c_P for which this type of equilibrium can exist:

$$c_P \geq \beta(1-p)w.$$

3.2.2 Babbling equilibrium under centralisation

When $c_A > \hat{c}_A$, in any equilibrium the uninformed principal ignores the agent's message m_a as it is not sufficiently likely to come from an informed agent. In this case, the agent can never affect the principal's decision. To see this, note that the only case where agent's communication may be influential is when the principal isn't informed. In that case, the principal will choose action b regardless of the message sent by the agent. As a result, the agent exerts no effort and the principal chooses e_P to maximize

$$e_P p(1-\beta)w - \frac{e_P^2}{2} c_P$$

leading to:

$$e_P = \frac{p(1-\beta)w}{c_P}.$$

Parallel to the case of babbling under delegation, here the principal exerts more effort the higher is the benefit of acquiring a signal which would change her decision, $(1-\beta)pw$, and the lower is the principal's cost c_P.

Indeed, this type of equilibrium also exists when $c_A < \hat{c}_A$ simultaneously with the influential equilibrium. It is easy to show that in case of equilibrium multiplicity under centralisation, the principal's preferred equilibrium is the influential one. The principal cannot be worse-off by getting a recommendation: if it were the case, she would simply ignore the recommendation which would in return mean the babbling equilibrium is unique.

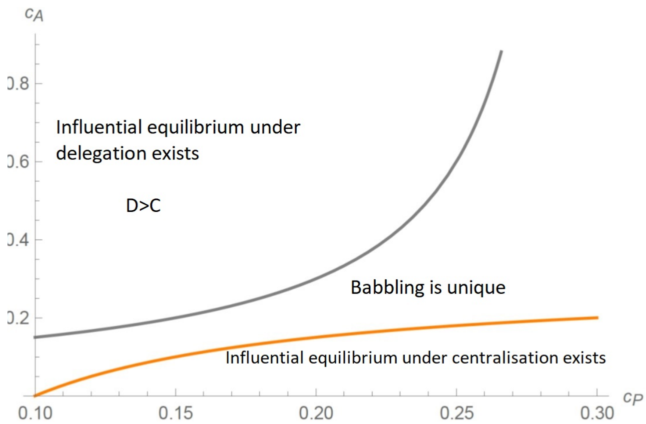


Figure 3: Characterisation of equilibria for parameter values $w = 0.5$, $\beta = 0.6$, $p = 0.3$.

4 Optimal organizational form

First, it is straightforward to verify that $\hat{c}_A$ is increasing and concave in c_P, and $\hat{c}_P$ is increasing and concave in c_A. Using Assumption 1, the minimum values of both functions are 0, when $c_P = c_P^{min} = \beta(1-p)w$ and when $c_A = c_A^{min} = \beta pw$, respectively.

Assuming the influential equilibrium regions do not overlap (which is, as we can verify, the case for most parameter values), we will focus respectively on the three regions seen in figure 3. We first focus on the region in the middle where **babbling** is unique, i.e. only the decision maker puts in any effort and no communication takes place. The following proposition focuses on this region where only babbling equilibria exist and compares both organizational forms.

Proposition 2: *When no communication is possible and hence babbling is the unique equilibrium under either organizational structure, the principal will prefer to delegate only if the agent is very efficient, namely if*

$$c_A \leq \frac{2(1-\beta)\beta c_P(1-p)^2 w}{2c_P(\beta - p) + (1-\beta)^2 p^2 w} \tag{4.1}$$

and centralise otherwise. This provides the optimal organizational structure in the region where $c_A > \hat{c}_A$ *and* $c_P > \hat{c}_P$ *and hence babbling is the unique outcome.*

Figure 4 provides the condition for centralisation to dominate delegation in case babbling is the equilibrium in either case. This picture is drawn excluding the possibility of influential equilibria, which will be considered later.

In the region $c_A > \hat{c}_A$ and $c_P > \hat{c}_P$, under either organizational structure no communication can take place and so the decision maker is the only player to exert positive effort. Intuitively, the principal delegates only if the agent is sufficiently efficient relative to the principal, hence the agent is very likely to be informed under delegation. Under delegation, the principal doesn't incur the cost of information while at the same time she loses decision-making power altogether. Hence, delegation to a very efficient agent is optimal which resonates with the trade-off in

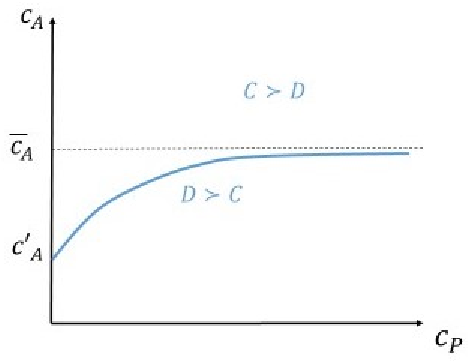


Figure 4: Centralisation versus delegation under babbling.

Aghion and Tirole (1997) and more generally in the literature on delegation, of that between losing decision-making power versus giving incentives to the agent to get informed. The trade-offs change when we consider the regions where influential equilibria under centralisation or delegation exists.

It is easy to show that the RHS of 4.1 is concave and increasing in c_P. Hence, for higher c_P, the constraint for delegation to be optimal is more relaxed, though in a diminishing way. Notice that the RHS of 4.1 converges monotonically to $\bar{c}_a$ as c_p goes to infinity. Moreover, for $c_P = c_P^{min}$, the RHS is

$$c'_A := \frac{2\beta(1-p)^2(1-\beta)w}{2\beta - \beta p - p} < \bar{c}_A.$$

Finally, since

$$c'_A - (1-\beta)(1-p)w = \frac{(1-\beta)^2(1-p)pw}{2\beta - \beta p - p} > 0,$$

we have $c_A^{min} < c'_A < \bar{c}_A$, and therefore the RHS of 4.1 starts at $c'_A \in (c_A^{min}, \bar{c}_A)$ and converges monotonically, in a concave way, to $\bar{c}_A$ as c_P goes to infinity.

We now study the regions in which influential equilibria exist. First, the we consider the region where $c_P \leq \hat{c}_P$ and $c_A > \hat{c}_A$; where influential equilibrium under delegation exists in which the agent follows principal's recommendation whereas under centralisation the agent can never influence the principal. As a result, the unique equilibrium under centralisation involves no effort by the agent. Of course, babbling is always an equilibrium hence is an equilibrium under delegation. However, as the principal is the one first moves by choosing the organizational structure, we assume that the principal optimal equilibrium is played.

Proposition 3: *In the region where $c_P \leq \hat{c}_P$ and $c_A > \hat{c}_A$, i.e. influential equilibrium exists under delegation while babbling is the unique outcome under centralisation, delegation dominates centralisation for the principal and the principal incurs no loss of authority.*

The idea of the proof is intuitive. Under centralisation, the agent does not exert any effort and the principal's payoff is:

$$(1-\beta)e_P pw - \frac{e_P^2}{2}c_P$$

reflecting the fact that whenever uninformed the principal chooses action b which gives a sure payoff of 0. In this case the principal's optimal effort is $e_P = \frac{(1-\beta)pw}{c_P}$. Now, the payoff in the influential equilibrium under delegation can be written as:

$$[e_P + (1-e_P)e_A](1-\beta)pw - \frac{e_P^2}{2}c_P.$$

If, under delegation, the principal deviates from the equilibrium effort and exerts effort $e_P = \frac{(1-\beta)pw}{c_P}$ while the agent still maintains equilibrium expectations of the principal's effort, the principal does strictly better than under centralisation. Comparing both expected payoffs above, we see that under delegation the principal's payoff has an additional component $(1-e_P)e_A p(1-\beta)w$ which is strictly positive. With other words, the principal could work as hard under delegation as under centralisation, while still benefiting from agent's effort and not losing the actual decision power due to her persuasive recommendation.

Furthermore, this region exists for $c_A \in [\beta pw, \infty]$ and $c_p \in [(1-\beta)pw, \bar{c}_p]$. Thus, whenever the conditions of Proposition 3 are satisfied, meaning the principal is sufficiently efficient to induce the uninformed agent to follow her recommendation, delegation is the strictly optimal organizational structure. Given that babbling is always an equilibrium, a babbling equilibrium under delegation exists simultaneously with the influential equilibrium. Hence, one question might be whether babbling equilibrium under delegation dominates the influential equilibrium in terms of principal welfare. Indeed, this might be possible if the principal prefers to commit not to exerting any effort. This question is only relevant in the region where babbling equilibrium under delegation dominates the babbling equilibrium under centralisation. Corollary 1 below is a direct consequence of Propositions 2 and 3, and pins down a condition under which influential equilibrium outperforms babbling equilibrium under delegation:

Corollary 1: *Given $c_A^{min} < c_A' < \bar{c}_A$, in the region where influential equilibrium under delegation exists, there is a region in which babbling under delegation dominates babbling under centralisation. Only in this region, it may be possible that babbling equilibrium under delegation dominates the influential equilibrium for the principal.*

The corollary makes use of Propositions 2 and 3 to deal with the multiplicity of equilibrium and find the principal's optimal equilibrium under delegation. For this, we only need to check the region where babbling under delegation dominates babbling under centralisation and coincides with the influential equilibrium under delegation exists. For the region with $c_A > c_A^{min}$ and $c_P < \hat{c}_P$, given that babbling under centralisation dominates babbling under delegation and that influential equilibrium dominates babbling under centralisation, the influential equilibrium is the optimal equilibrium under delegation for the principal. In overall, this discussion does not affect the optimality of delegation for the principal, but given that delegation is always optimal in this influential region under delegation, it tackles the question of whether babbling dominates the influential equilibrium.

Finally, we consider the region where influential equilibrium under centralisation exists, $c_A \leq \hat{c}_A$ and $c_P > \hat{c}_P$, inside which the only equilibrium under delegation is a babbling one, whereas the agent is efficient enough for an influential equilibrium to arise under centralisation. Proposition 4 provides the conditions on c_P and c_A such that the principal wants to delegate.

Proposition 4: *In the region where $c_P > \hat{c}_P$ and $c_A \leq \hat{c}_A$, an influential equilibrium exists under centralisation and babbling is the unique equilibrium under delegation. Inside this region, delegation dominates the influential equilibrium under centralisation either when*

$$c_A < 2(1-\beta)(1-p)w \tag{4.2}$$

or when $c_A \in [2(1-\beta)(1-p)w, 3(1-\beta)(1-p)w]$, and:

$$c_P > \frac{2(1-\beta)^2\beta(1-p)^3w^3}{c_A(3(1-\beta)(1-p)w - c_A)}, \tag{4.3}$$

and otherwise centralisation is optimal for the principal.

Note, first, that if the influential equilibrium exists under centralisation then it is strictly better than the babbling equilibrium under centralisation. This relies on the simple intuition that the principal could always ignore the agent's recommendation. Under delegation, babbling is unique meaning that the principal doesn't exert any effort and, whenever uninformed, the agent chooses action a. To answer the question of whether the principal should centralise or delegate, note that by centralising she is involved in information acquisition and decision-making, and additionally she can overrule the agent if the latter makes an uninformed recommendation. On the other side, the principal's benefit from delegation is that she commits not to exert any effort leading to increased incentives of the agent to exert effort. We show that delegation is the optimal organizational form only if the agent is very efficient in information acquisition. Indeed, under the parameter values such that $\beta - 2p + \beta p > 0$, we have $2(1-\beta)(1-p)w > \bar{c}_A$ and hence centralisation is optimal in the whole of the region described in Proposition 4.

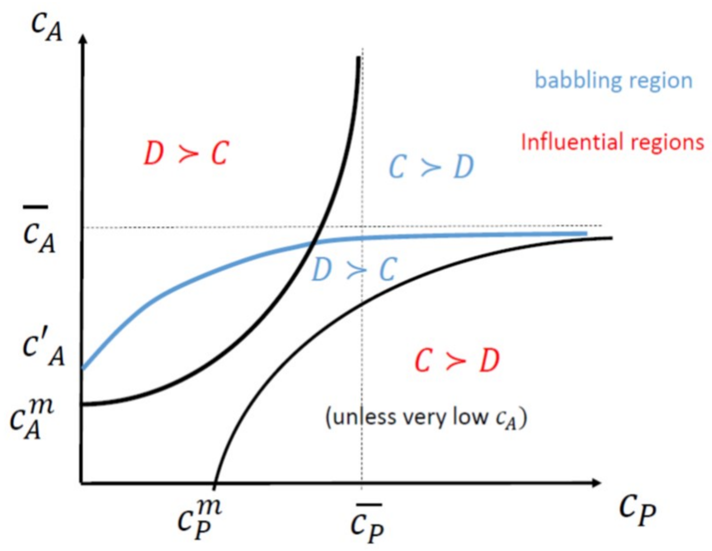


Figure 5: Optimal Organizational Structure

5 Welfare

We now consider the question of the overall welfare that could be, for instance, an important consideration of a manager allocating decision-making power among employees in order to incentivize them to acquire and share information. We so assume that the manager cares about the overall welfare of the employees. The question is now, whom should the manager grant the decision-making power depending on the players' information acquisition costs?

Proposition 5: *Whenever an influential equilibrium exists, it is welfare-optimal to allocate decision-making power to the relatively inefficient agent so that there is mutual effort and communication. When babbling is the unique equilibrium, then the relatively efficient agent must hold decision-making power.*

Hence, allocating authority to the less efficient party is the welfare optimal thing to do whenever an influential equilibrium exists, which as we saw happens when there is sufficient difference in the abilities of the two agents in terms of ability to acquire information. This is also in line with our result that the principal always prefers delegating when an influential equilibrium under delegation exists. On the other hand, when the relative efficiencies of the principal and agent are very similar, or both of them are rather inefficient that no influential equilibrium can arise, making babbling the unique equilibrium, then the welfare optimal thing is to give authority to the party that is sufficiently more efficient, in order to maximize the overall welfare.

6 Extensions

6.1 Generalizing preferences

In the baseline model we focused on a specific setup, normalizing the payoff from one action to zero and assuming a symmetric bias of the principal and the agent toward opposite actions. Our results hold in any setup where, conditional on the state, there is a mutually optimal action and, further, for a given initial belief the players disagree over the optimal action. As the prior is common, the initial conflict comes from the differential preference for making the right decision as opposed to a wrong decision in the corresponding states. The general setup looks like the following state- and action-contingent payoff matrix where the first entry is the agent's payoff:

	$\theta = a$	$\theta = b$
$\omega = \mathcal{A}$	u, x	$0, 0$
$\omega = \mathcal{B}$	$-y, -z$	$0, 0$

As before, we assume a common prior on the state space where each player assigns probability p to the state $\mathcal{A}$. The condition for the uninformed agent to prefer a over b is

$$pu > (1 - p)y.$$

and the condition for the uninformed principal to prefer b over a is

$$px < (1 - p)z.$$

Which leads to the two conditions:

$$\frac{y}{u} < \frac{p}{1-p} < \frac{z}{x}$$

for which the principal prefers action b and the agent prefers a in the beginning of the game. The agent has a relatively higher expected loss of wrongly choosing action b than the principal and the principal has a relatively higher expected loss of wrongly choosing action a.

The principal benefits from the agent's effort whenever the agent affects the final decision. When the agent is sufficiently inefficient, the principal would ignore the agent's recommendation under centralisation, which in return implies the agent wouldn't exert any effort. Thus, the only way to induce agent's effort is to delegate decision-making when an influential equilibrium exists under delegation. The next proposition generalizes our result that delegating in this setup does not lead any loss of principal's control as an efficient principal retains real authority under delegation.

Proposition 6: *If the principal is sufficiently efficient, namely:*

$$c_P \leq \frac{p^2ux(c_A-(1-p)y)}{c_A(pu-(1-p)y)},$$

then there exists an influential equilibrium under delegation in which the agent exerts effort and follows the principal's recommendation if unable to obtain an informative signal. In this case, it is strictly optimal for the principal to delegate and she doesn't lose any authority.

We have the following observations. First, for any efficiency level of the agent, the principal's constraint is relaxed, the larger is x, which is the principal's payoff from choosing a in state $\mathcal{A}$. To see why, notice, first, that the players' best response functions at the effort stage are

$$e_A(e_P)=\frac{(1-e_P)pu}{c_A},\ e_P(e_A)=\frac{(1-e_A)px}{c_P}.$$

Thus, the higher is x, which is the benefit of learning state $\mathcal{A}$ and changing the action to a, the larger is the principal's effort to obtain an informative signal. Intuitively, when nobody is informed, in equilibrium action b is chosen, which leads to 0. Given this incentive, even for a larger c_P the agent can be still persuaded to follow the recommendation if x is sufficiently high. The second observation is that, given $c_A > (1-p)y$, the threshold for c_P is decreasing in u. This is expected as, higher u gives a higher payoff to the agent from action a and hence will be less eager to switch to action b, hence in equilibrium the principal has to exert higher effort to persuade the agent.

To conclude, our results that a sufficiently efficient principal doesn't lose any authority by delegating extend to any setup where there is an initial conflict between the agent and principal which would resolve by the arrival of information. The influential equilibrium under delegation exists whenever the equilibrium effort of the principal is high enough to make the uninformed agent to switch away from their ex ante preferred action.

6.2 Verifiable information

We now study the case in which the signal resulting from information acquisition is verifiable, where information acquisition efforts are simultaneous as in our benchmark setup. Next proposition summarizes our findings and the comparison of the verifiable information game to our main model of cheap talk communication.

Proposition 7: *The equilibrium effort levels as well as the payoffs of the agent and the principal under centralisation in the verifiable information game are equivalent to those in the influential equilibrium under delegation in the cheap talk game. The same equality holds between delegation in the verifiable information game and the influential equilibrium in the cheap talk game.*

With verifiable information, there is a unique equilibrium under either organizational struc-

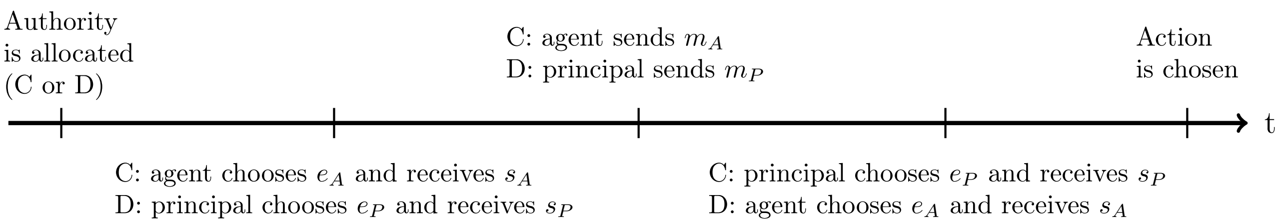


Figure 6: Timing of Events

ture, as there is no babbling equilibrium due to information being verifiable: whenever the sender has information it is optimal to reveal it and upon lack of revelation the decision maker will understand that no information was acquired. First, there is no possibility of pretending to have information, as if one has information it is verifiable. Second, there is no incentive to hide a signal that arrived. This means, under centralisation, upon no information being acquired by both sides, the principal will choose action b which she prefers when uninformed. Now, it can be seen that, the type of decision in this case is identical to that in influential equilibrium under delegation in our main model: either there is information and the mutually optimal project is chosen or no one is informed and action b is chosen by the agent, given that the principal would have recommended it although uninformed. In addition, given identical equilibrium efforts, we see that these two equilibria are identical. This shows us that, under certain parameter conditions, the same decision-making as the verifiable information can be achieved under cheap talk game that we considered. Indeed, this means non verifiability of information does not necessarily lead to less informative outcomes.

6.3 Sequential information acquisition

We now extend our model to consider sequential information acquisition and communication. Under centralisation, first the agent chooses effort into acquiring a signal and communicate to the principal via a cheap-talk message. Then, the principal decides on her effort and subsequently chooses an action. Under delegation, first the principal exerts effort and communicates her research findings to the agent using a cheap-talk message. Then, the agent decides his effort and subsequently chooses one of the actions.

The simultaneous effort assumption in our main model is justified in institutional settings where there is some time constraint for making the decision. If the first mover spends too much time looking for information, by the time he communicates his findings the decision maker may not have enough time left to investigate. This may cause the first mover to strategically wait longer before communicating. Relaxing this assumption, i.e. the case in which there are no time considerations at all, sequentiality becomes a feature of equilibrium: when the principal holds decision-making power, given that effort is unobservable, it is optimal for her to wait until the agent communicates before deciding on her effort and reversely, when the agent holds decision-making power it is optimal for him to wait for the principal's communication before deciding on effort himself.

The next proposition establishes the conditions for existence of a truthful equilibrium under either organizational form.

Proposition 8: *There exists an equilibrium with truthful communication under delegation if*

$$c_A \leq \frac{(1-\beta)\beta(1-p)^2 w}{\beta - p} := \bar{c}_A.$$

Further, there exists an equilibrium with truthful communication under centralisation if

$$c_P \leq \frac{p^2 w \beta(1-\beta)}{\beta + p - 1} := \bar{c}_P.$$

To understand the proposition, notice that the sender could only have an incentive to misinform the decision maker when uninformed. The rationale to be truthful about the absence of a signal is to incentivize information acquisition by the decision maker which is going to be more when the decision maker has a lower cost.[15]

We next characterize the optimal allocation of authority in the region $c_P \leq \bar{c}_P$ and $c_A \leq \bar{c}_A$, which is the truthful region for both sides. The next proposition shows that within this truthful region $[(1-\beta)pw, \bar{c}_P] \times [(1-p)(1-\beta)w, \bar{c}_A]$, there is a continuous and convex function lying between the "corners" of the truthful region $((1-\beta)pw, \bar{c}_A)$ and $((1-p)(1-\beta)w, \bar{c}_P)$ such that above this curve centralisation with truthful communication dominates delegation with truthful communication.

Proposition 9: *In case truthtelling equilibrium exists and is played under both regimes, centralisation dominates delegation whenever either c_A, c_P, or both, are sufficiently high, namely if*

$$c_P\Big[c_A(\beta - p) + (1-\beta)\beta(2p-1)w\Big] \geq (1-\beta)^2 \beta w^2 p^3.$$

Moreover, when $c_A = c_A^{min}$ or $c_P = c_P^{min}$ delegation dominates centralisation, while when either $c_A = \bar{c}_A$ and $c_P > c_P^{min}$ or $c_P = \bar{c}_P$ and $c_A > c_A^{min}$ centralisation dominates delegation.[16]

Notice that the necessary conditions for these regions to exist are $\beta - p > 0$ and $\beta + p - 1 > 0$ (since otherwise $\bar{c}_A \leq 0$ and $\bar{c}_P \leq 0$) and are indeed satisfied by our initial assumptions, hence the influential equilibria always exists for certain cost parameters. When truthful communication equilibrium exists under both regimes, the principal's choice of authority allocation is

[15]This motive, of course, is absent if efforts are exerted simultaneously, and therefore complete truthtelling is non-existent with simultaneous efforts, as we saw in Proposition 1.

[16]As shown in the proof, this is a sufficient condition although not necessary. Hence, there is possibly a larger set of parameters for which centralisation dominates delegation.

affected by the effort provision. If the agent is very efficient, i.e. c_A is very close to c_A^{min}, then the principal wants to delegate as she assigns a high likelihood to the agent obtaining a signal if the principal fails to do so. The cost is that in case both remain uninformed, the agent chooses his preferred action which is different to the principal's. However, for a very efficient agent, the high effort provided under delegation outweighs the loss of decision-making authority. This result clearly resonates with the main insight from the literature following Aghion and Tirole (1997) where delegation motivates effort but leads to loss of authority. On the other hand, if the agent gets less efficient, the principal centralizes – which is exactly the sufficient condition in Proposition 2. In this case, the effect coming from the loss of authority dominates the higher effort of the agent under delegation.

Notice that Proposition 9 does not answer generally the question of optimality of authority allocation, as influential equilibria might also exist in the truthful region.

The next proposition establishes the conditions for influential equilibria under both organizational forms. The communication strategy of the first mover in influential equilibrium is the same as before: he truthfully informs the decision maker when the signal indicates that the decision maker's ex ante preferred action is optimal, otherwise recommends to pick his ex ante preferred action. Denote by $(e_A^{d,i}, e_A^{d,i})$ the agent's and principal's efforts in the influential equilibrium under delegation and by $(e_A^{c,i}, e_P^{c,i})$ the agent's and principal's efforts in the influential equilibrium under centralisation[17].

Proposition 10: *There exists an influential equilibrium under delegation for* $c_P \leq \hat{c}_P$ which is:

$$c_P \leq \frac{\beta p^2(1-\beta)w(c_A - (1-\beta)\beta w)}{c_A(\beta + p - 1)}.$$

There exists an influential equilibrium under centralisation for $c_A \leq \hat{c}_A$ which is:

$$c_A \leq \frac{(1-\beta)\beta(1-p)^2 w(c_P - (1-\beta)\beta w)}{c_P(\beta - p)}.$$

In addition, from the above we can find a minimum c_A for influential equilibrium under delegation to exist, which is $c_A(min) = \frac{\beta^2 wp}{(1-p)}$, while the minimum c_P above which influential equilibrium under centralisation exists is given by $c_P(min) = \frac{\beta^2(1-p)w}{p}$. This means, if $c_A(min) > \bar{c}_A$, then the region of influential equilibrium under delegation is outside the truth-telling region, and similarly if $c_P(min) > \bar{c}_P$, the region of influential equilibrium under centralisation is outside the truth-telling region. The result in Proposition 10 is intuitive. Consider, for example, the region where influential equilibrium under delegation exists. There, the condition is that the principal has to be very efficient. As a result, once the agent receives principal's recommendation, in order to choose the principal's preferred action, he must assign

[17]Those notations are used in the proof.

a sufficient posterior to the principal being informed in order to follow the recommendation. If the principal is less efficient, she is not able to persuade the agent. The logic is similar for the region where the influential equilibrium exists under centralisation.

Proposition 10 only establishes the existence of influential equilibria. We now turn to the question of optimality of equilibria. The next proposition characterizes the condition under which the influential equilibrium under delegation payoff dominates centralisation with truthful communication for the principal. We must also specify that in the regions where neither truthful nor influential equilibria exist, babbling is the unique equilibrium.

Proposition 11: *Influential equilibrium under delegation dominates centralisation with truth-telling whenever:*[18]

$$c_A \leq \frac{pw(\beta(3-2p)+p-1)}{2(1-p)}.$$

Conditional on both types of equilibria existing, Proposition 11 gives a sufficient condition for influential equilibrium under delegation to outperform centralisation with truthful communication: the agent has to be sufficiently efficient, as well as the condition for influential equilibrium to exist which required the principal to be sufficiently efficient. In that case, the principal is both able to incentivize the agent to exert higher effort as the agent can take decision and to follow her recommendation in case he does not receive an informative signal.

7 Conclusions

This paper studies how heterogeneity in players' abilities to acquire information affects the allocation of decision-making power within an organization. Our baseline results suggest that for two-sided information acquisition and influential communication to take place, a less efficient party should be endowed with decision-making power that will allow the more efficient party to maintain real authority. This authority comes in form of a recommendation which the less efficient party follows whenever uninformed himself. Crucially, the disagreement between the parties exists only in the absence of decision-relevant information and is resolved upon the arrival of information. As a result, a sufficiently efficient principal optimally delegates to a sufficiently inefficient agent, providing stronger incentives for the agent to acquire information while not losing any authority as she is able to persuade the agent to follow her recommendation.

Another point we make is that the credibility of communication in the influential equilibrium under delegation makes delegation credible. We so account for the right criticism in the literature suggesting that the principal could revoke authority when the agent acts against her

[18]This is a sufficient but not a necessary condition. Hence, whenever this condition is satisfied delegation is optimal, but there is possibly a wider range of parameters for which delegation is optimal.

interest. This is never the case in our influential equilibrium, as the agent never overrules the principal's recommendation except for when he is informed in which case the mutually optimal action is taken.

Our results also suggest that with endogeneous information acquisition, influential communication only happens when the principal and the agent are sufficiently different in terms of their abilities to get information. This is because, given the substitutability of efforts, if the two were sufficiently similar in their abilities of obtaining information, neither of the them alone would exert sufficiently high effort to make a persuasive recommendation. As a result, the principal only delegates whenever the agent is sufficiently efficient and may centralise whenever the agent is inefficient.

Our results have important implications for the design of organizations in sectors where agents in different layers of the hierarchy are actively involved in obtaining decision-relevant information. This is more likely to happen in smaller firms where the managerial attention is not absorbed by managing complex organizational processes so that the manager is involved in information production.

It will be interesting to empirically test our main predictions. There is an emerging literature emphasizing a positive relation between the quality of the organizational human capital and delegation (e.g. Bloom et al. (2012)). Our results suggest to have a closer look at the relative qualifications within manager-subordinate relationships. We hypothesize that if the manager is sufficiently qualified and invests time in research, she is able to provide a credible recommendation to her subordinates and is therefore more likely to delegate decisions.

References

Acemoglu, D., P. Aghion, C. Lelarge, J. Van Reenen, and F. Zilibotti (2007): "Technology, Information, and the Decentralization of the Firm," *The Quarterly Journal of Economics*, 122, 1759–1799.

Acharya, V. V. and K. V. Subramanian (2009): "Bankruptcy codes and innovation," *The Review of Financial Studies*, 22, 4949–4988.

Aghion, P., N. Bloom, B. Lucking, R. Sadun, and J. Van Reenen (2017): "Turbulence, firm decentralization and growth in bad times," Tech. rep., National Bureau of Economic Research.

Aghion, P. and J. Tirole (1997): "Formal and real authority in organizations," *Journal of political economy*, 105, 1–29.

Aghion, P., J. Van Reenen, and L. Zingales (2013): "Innovation and institutional ownership," *American economic review*, 103, 277–304.

Alonso, R., W. Dessein, and N. Matouschek (2008): "When does coordination require centralization?" *American Economic Review*, 98, 145–79.

Alonso, R. and N. Matouschek (2008): "Optimal delegation," *The Review of Economic Studies*, 75, 259–293.

Argenziano, R., S. Severinov, and F. Squintani (2016): "Strategic Information Acquisition and Transmission," *American Economic Journal: Microeconomics*, 8, 119–155.

Austen-Smith, D. (1994): "Strategic Transmission of Costly Information," *Econometrica*, 62, 955–963.

Azoulay, P., J. S. Graff Zivin, and G. Manso (2011): "Incentives and creativity: evidence from the academic life sciences," *The RAND Journal of Economics*, 42, 527–554.

Baker, G., R. Gibbons, and K. J. Murphy (1999): "Informal authority in organizations," *Journal of Law, Economics, and organization*, 15, 56–73.

Barberis, N., M. Boycko, A. Shleifer, and N. Tsukanova (1996): "How does privatization work? Evidence from the Russian shops," *Journal of Political Economy*, 104, 764–790.

Besley, T., O. Folke, T. Persson, and J. Rickne (2017): "Gender quotas and the crisis of the mediocre man: Theory and evidence from Sweden," *American economic review*, 107, 2204–42.

Bloom, N., L. Garicano, R. Sadun, and J. Van Reenen (2014): "The distinct effects of information technology and communication technology on firm organization," *Management Science*, 60, 2859–2885.

Bloom, N., R. Sadun, and J. Van Reenen (2012): "The organization of firms across countries," *The quarterly journal of economics*, 127, 1663–1705.

Bloom, N. and J. Van Reenen (2007): "Measuring and explaining management practices across firms and countries," *The quarterly journal of Economics*, 122, 1351–1408.

Campbell, M., S. Baldwin, S. Johnson, R. Chapman, A. Upton, and F. Walton (2001): "Skills in England 2001: the research report," .

Caroli, E. and J. Van Reenen (2001): "Skill-biased organizational change? Evidence from a panel of British and French establishments," *The Quarterly Journal of Economics*, 116, 1449–1492.

Caselli, F. and N. Gennaioli (2008): "Economics and politics of alternative institutional reforms," *The Quarterly Journal of Economics*, 123, 1197–1250.

——— (2013): "Dynastic management," *Economic Inquiry*, 51, 971–996.

Che, Y.-K. and N. Kartik (2009): "Opinions as incentives," *Journal of Political Economy*, 117, 815–860.

Collins, C. J. and K. G. Smith (2006): "Knowledge exchange and combination: The role of human resource practices in the performance of high-technology firms," *Academy of management journal*, 49, 544–560.

Crawford, V. P. and J. Sobel (1982): "Strategic information transmission," *Econometrica: Journal of the Econometric Society*, 1431–1451.

Deimen, I. and D. Szalay (2016): "Delegated Expertise, Authority, and Communication," *working paper.*

Dessein, W. (2002): "Authority and communication in organizations," *The Review of Economic Studies*, 69, 811–838.

Deutsch, M. (1960): "The effect of motivational orientation upon trust and suspicion," *Human relations*, 13, 123–139.

Dewatripont, M. and J. Tirole (2005): "Modes of communication," *Journal of Political Economy*, 113, 1217–1238.

Egorov, G. and K. Sonin (2011): "Dictators and their viziers: Endogenizing the loyalty–competence trade-off," *Journal of the European Economic Association*, 9, 903–930.

Garicano, L. and L. Rayo (2016): "Why organizations fail: models and cases," *Journal of Economic Literature*, 54, 137–92.

Garrett, J., R. Hoitash, and D. F. Prawitt (2014): "Trust and financial reporting quality," *Journal of Accounting Research*, 52, 1087–1125.

Gibbons, R., N. Matouschek, and J. Roberts (2013): "Decisions in organizations," *The handbook of organizational economics*, 373–431.

Green, J. R. and N. Stokey (1980): "The value of information in the delegation problem," *Working paper.*

Grossman, S. J. and O. D. Hart (1986): "The costs and benefits of ownership: A theory of vertical and lateral integration," *Journal of political economy*, 94, 691–719.

GUADALUPE, M. AND J. WULF (2010): "The flattening firm and product market competition: The effect of trade liberalization on corporate hierarchies," *American Economic Journal: Applied Economics*, 2, 105–27.

HARRIS, M. AND A. RAVIV (2005): "Allocation of decision-making authority," *Review of Finance*, 9, 353–383.

HART, O. AND J. MOORE (1990): "Property Rights and the Nature of the Firm," *Journal of political economy*, 98, 1119–1158.

HIDIR, S. (2018): "Selecting the wisdom of an expert," *Working paper.*

HOLMSTROM, B. (1982): "Moral hazard in teams," *The Bell Journal of Economics*, 324–340.

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

KATAYAMA, H., K. J. MEAGHER, AND A. WAIT (2018): "Authority and communication in firms," *Journal of Economic Behavior & Organization*, 155, 315–348.

LEARNING, S. C. G. B. G. B. D. FOR EDUCATION, AND S. D. S. S. D. A. G. BRITAIN)(SSDA) (2004): "National Employers Skills Survey 2003: key findings," .

LIU, S. AND D. MIGROW (2018): "Designing Organizations in Volatile Markets," *Available at SSRN 3275742.*

MATTOZZI, A. AND A. MERLO (2015): "Mediocracy," *Journal of Public Economics*, 130, 32–44.

MAYER, R. C., J. H. DAVIS, AND F. D. SCHOORMAN (1995): "An integrative model of organizational trust," *Academy of management review*, 20, 709–734.

MAYER, R. C. AND M. B. GAVIN (2005): "Trust in management and performance: who minds the shop while the employees watch the boss?" *Academy of management journal*, 48, 874–888.

MEAGHER, K. J. AND A. WAIT (2018): "Worker (dis) trust in management and the delegation of real authority," *Working paper.*

NEWMAN, D. P. AND K. E. NOVOSELOV (2009): "Delegation to encourage communication of problems," *Journal of Accounting research*, 47, 911–942.

PEI, H. D. (2015): "Communication with endogenous information acquisition," *Journal of Economic Theory*, 160, 132–149.

Porter, M. E. (1992): "Capital disadvantage: America's failing capital investment system." *Harvard business review*, 70, 65–82.

Prendergast, C. and R. H. Topel (1996): "Favoritism in organizations," *Journal of Political Economy*, 104, 958–978.

Rantakari, H. (2008): "Governing adaptation," *The Review of Economic Studies*, 75, 1257–1285.

——— (2012): "Employee initiative and managerial control," *American Economic Journal: Microeconomics*, 4, 171–211.

Roberts, K. H. and C. A. O'Reilly III (1974): "Failures in upward communication in organizations: Three possible culprits," *Academy of Management Journal*, 17, 205–215.

Sadun, R., N. Bloom, and J. Van Reenen (2017): "Why do we undervalue competent management?" .

Yukl, G. and P. P. Fu (1999): "Determinants of delegation and consultation by managers," *Journal of Organizational Behavior*, 20, 219–232.

8 Appendix

Proof Proposition 1: Suppose, by contradiction, that there is a truthful equilibrium. When the principal is informed, there are no incentives to deviating to another message. Consider the case when the principal isn't informed as a result of her investment. Given the only case in which the agent's decision can be influenced is when the agent is uninformed, the principal bases her strategy on this state. But then, if the principal tells the truth that she is uninformed, agent will choose a, given his prior. This gives the principal a payoff of $-p\beta+(1-p)(1-\beta) < 0$, whereas if the principal deviates to recommend b when uninformed, the agent will take action b which gives the principal a payoff of 0. Hence, this is a profitable deviation and a truthtelling equilibrium cannot exist. The case for centralisation is similar.
Q.E.D.

Proof of Proposition 2: First, the delegation payoff of the principal is given by:

$$\frac{(1-p)(1-\beta)w}{c_A}\Big(p(1-\beta)w\Big) + \Big(1 - \frac{(1-p)(1-\beta)w}{c_A}\Big)(p(1-\beta)w - (1-p)\beta w)$$

which simplifies to:

$$\frac{(1-p)^2(1-\beta)\beta w^2}{c_A} + p(1-\beta)w - (1-p)\beta w = X.$$

The centralisation payoff of the principal is given by:

$$\frac{(1-\beta)pw}{c_P}\Big(p(1-\beta)w\Big) - \frac{((1-\beta)pw)^2}{2c_P}$$

which simplifies to:

$$\frac{(1-\beta)^2p^2w^2}{2c_P} = Y.$$

Now, the difference between delegation and centralisation payoff $X - Y$ is:

$$2c_Ac_P(-\beta+p) + (1-\beta)(2\beta c_P(p-1)^2 - (1-\beta)c_Ap^2)w.$$

We check that the above is decreasing in c_A, and it is increasing in c_P for small enough c_A, but it is decreasing in c_P for high enough c_A. The condition for delegation to dominate centralisation is:

$$c_A \leq \frac{2(1-\beta)\beta c_P(1-p)^2w}{2c_P(\beta-p) + (1-\beta)^2p^2w}.$$

i.e. when the agent's cost of information acquisition is sufficiently lower than that of the principal.

Q.E.D.

Proof of Proposition 3: Let's check the principal's payoff in centralisation when the agent doesn't exert any effort:

$$(1-\beta)pwe_P - \frac{e_P^2}{2}c_P$$

where $e_P = \frac{(1-\beta)pw}{c_P}$.

The principal's payoff in the influential equilibrium under delegation is:

$$(e_P + (1-e_P)e_A)p(1-\beta)w - \frac{e_P^2}{2}c_P.$$

Now, we see that the only difference in the payoff functions is $(1-e_P)e_Ap(1-\beta)w$ which is added in the influential equilibrium under delegation. As the principal could replicate the same effort in influential equilibrium under delegation as that one in centralisation, it is easy to see that influential equilibrium under delegation is strictly better than babbling under centralisation.

Q.E.D.

Proposition 4: First, let us calculate the principal's payoff in the influential equilibrium under centralisation:

$$p(1-\beta)w-(1-e_p)(1-e_A)(1-p)\beta w-\frac{e_P^2}{2}c_P. \tag{8.1}$$

Then we get the principal's effort:

$$e_P=\frac{(1-p)\beta w(1-e_A)}{c_P}. \tag{8.2}$$

Now, making use of these, the payoff simplifies to:

$$p(1-\beta)w-(1-e_A)(1-p)\beta w(1-\frac{e_P}{2}). \tag{8.3}$$

The payoff of principal in babbling under delegation:

$$p(1-\beta)w-(1-e_A)(1-p)\beta w \tag{8.4}$$

where:

$$e_A=\frac{(1-p)(1-\beta)w}{c_A}.$$

Let's call e_A^c and e_P^c the effort levels in centralisation and e_A^d the effort level of agent in delegation. Now the condition for influential equilibrium under centralisation to dominate babbling under delegation becomes:

$$e_A^c+\frac{e_P^c(1-e_A^c)}{2}\geq e_A^d \tag{8.5}$$

which further simplifies to:

$$\frac{(1-p)(1-\beta)w(1-e_P)}{c_A}(1-\frac{e_P}{2})+\frac{e_P}{2}\geq\frac{(1-p)(1-\beta)w}{c_A}$$

where now e_P denotes the principal's effort in centralisation. This further simplifies to:

$$\frac{e_P}{2}-\frac{(1-p)(1-\beta)w}{c_A}(\frac{3}{2}e_P-\frac{e_P^2}{2})\geq 0$$

simplified by e_P and $1/2$, we get:

$$\frac{(1-p)(1-\beta)w}{c_A}(3-e_P)\leq 1$$

which is going to be satisfied for e_P and c_A large enough, which is equivalent to large enough

c_A and low enough c_P. This condition is equivalent to:

$$e_P \geq 3 - \frac{c_A}{(1-p)(1-\beta)w}.$$

When $c_A > 3(1-\beta)(1-p)w$, then for any c_P, influential equilibrium under centralisation dominates delegation. Plus, whenever $c_A < 2(1-p)(1-\beta)w$, the condition can never be satisfied, given that $e_P \leq 1$. In that case, delegation is optimal for any c_P.

Now, in the region $2(1-p)(1-\beta)w \leq c_A \leq 3(1-p)(1-\beta)w$, there is a threshold for c_P such that centralisation is optimal above that level. When we replace the e_P in influential equilibrium under centralisation, we get:

$$c_P \leq \frac{2(1-\beta)^2\beta(1-p)^3w^3}{c_A(3(1-\beta)(1-p)w - c_A)} \tag{8.6}$$

for the influential equilibrium under centralisation to dominate babbling under delegation. In addition, given that influential equilibrium under delegation doesn't exist, we have:

$$c_P > \frac{p^2(1-\beta)\beta w(c_A - (1-p)(1-\beta)w)}{c_A(p+\beta-1)} = \frac{p^2(1-\beta)\beta w}{p+\beta-1}\Big(1 - \frac{(1-p)(1-\beta)w}{c_A}\Big) := \hat{c}_P. \tag{8.7}$$

Hence, it must be that either

$$\hat{c}_P < c_P < \frac{2(1-\beta)^2\beta(1-p)^3w^3}{c_A(3(1-\beta)(1-p)w - c_A)} \tag{8.8}$$

or

$$c_A > 3(1-\beta)(1-p)w \tag{8.9}$$

for influential equilibrium under centralisation to be optimal, and delegation is optimal otherwise.

First, delegation is optimal if the agent is very efficient, no matter what c_P is ($c_A < 2(1-\beta)(1-p)w$), in which case only the agent acquires information. Second, if the agent is not so efficient, delegation is still optimal for high enough c_P. The benefit of delegation is to increase the agent's effort by cutting out the principal's effort, while the cost of delegation is that the principal no longer has the option to influence the decision which could lead to higher payoff in the event that the agent is uninformed.

Considering the comparative statics, the derivative of the RHS of 4.3 with respect to c_A is

$$\frac{2(1-\beta)^2\beta(1-p)^3w^2(2c_A - 3(1-\beta)(1-p)w)}{c_A^2(c_A - 3(1-\beta)(1-p)w)^2}.$$

The derivative is positive if and only if $c_A > \frac{3}{2}(1-\beta)(1-p)w$. Hence, the threshold for c_P

below which the principal prefers to delegate increases in c_A when $c_A > \frac{3}{2}(1-\beta)(1-p)w$. Indeed, this threshold is defined for $c_A > 2(1-p)(1-\beta)w$: as otherwise the agent is so efficient that the principal prefers to delegate no matter what is c_p, we see that the threshold has to increase in c_A. To understand the intuition, consider an increase in c_A. As the agent becomes less efficient (while still maintaining the necessary level to provide a persuasive recommendation to the principal), a slight decrease in the efficiency of the principal can still rationalize centralisation.

Q.E.D.

Proof of Proposition 5: Let's consider the case of agent authority. In the influential equilibrium under delegation, we have the overall welfare (principal's and agent's summed):

$$\Pi = (e_A + (1-e_A)e_P)p(\beta w + (1-\beta)w) - \frac{e_A^2}{2}c_A - \frac{e_P^2}{2}c_P. \tag{8.10}$$

In the babbling equilibrium under delegation, the overall welfare is:

$$\Pi = p(\beta w + (1-\beta)w) - (1-e_A)(1-p)(\beta w + (1-\beta)w) - \frac{{e_A}^2}{2}c_A. \tag{8.11}$$

Second, we consider the case of principal's authority. In the influential equilibrium under centralisation, the overall welfare is:

$$\Pi = p(\beta w + (1-\beta)w) - (1-e_A)(1-e_P)(1-p)(\beta w + (1-\beta)w) - \frac{e_A^2}{2}c_A - \frac{e_P^2}{2}c_P \tag{8.12}$$

In the babbling equilibrium under centralisation, the overall welfare is:

$$e_P p(\beta w + (1-\beta)w) - \frac{e_P^2}{2}c_P. \tag{8.13}$$

Now let's find out the welfare optimal organizational structure. If we consider the influential region under delegation where under centralization babbling is unique, we need to compare equations 8.10 and 8.13 which are respectively:

$$(e_A + (1-e_A)e_P)pw - \frac{e_A^2}{2}c_A - \frac{e_P^2}{2}c_P$$

$$e_P pw - \frac{e_P^2}{2}c_P$$

where, given that $e_A > 0$ when the agent is maximizing only his payoff in the case of delegation, then if we look at welfare optimality, $e_A > 0$ leads to higher welfare then $e_A = 0$. Hence, we conclude that in the region where influential equilibrium exists under delegation, it is optimal for the agent to have authority.

If we consider the region in which influential equilibrium exists under principal authority (centralisation) and babbling is unique under agent authority (delegation), the payoffs are respectively in 8.12 and 8.11:

$$pw - (1 - e_A)(1 - e_P)(1 - p)w - \frac{e_A^2}{2}c_A - \frac{e_P^2}{2}c_P$$

$$pw - (1 - e_A)(1 - p)w - \frac{{e_A}^2}{2}c_A.$$

Given that $e_P > 0$ in the principal's best response, then when we take into account the overall welfare, then the welfare under influential equilibrium payoff is higher than the babbling equilibrium under agent authority.

Finally, when babbling equilibrium exists uniquely under either centralisation or delegation, then, the comparison of the payoffs show that agent authority is optimal if and only if c_A is low enough, or when p is high enough whereas principal authority is optimal.

Q.E.D.

Proof of Proposition 6: Denote by (e_P, e_A) the principal's and agent's efforts in the influential equilibrium under delegation. In this equilibrium, the principal's communication strategy is either to recommend action a or action b to the agent.

Upon receiving the latter, the agent assigns probability $1 - \bar{p} = \frac{1-p}{1-e_p p}$ to the principal being informed that $\omega = B$. At the effort stage, anticipating e_P, the agent chooses e_A to maximize

$$e_A(1 - e_P)pu - c_A\frac{e_A^2}{2},$$

and the principal chooses e_P to maximize

$$e_P(1 - e_A)px - c_P\frac{e_P^2}{2}.$$

The equilibrium efforts are

$$e_P^* = \frac{px(1 - e_A)}{c_P},\ e_A^* = \frac{pu(1 - e_P)}{c_A}.$$

The condition for a persuasive recommendation is

$$-(1 - \bar{p})y + \bar{p}u \leq 0$$

which leads to:

$$\frac{y}{u} \leq \frac{\bar{p}}{(1 - \bar{p})}.$$

Solving for e_P^* and replacing it in the above, the condition can be written as

$$c_P \leq \frac{p^2ux(c_a - (1-p)y)}{c_A(pu - (1-p)y)}.$$

Q.E.D.

Proof of Proposition 7: First, we consider delegation. There is a unique equilibrium given that both players have a uniquely optimal action: first both exert effort, then the principal reveals her signal if informed and cannot reveal anything if uninformed. If the agent is informed he chooses the optimal action or follows the principal's signal, if neither the principal nor the agent have a signal, the agent chooses project a. This is the unique equilibrium as both players have a unique optimal action.

At the effort stage the agent is maximizing over e_A:

$$p\beta w - (1-e_P)(1-e_A)(1-p)(1-\beta)w - e_A^2 c_A/2.$$

The optimization procedure yields the best response:

$$e_A = \frac{(1-\beta)(1-e_P)(1-p)w}{c_A}.$$

The principal is maximizing over e_P:

$$p(1-\beta)w - (1-e_P)(1-e_A)(1-p)\beta w - e_P^2 c_P/2.$$

The optimization procedure yields the best response:

$$e_P = \frac{(1-e_A)(1-p)\beta w}{c_P}.$$

Solving for both best responses yields the equilibrium effort levels:

$$e_P = \frac{\beta(1-p)w(c_A - (1-p)(1-\beta)w)}{c_A c_P - (1-p)^2(1-\beta)\beta w^2},$$

$$e_A = \frac{(1-\beta)(1-p)w(c_P - (1-p)\beta w)}{c_A c_P - (1-p)^2(1-\beta)\beta w^2}.$$

Upon comparison with our cheap talk game, we see that these effort levels are identical to the effort levels in the influential equilibrium under centralisation in our main model. Then, it is easy to see that the payoffs are also identical.

Now, let's consider centralisation. With the same arguments, there is a unique equilibrium under centralisation. The strategy profile is as follows: first, both players exert effort, then the agent discloses his finding to the principal after which the principal chooses a project. If no information at all was acquired, the principal chooses project b.

At the effort stage the agent maximizes over e_A:

$$(e_P + (1 - e_P)e_A)(p\beta w) - e_A^2 c_A/2$$

implying the best response

$$e_A = \frac{\beta(1 - e_P)pw}{c_A}.$$

At the effort stage the principal maximizes over e_P:

$$(e_P + (1 - e_P)e_A)(p(1 - \beta)w) - e_P^2 c_P/2$$

implying the best response

$$e_P = \frac{(1 - \beta)(1 - e_A)pw}{c_P}.$$

Solving for equilibrium yields:

$$e_A = \frac{\beta pw(c_P - (1 - \beta)pw)}{c_A c_P - (1 - \beta)\beta p^2 w^2},$$

$$e_P = \frac{(1 - \beta)pw(c_A - \beta pw)}{c_A c_P - (1 - \beta)\beta p^2 w^2}.$$

Comparison with the influential equilibrium under delegation in the cheap talk game, we can see that the effort levels are identical. It is also easy then, to verify that the payoffs are identical.

Q.E.D.

Proof of Proposition 8: Consider, first, truthful communication under delegation. This is a strategy profile in which the principal truthfully transmits her signal to the agent. If the principal recommends an action, whenever uninformed, the agent follows principal's recommendation. If the principal is uninformed, then the agent chooses effort to maximize his expected payoff

$$p\beta w - (1 - e_A)(1 - p)(1 - \beta)w - \frac{(e_A)^2}{2}c_A$$

resulting in

$$e_A^{d,t} = \frac{(1-p)(1-\beta)w}{c_A}. \tag{8.14}$$

The level of the optimal effort is intuitive. The default action is for the agent to choose action a and receive the payoff $p\beta w$ but if uninformed, the agent incurs an expected loss of $(1-p)(1-\beta)w$ from wrongly choosing this action. Thus, the higher is the payoff difference, $(1-p)(1-\beta)w$, the higher is the value of information and therefore the higher is the optimal level of effort for any given costs of effort.

The principal anticipates the agent's best response and chooses her effort to maximize

$$p(1-\beta)w - (1-e_P)(1-e_A)(1-p)\beta w - \frac{(e_P)^2}{2}c_P,$$

resulting in

$$e_P^{d,t} = \frac{(1-e_A^{d,t})(1-p)\beta w}{c_P}.$$

Consider, now, the principal's incentives at the communication stage in case she receives an uninformative signal. If she reveals her signal truthfully, her expected payoff is

$$p(1-\beta)w - (1-e_A^{d,t})(1-p)\beta w.$$

If she deviates and informs the agent that her signal is b (which is her best deviation conditional on being uninformed), and the agent believes that communication is truthful, she expects the agent to choose b resulting in her expected payoff 0. Thus, the does not deviate for

$$c_A \leq \frac{(1-\beta)\beta(1-p)^2 w}{\beta - p} := \overline{c}_A. \tag{8.15}$$

Intuitively, the agent has to be sufficiently efficient in order to induce truthful revelation by the principal. If this is the case, the principal anticipates that, if uninformed, the agent puts high effort to obtain a signal. Notice that the effort levels are parallel to the influential equilibrium under centralisation. In this case the principal's expected payoff is

$$p(1-\beta)w - (1-e_P^{d,t})(1-e_A^{d,t})(1-p)\beta w - \frac{(e_P^{d,t})^2}{2}c_P. \tag{8.16}$$

which is also equivalent to the influential equilibrium under centralisation as a result. (same holds for the agent.)

Second, we consider truthful communication under centralisation. In this case, if the agent reveals to the principal that he hasn't obtained an informative signal, the principal chooses effort to maximize

$$p(1-\beta)we_P - \frac{(e_P)^2}{2}c_P, \tag{8.17}$$

where e_P denotes principal's effort and we find that it is:

$$e_P^{c,t} = \frac{p(1-\beta)w}{c_P}. \tag{8.18}$$

Intuitively, the principal's consideration at the effort stage goes as follows when the agent doesn't disclose a signal. If she does not obtain an informative signal she chooses b and her expected payoff is 0. If, however, she obtains a perfectly revealing signal, then her payoff is $(1-\beta)w$. Thus, the higher is $(1-\beta)pw$, the higher is the value of information for the principal and, therefore, the higher is her effort.

Now, consider the agent's consideration at the communication stage. If the agent does not make a recommendation to the principal, either the principal gets a signal or the principal remains uninformed and chooses action b whereas the agent prefers a. On the other hand, if the agent misinforms the principal that the optimal action is a, then she prevents the possibility of the principal obtaining a signal which will increase their payoff in case the optimal action is b. Therefore, conditional on no signal received, the agent truthfully admits that he is uninformed to the principal if

$$p\beta w - (1-p)(1-\beta)w \leq e_P^{c,t}p\beta w$$

that implies

$$c_P \leq \frac{\beta(1-\beta)p^2 w}{\beta + p - 1} := \bar{c}_P. \tag{8.19}$$

Intuitively, the principal should be efficient enough. This ensures that the agent has no interest in misinforming the principal as he assigns a sufficiently high probability to the principal being able to obtain a perfectly revealing signal. Given that the agent truthfully reveals his signal at the communication stage, he chooses the effort e_A that maximizes

$$e_A p\beta w + (1-e_A)\hat{e}^* p\beta w - \frac{(e_A)^2}{2}c_A$$

resulting in

$$e_A^{c,t} = \frac{(1-e_P^{c,t})\beta pw}{c_A}. \tag{8.20}$$

The agent's rationale is similar to the principal's characterized above - the higher is βpw, the higher is the value of information for the agent and therefore the higher is e_A. The principal's expected payoff is then

$$(e_A^{c,t} + (1 - e_A^{c,t})e_P^{c,t})p(1-\beta)w - (1-e_A)\frac{(e_P^{c,t})^2}{2}c_P.$$

Q.E.D.

Proof of Proposition 9: Consider the following scenario: the principal centralizes and commits to exert effort $e_p = \frac{(1-\beta)pw}{c_P}$ independent of the agents' message. This will give us a lower principal payoff than in equilibrium but due to the expression make it easier to compare centralisation to delegation payoff. In the truthful equilibrium under centralisation we found in proposition 8 that the agent's effort is $e_A = \frac{(1-e_P)\beta pw}{c_A}$ and therefore the principal's expected payoff is

$$(e_A + (1-e_A)e_P)p(1-\beta)w - \frac{(e_P)^2}{2}c_P.$$

Notice that the difference to the principal's expected payoff under centralisation with truthtelling and no commitment to the case with commitment is that the last term in the former case is $-(1-e_A)\frac{(e_P)^2}{2}c_P$ whereas the last term in the latter case is simply $-\frac{(e_P)^2}{2}c_P$.

In the following we show that in the case with commitment, the principal prefers to centralize instead of decentralize and implement an equilibrium with truthful communication if the following condition is satisfied:

$$c_P\Big[c_A(\beta - p) + (1-\beta)\beta(2p-1)w\Big] \geq (1-\beta)^2\beta w^2 p^3.$$

First, we show that the principal exerts more effort under centralisation with commitment than under delegation. Using the results of the previous sections we have

$$e_P^d = \frac{\beta w(1-p)(c_A + p + \beta(1-p) - 1)}{c_A c_P}, \; e_P^c = \frac{(1-\beta)pw}{c_P}.$$

The difference between both efforts is

$$e_P^c - e_P^d = \frac{w(c_A(p-\beta) + (1-\beta)\beta(1-p)^2 w))}{c_A c_P}.$$

which is positive for

$$c_A \leq \frac{(1-\beta)\beta(1-p)^2 w}{\beta - p} = \bar{c}_A$$

and therefore we conclude that $e_P^c \geq e_P^d$. Suppose momentarily that the principal exerts the same effort under centralisation with commitment as under delegation, and that the agent expects principal's effort to be at the "equilibrium level" as described above. Denote principal's effort under delegation by $\hat{e}$. Then the difference in principal's corresponding payoffs is:

$$(1-p)\beta w\Big[1-e_A^d(1-\hat{e})-\hat{e}\Big]-p(1-\beta)w\Big[1-e_A^c(1-\hat{e})-\hat{e}\Big].$$

The expression is positive if

$$(\beta-p)(1-\hat{e})\geq(1-p)\beta e_A^d(1-\hat{e})-p(1-\beta)e_a^c(1-\hat{e})\ \Rightarrow$$

$$(\beta-p)\geq(1-p)\beta e_A^d-p(1-\beta)e_A^c\ \Rightarrow$$

$$\beta-p+p\beta e_A^d+pe_A^c\geq\beta e_A^d+p\beta e_A^c\ \Rightarrow$$

$$\beta(1+pe_A^d-e_A^d)\geq p(1+\beta e_A^c-e_A^c)\ \Rightarrow$$

$$\beta(1-e_A^d(1-p))\geq p(1-e_A^c(1-\beta)).$$

Rewriting the above inequality while using $e_A^c=\frac{\beta pw(c_P-(1-\beta)pw)}{c_Ac_P}$ and $e_A^d=\frac{(1-\beta)(1-p)w}{c_A}$, we get:

$$c_Ac_P(\beta-p)+(1-\beta)\beta w(c_P(2p-1)-(1-\beta)p^3w)\geq 0$$

that can be rewritten as

$$c_P\Big[c_A(\beta-p)+(1-\beta)\beta(2p-1)w\Big]-(1-\beta)^2\beta w^2p^3\geq 0. \tag{8.21}$$

Since per assumption $\beta\geq p$ (see model section for the explanation why it is necessary to generate an ex ante conflict of interest) the above inequality is maximized for the largest possible c_A. Use the upper bound $\frac{(1-\beta)\beta(1-p)^2w}{\beta-p}$ (to check if (8.21) can ever be positive). Then, the inequality becomes:

$$(1-\beta)\beta p^2w(c_P-(1-\beta)pw)\geq 0$$

that is satisfied for $c_P\geq(1-\beta)pw$. To remind, the truthtelling constraint is

$$c_P\leq\frac{(1-\beta)p^2w\beta}{\beta+p-1}$$

and so (8) can only be satisfied if

$$\frac{(1-\beta)p^2w\beta}{\beta+p-1}-(1-\beta)pw\geq 0 \tag{8.22}$$

which is true if

$$\frac{(1-\beta)p(\beta+p(1+\beta)-1)w}{\beta+p-1}\geq 0$$

which is true since we assumed $\beta + p - 1 \geq 0$ as otherwise the upper bound for c_p that guarantees truthtelling is negative. To summarize, the costs of information acquisition have to be sufficiently high.

In the next part of the proof we show that the condition goes through the points $[c_P^{min}, \bar{c}_A]$ and $[c_A^{min}, \bar{c}_P]$ and it is a convex function of c_P. If we use c_P^{min} where (8.21) is satisfied with equality, then we have

$$c_A = \bar{c}_A.$$

Further, if we use c_A^{min} where (8.21) is satisfied with equality, then we have

$$c_P = \bar{c}_P.$$

Moreover, if we write the condition (8.21) with equality and rearrange for c_A, we get:

$$c_A = \frac{(1-\beta)\beta w(-c_P(2p-1) + (1-\beta)p^3 w)}{c_P(\beta - p)}$$

where the first and second derivatives with respect to c_P are:

$$-\frac{(1-\beta)^2 \beta p^3 w^2}{c_P^2(\beta - p)} < 0, \quad \frac{2(1-\beta)^2 \beta p^3 w^2}{c_P^3(\beta - p)} > 0$$

and therefore the condition is convex in c_P.

Finally, we show that the case with commitment is dominated by the case without commitment. It is easy to see this as the only difference in the expected payoff of the principal is the last cost term such that in case with commitment the costs are higher than without commitment. As a result, if (8.21) is satisfied, then delegation with truthtelling is dominated by centralisation with truthtelling (and without commitment) if the sufficient condition in the proposition is satisfied. However, as this is a sufficient condition, this gives the minimum region of parameters for which centralisation is optimal, although there may exist a larger region in which centralisation is optimal.

Q.E.D.

Proof of Proposition 10: Consider, first, a situation where the principal exerts effort and then sends a recommendation to the agent who follows it if uninformed. As we show below, the principal's recommendation is persuasive if and only if she is sufficiently efficient. Moreover, under delegation she can induce the agent to work harder compared to centralisation as she uses her first-mover advantage to back-load some effort burden to the agent.

The principal's communication strategy consists of sending one of the two signal-contingent messages in equilibrium. If she receives the signal indicating that the optimal action is a, she perfectly reveals the signal to the agent (who then follows her recommendation): we denote this message by m_a. For the two other signal realizations she sends a message m_b. Thus, upon receiving the latter message, the agent does not know whether the principal is uninformed or genuinely informed that the optimal action is b. The agent, then, exerts effort and, if uninformed, follows the principal's recommendation and chooses b.

To understand the incentives behind this strategy profile, we start with the agent's optimal choices. First, whenever the agent receives m_b, she assigns posterior probability

$$\overline{p}_A = \frac{p(1-e_P)}{1-pe_P} \tag{8.23}$$

to the optimal action being a. After investment in information, if the agent remains uninformed, he chooses to follow principal's recommendation if $0 \geq \overline{p}_A \beta w - (1-\overline{p}_A)(1-\beta)w$ which implies for the choice of the principal's effort

$$e_P^{d,r} \geq \frac{p-(1-\beta)}{\beta p} \tag{8.24}$$

which means that the principal should have exerted enough effort to induce a sufficiently high agent's belief that the recommendation is based on an informative signal rather than the ex ante preference.

Suppose the condition above is satisfied. Then, upon receiving the message m_b the agent chooses his effort optimally, it means to maximize

$$\overline{p}_A\Big[e_A \beta w\Big] - \frac{e_A^2}{2}c_A$$

which implies

$$e_A^{d,r} = \frac{\beta \overline{p}_A w}{c_A}.$$

The higher is the agent's payoff from choosing her preferred action, the higher is the value of a signal, and therefore the higher is the agent's effort. Using the agent's posterior, his effort is

$$e_A^{d,r} = \frac{p(1-e_P)\beta w}{c_A(1-e_P p)}. \tag{8.25}$$

The principal anticipates the agent's strategy: the agent will exert some effort and if he remains uninformed, he will follow the principal's recommendation. The principal's expected payoff is therefore

$$pe_P(1-\beta)w + (1-e_P)e_A^{d,r}p(1-\beta)w - \frac{(e_P)^2}{2}c_P.$$

Since her objective is concave in her effort, the unique optimal effort is characterized by

$$e_P^{d,r} = \frac{(1-\beta)(1-e_A^{d,r})pw}{c_P}. \tag{8.26}$$

Since the agent only follows the principal's recommendation if her effort is sufficiently high, the prescribed strategy profile is an equilibrium for

$$c_P \leq \frac{p^2(1-\beta)(1-e_A^{d,r})\beta w}{\beta+p-1} := \hat{c}_P. \tag{8.27}$$

The principal's expected payoff is

$$p(1-\beta)w\left[e_P^{d,r} + (1-e_P^{d,r})e_A^{d,r}\right] - \frac{(e_P^{d,r})^2}{2}c_P. \tag{8.28}$$

Consider, second, a strategy profile in which an agent provides a recommendation to the principal, and the principal follows it *if* she does not obtain an informative signal. In other words, the principal rubberstamps the agent's recommendation. Think of an agent's communication strategy that uses one of the two signal-contingent messages. If the agent receives a signal indicating that the optimal action is b, he discloses his finding to the principal sending $m = b$. Otherwise he recommends the principal to choose action a: we denote the corresponding message by $m = a$. Thus, upon receiving the second message the principal cannot distinguish whether the agent is uninformed or is genuinely informed that the optimal action is a. When will the principal follow this recommendation, it means, choose $\theta = a$ if she does not receive any informative signal?

To see this, first, notice that given the effort choice of the agent, e_A, the principal's posterior upon receiving $m = a$ assigns probability $\frac{p}{pe_A+(1-e_A)} := \overline{p}$ to the agent being informed that the optimal action is a. Given her posterior $\overline{p}$, the principal chooses effort to maximize

$$\overline{p}(1-\beta)w - (1-e_P)\beta w(1-\overline{p}) - \frac{(e_P)^2}{2}c_P$$

resulting in

$$e_P^{c,r} = \frac{(1-\overline{p})\beta w}{c_P}. \tag{8.29}$$

Given the specified communication strategy and the principal's best response, the agent maximizes his expected payoff which results in the following optimal choice of his effort:

$$e_A^{c,r} = \frac{(1-\beta)(1-e_P^{c,r})(1-p)w}{c_A}.$$

The principal chooses after receiving message $m = a$ and if she is uninformed if $\overline{p}(1-\beta)w \geq (1-\overline{p})\beta w$. This implies that the principal rubberstamps if $e_A^{c,r} \geq 1 - \frac{p}{1-p}\frac{(1-\beta)}{\beta}$, which implies

$$c_A \leq \frac{w(1-p)(1-\beta)(1-e_P^*)}{1-\frac{p(1-\beta)}{(1-p)\beta}} := \hat{c}_a.$$

Intuitively, the principal rubberstamps if she assigns high enough posterior probability to the optimal action being a conditional on the message m_a. Notice that although the principal assigns sufficiently high belief to the agent being informed, she nonetheless exerts effort and tries to obtain an informative signal herself. This is because, conditional on the agent being uninformed, there is a disagreement on the preferred action. If the principal remains uninformed after exerting her effort, her best response is to follow the agent's recommendation. In this case, the principal's expected payoff (given that the probability of the message m_b is $e_A(1-p)$) is:

$$p(1-\beta)w - \beta w(1-p)(1-e_P^{c,r})(1-e_A^{c,r}) - (1-e_A(1-p))\frac{(e_P^{c,r})^2}{2}c_P.$$

Now, we find $\hat{c}_A$ and $\hat{c}_P$ explicitly.

Under influential equilibrium with delegation:

$$e_A^d = \frac{p(1-e_P^d)\beta w}{c_A(1-e_P^d p)},\ e_P^d = \frac{(1-\beta)(1-e_A^d)pw}{c_P}.$$

Solving the equation

$$e_A^d = \frac{p\beta w\left(1-\frac{(1-\beta)(1-e_A^d)pw}{c_P}\right)}{c_A\left(1-\frac{(1-\beta)(1-e_A^d)pw}{c_P}p\right)}$$

we obtain two roots, where the correct root is

$$\frac{1}{2(\beta-1)c_Ap^2w}(c_A\left((\beta-1)p^2w+c_P\right)+(\beta-1)bp^2w^2)-$$

$$\frac{\sqrt{(c_A\left((\beta-1)p^2w+c_P\right)+(\beta-1)\beta p^2w^2)^2-4(\beta-1)\beta c_Ap^3w^2((\beta-1)pw+c_P)}}{2(\beta-1)c_Ap^2w}.$$

Since delegation with rubberstamp exists for

$$c_P \leq \hat{c}_P,$$

using the solution for e_A^d in the above inequality yields

$$c_P \leq \frac{\beta p^2(1-\beta)w(c_A-(1-\beta)\beta w)}{c_A(\beta+p-1)}.$$

We know that under centralisation with rubberstamp

$$e_A^c = \frac{(1-\beta)(1-p)(1-e_P^c)w}{c_A},\ e_P^c = \frac{(1-\bar{p})\beta w}{c_P} = \frac{\beta(1-p)(1-e_A^c)w}{c_P - c_P e_A^c(1-p)}$$

and solving the equation

$$e_P^c = \frac{\beta(1-p)\left(1-\frac{(1-\beta)(1-p)(1-e_P^c)w}{c_A}\right)w}{c_P\left(1-\frac{(1-\beta)(1-p)(1-e_P^c)w}{c_A}(1-p)\right)}$$

yields the solution:

$$e_P^c = \frac{1}{2(\beta-1)c_P(p-1)^2 w}(c_A c_P + (-1+\beta)(-1+p)^2 w(c_p+\beta w)) -$$

$$\frac{\sqrt{((\beta-1)(p-1)^2 w(\beta w + c_P) + c_A c_P)^2 - 4(\beta-1)\beta c_P (p-1)^3 w^2((\beta-1)(p-1)w - c_A)}}{2(\beta-1)c_P(p-1)^2 w}.$$

Before we obtained that influential equilibrium under centralisation exists for

$$c_A \leq \hat{c}_A,$$

using the solution for e_P^c we obtain the condition for centralisation with rubberstamp to exist that is

$$c_A \leq \frac{(1-\beta)\beta(1-p)^2 w(c_P-(1-\beta)\beta w)}{c_P(\beta-p)}.$$

Q.E.D.

Proof of Proposition 11: We can write the payoff of the principal under centralisation with truthful communication:

$$p(1-\beta)w(e_A^{c,t} + (1-e_A^{c,t})e_P^{c,t}) - (1-e_A)\frac{(e_P^{c,t})^2}{2}c_P,$$

when we replace $e_P = \frac{p(1-\beta)w}{c_P}$, we get:

$$p(1-\beta)we_A^{c,t} + (1-e_A^{c,t})\frac{p^2(1-\beta)^2 w^2}{2c_p},$$

$$p(1-\beta)w(e_A^{c,t} + (1-e_A^{c,t})\frac{e_P^{c,t}}{2})$$

We can write the payoff of the principal in the influential equilibrium under delegation:

$$p(1-\beta)w\Big[e_P^{d,r} + (1-e_P^{d,r})e_A^{d,r}\Big] - \frac{(e_P^{d,r})^2}{2}c_P.$$

when we replace e_P, we get:

$$p(1-\beta)e_A^{d,r} + (1-e_A^{d,r})^2\frac{(1-\beta)^2p^2w^2}{2c_P}.$$

$$p(1-\beta)(e_A^{d,r} + (1-e_A^{d,r})^2\frac{e_P^{d,r}}{2}).$$

Now, we can rewrite the difference of the payoffs between the influential equilibria under delegation and centralisation with truthful communication as:

$$p(1-\beta)w(e_A^{d,r} - e_A^{c,t}) + (1-e_A^{d,r})^2\frac{(1-\beta)^2p^2w^2}{2c_P} - (1-e_A^{c,t})\frac{(1-\beta)^2p^2w^2}{2c_P}$$

$$(e_A^{d,r} - e_A^{c,t}) + (1-e_A^{d,r})^2\frac{(1-\beta)pw}{2c_P} - (1-e_A^{c,t})\frac{(1-\beta)pw}{2c_P}$$

$$(e_A^{d,r} - e_A^{c,t}) + \frac{(1-\beta)pw}{2c_P}(e_A^{d,r\,2} - 2e_A^{d,r} + e_A^{c,t}).$$

Using the efforts and the notation $k = \frac{1-e_P^d}{1-e_P^d p}$ we obtain the condition that delegation with rubberstamp dominates centralisation with truthful communication if:

$$\frac{\beta pw}{2c_A^2c_P^2}\Big((1-\beta)\beta c_P(kpw)^2 + c_A((1-\beta)pw - 2c_p p(1-k))(c_P - (1-\beta)pw)\Big) \geq 0.$$

where the sufficient condition for delegation with rubberstamp to dominate centralisation with truthful communication is

$$(1-\beta)pw \geq 2c_P(1-k). \tag{8.30}$$

To see when (8.30) is satisfied, notice that k decreases in $e_p^{d,r}$ since

$$\frac{\partial k}{\partial e_P^d} = -\frac{1-p}{(1-pe_P^d)^2} < 0.$$

We now look for the maximal $e_p^{d,r}$ so that wherever (8.30) is satisfied for $e_p^{d,r}, max$, then it will be satisfied for all $e_p^{d,r} < e_p^{d,r}, max$.

Since $e_P^{d,r} = \frac{(1-\beta)pw(1-e_A^d)}{c_P}$ and $c_P \geq (1-\beta)pw$, we have $e_P^{d,r}, max = 1 - e_A^{d,r}$. Further, using it for the $e_A^{d,r}$ expression, we get

$$e_A^{d,r} = \frac{p\beta w(1-1-e_A^{d,r})}{c_A(1-p(1-e_A^{d,r}))}$$

resulting in

$$e_A^{d,r} = 1 - \frac{1}{p} + \frac{\beta w}{c_A},$$

so that

$$e_P^{d,r} = \frac{1}{p} - \frac{\beta w}{c_A}. \tag{8.31}$$

To ensure that efforts do not exceed 1, we put the constraint

$$c_A \leq \frac{\beta p w}{1-p}.$$

To make sure that $\frac{\beta p w}{1-p} < \bar{c}_A$ we require $(1-p)^3(1-\beta) - p(1-\beta) < 0$ which can be shown to be satisfied, for example, for all $p \geq 1/2$. For the tractability of the argument, we assume from now on $(1-p)^3(1-\beta) - p(1-\beta) < 0$.

Plugging in (8.31) into k, we get

$$k, max = \frac{1}{p} - \frac{c_A(1-p)}{p^2\beta w}.$$

Now, consider the lowest possible $c_A = \frac{\beta^2 wp}{1-p}$ required for the existence of delegation with rubberstamp. Then, $k, min = \frac{1-\beta}{p}$ and the condition (8.30) becomes

$$(2\beta - 1)(1-\beta)pw > 0$$

which is true since – given our previous assumptions – we require $\beta \geq \frac{1}{2}$.

Now, take $c_a = \bar{c}_A = \frac{(1-p)^2\beta(1-\beta)w}{\beta - p}$. Take the largest $c_P = \bar{c}_p$. Then, condition (8.30) is equivalent to

$$p - \frac{2\beta(1-p)(1-2(1-p)p-\beta+\beta(1-p)p)}{(\beta-p)(\beta+p-1)} \geq 0$$

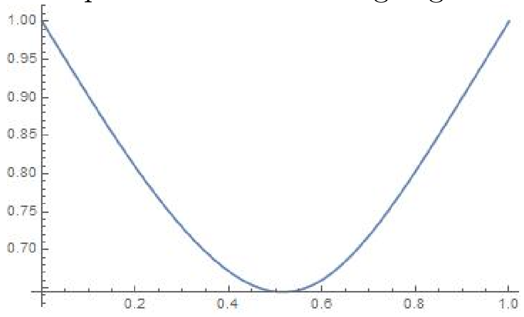
that implies

$$\beta \geq \beta(p)$$

where (obtained with the help of Mathematica)

$$\beta(p) = \frac{p(4(p-2)p+5) - \sqrt{(p-2)(p(4p(p(2(p-3)p+7)-5)+9)-2)} - 2}{2p(2(p-2)p+3)-4}$$

and is depicted in the following Figure:



Notice that, as the graph shows, the condition $\beta \geq 1/2$ is satisfied.

What happens if $c_A > \bar{c}_A$? Consider $\bar{c}_P$. Then, the condition (8.30) can be expressed as

$$c_A \leq \hat{c}_A = \frac{pw(\beta(3-2p)+p-1)}{2(1-p)}.$$

To ensure that for $\hat{c}_a > \bar{c}_a$ such that delegation with rubberstamp dominates centralisation with truthful communication is true even when delegation with truthful communication does not exist, we require

$$p(\beta - p)(\beta(3-2p)+p-1) > 2(1-p)^3\beta(1-\beta).$$

But this is exactly the same condition as above, namely

$$\beta(p) = \frac{p(4(p-2)p+5) - \sqrt{(p-2)(p(4p(p(2(p-3)p+7)-5)+9)-2)} - 2}{2p(2(p-2)p+3)-4}. \tag{8.32}$$

Thus, we conclude that if (8.32) is satisfied, then delegation with rubberstamp dominates centralisation with truthful communication for $c_a < \frac{pw(\beta(3-2p)+p-1)}{2(1-p)} > \bar{c}_a$.

Notice that $\beta(p)$ is convex with $\beta(p = 0.5) \approx 0.65$ and $\beta(p) = 1$. But then, if we draw a line going through the points $[0.5, 0.65]$ and $[1, 1]$, then the line has the formula $0.3 + 0.7p$, and whenever $\beta(p) > 0.3 + 0.7p$, then the above condition (8.32) is satisfied for $p \geq 1/2$. As a mirror imagine, for $p < 1/2$ the corresponding line is $1 - 0.7p$.

Q.E.D.