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.

Keywords: organizational design, cheap talk, two-sided information acquisition

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 are known in advance not to 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 (Nicholas Bloom and John Van Reenen, 2007).[3]

In this paper we show how granting decision rights to a less efficient agent can be compatible with optimal organizational design. Specifically, in a setting where a principal and agent differ in their abilities to access information required for successful decision-making, we show that a high-ability principal sometimes benefits from credibly delegating decision rights to a lower ability agent. The situation in which such an equilibrium to exist is that given the initial common prior about the state the players disagree over an optimal action ex-ante, i.e. without further information. If, however, the players were perfectly informed, then they would agree on the optimal action, i.e. information resolves the initial conflict. Under delegation, a less efficient 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

[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 (Francesco Caselli and Nicola Gennaioli, 2013) or transition environments where posts are allocated to often untalented political insiders (e.g. Nicholas Barberis, Maxim Boycko, Andrei Shleifer and Natalia Tsukanova (1996)), but also in the context of market economies (Francesco Caselli and Nicola Gennaioli, 2008). For example, Mike Campbell, Simon Baldwin, Steve Johnson, Rachael Chapman, Alexandra Upton and Fiona Walton (2001) uncovered substantial gaps in qualifications of organizational decision makers: a finding that was also recognized in subsequent reports (e.g. (2004)Learning, Skills Council (Great Britain)(LSC) Great Britain. Department for Education and Skills (DfES); Sector Skills Development Agency (Great Britain)(SSDA) (SSDA)).

[2]In a political economy context, Andrea Mattozzi and Antonio 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 Raffaella Sadun, Nicholas Bloom and John Van Reenen (2017).

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] (Nicholas Bloom, Raffaella Sadun and John Van Reenen, 2012; Eve Caroli and John Van Reenen, 2001) and how credibility acts as a determinant of organizational design, in particular the credibility of communication (e.g. Wouter Dessein (2002), Ricardo Alonso, Wouter Dessein and Niko Matouschek (2008), Heikki Rantakari (2008)) and the question of trust within organizations (George Baker, Robert Gibbons and Kevin J Murphy, 1999). Similar to the above-mentioned papers, we follow the incomplete contracting approach assuming that information 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 have heterogeneous in their cost of obtaining decision relevant information. We refer to this as the **efficiency** parameter. 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, they agree on it. The initial disagreement is due to the players' disagreement 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 (Vincent P Crawford and Joel Sobel, 1982) and the only distinction between the principal and the agent (in addition to efficiency) is that the

[4] Important empirical studies of delegation include Daron Acemoglu, Philippe Aghion, Claire Lelarge, John Van Reenen and Fabrizio Zilibotti (2007), Maria Guadalupe and Julie Wulf (2010), Nicholas Bloom, Luis Garicano, Raffaella Sadun and John Van Reenen (2014) and Philippe Aghion, Nicholas Bloom, Brian Lucking, Raffaella Sadun and John Van Reenen (2017).

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.

We proceed by first characterizing 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. Although there is no incentive to lie upon successful information acquisition, there is no incentive to be truthful upon the lack of successful information acquisition as conditional on no additional information the players disagree over the optimal action. 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 himself 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 finds the conditions existence of influential equilibria under both delegation and centralisation. In this type of equilibrium, the decision maker always follows the recommendation by the other player (adviser) when uninformed, as 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 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. In the influential equilibrium, 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, if the principal's anticipated effort is high enough (happens when the principal is sufficiently efficient), her recommendation is credible enough to switch the action of an uninformed agent towards 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. As efforts are substitutes in equilibrium, the more inefficient the agent is, the more effort the principal exerts, and the more likely it is that this equilibrium arises; hence why we talk about **relative efficiency**.[5] The conditions for an influential equilibrium under centralisation are symmetric: when the agent is relatively efficient compared to the principal, he makes a credible recommendation which the principal follows whenever uninformed.

The above results resonate with empirical findings that under delegation, management is still involved in consultations with the worker (Hajime Katayama, Kieron J Meagher and Andrew Wait, 2018) and that centralisation is more likely to arise the less the employee trusts the management (Kieron J Meagher and Andrew 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 (Gary Yukl and Ping Ping 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" (Christopher J Collins and Ken G Smith, 2006), it means the other party has the *ability* to act in a persuasive way (Morton Deutsch, 1960; Mayer and Gavin, 2005; Roger C Mayer, James H Davis and F David Schoorman, 1995). However, to our best knowledge this literature has not explored

[5]Substitutability of efforts leads to moral hazard à la Bengt Holmstrom (1982). Mathias Dewatripont and Jean 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, Sadun and Van Reenen (2012).

[7]Jace Garrett, Rani Hoitash and Douglas F 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 Roger C Mayer and Mark B Gavin (2005) and Karlene H Roberts and Charles A O'Reilly III (1974).

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 establish that as long as the principal is sufficiently efficient to make an influential recommendation under delegation, delegation is strictly better for the principal's payoff than centralization. This is due to the principal not losing any authority when delegation, while benefiting from the agent's additional effort. Under the parameter values for which an influential equilibrium under delegation exists, the agent is sufficiently inefficient and hence unable to produce a credible recommendation himself. Plus, the agent still 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 finding that the principal has no tradeoff in terms of loss of authority from delegation when an influential equilibrium exists has additional importance as it renders delegation credible in our setup.Baker, Gibbons and Murphy (1999) argue that as the principal is the ultimate stakeholder, granting authority might not be credible as 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 takes the mutually optimal decision. Hence, the credibility of principal's recommendation also translates into credibility of delegation even if it is not contracted upon.

When the principal is relatively inefficient, under delegation her recommendation is never

[8]Although we assume 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.

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 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

[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, Philippe Aghion and Jean Tirole (1997) soft information is equivalent to hard information as there are no incentives to lie, whereas for example, D Paul Newman and Kirill E 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.

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. 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 Heikki Rantakari (2012) and Yeon-Koo Che and Navin 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. Inga Deimen and Dezs̋o 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 (Sanford J Grossman and Oliver D Hart, 1986; Oliver Hart and John 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; Milton Harris and Artur Raviv, 2005). If the information is dispersed between multiple employees, the setting of coordi-

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

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

nated adaptation with exogenous information (Alonso, Dessein and Matouschek, 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 Shuo Liu and Dimitri 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.

We further connect to the literature on costly information acquisition before cheap talk, starting with David Austen-Smith (1994) who models uncertainty about expert's information acquisition cost. Some of the recent contributions to strategic communication with information acquisition include Harry Di Pei (2015), Rosella Argenziano, Sergei Severinov and Francesco Squintani (2016), Deimen and Szalay (2016) and Sinem 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, Severinov and Squintani (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 (Georgy Egorov and Konstantin Sonin, 2011). Empirically, Timothy Besley, Olle Folke, Torsten Persson and Johanna 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, Canice Prendergast and Robert H Topel (1996) use a similar loyalty-competence trade-off to model

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

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 consisting of a principal (she, P) and an agent (he, A) will take a decision among one of two actions, $\theta \in \{a, b\}$. There is an unobserved state $\omega \in \{\mathcal{A}, \mathcal{B}\}$ with the common prior $Pr(\omega = \mathcal{A}) = p$. The payoff from action b is zero both for the principal and the agent in either state, while their payoff from action a depends on the state. Below is the payoff matrix, where the first payoff is the agent's:

	$\theta = a$	$\theta = b$
$\omega = A$	$\beta,\ (1-\beta)$	$0, 0$
$\omega = B$	$-(1-\beta),\ -\beta$	$0, 0$

Hence, action a is mutually optimal in state $\mathcal{A}$, and action b is mutually optimal in state $\mathcal{B}$. The assumption $1 - \beta < p < \beta$ ensures that at the beginning of the game, i.e. before any information is acquired, the agent prefers action a while the principal prefers action b.[13] Hence, $\beta \in (1/2, 1]$ defines the bias towards different actions and additional information about the state could resolve the initial conflict of interest.

As given the beliefs, the only thing that matters for decision-making is the difference in the pay-off of choosing the right versus the wrong action, (i.e. different losses of making the wrong decision) we interpret the decision as one between a risky and a safe action (the status quo) by normalizing the payoff from safe action to zero. We so assume that the agent has a larger inclination towards the risky action than the principal while the principal has an inclination towards the status quo. Although we use this specific structure for simplicity of exposition, our

[13]In 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: $(1-p)\beta w > p(1-\beta)w$.

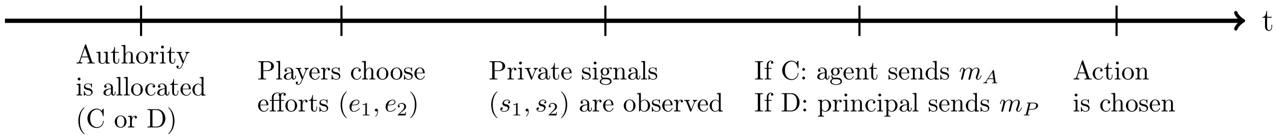

Figure 1: Timing of Events

setup generalizes to any in which the agent and the principal have different threshold posteriors $\tilde{p}_i$ such that whenever the posterior $\tilde{p}$ satisfies $\tilde{p} \geq \tilde{p}_i$ for $i \in \{A, P\}$, they prefer action a and otherwise prefer action b. The initial conflict arises whenever the initial common prior falls in between the two thresholds: $\tilde{p}_A < p < \tilde{p}_P$. Hence, the results generalize to any pay-off structure provided that there is a mutually optimal action conditional on the state, but disagreement given the prior due to differing preferences towards making the right as opposed to wrong decision in the corresponding states. (*this has been used in the literature.... *)

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 (Philippe Aghion, John Van Reenen and Luigi Zingales, 2013; Michael E 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 invest in a costly state-dependent signal. We assume success-enhancing effort as in Jerry R Green and Nancy Stokey (1980) where exerting effort $e_i \in [0, 1]$ for $i = P, A$ results in the arrival of a perfectly revealing privately observed 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. Cost of information acquisition c_i is different between the principal and agent, and this is what we call *efficiency*.

We follow the incomplete contracting approach (Grossman and Hart, 1986; Hart and Moore,

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

1990) and assume that the principal is unable to commit to transfers or decision functions based on reports, but can, at the beginning of the game, commit to an allocation of decision rights. The choice is between centralisation (principal authority) or delegation (agent authority). Under both structures, first, players simultaneously and privately exert effort into acquiring signals. Under centralisation, the agent sends a cheap talk message to the principal who, then, chooses an action. Under delegation, 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 show in equilibrium is equivalent to recommending one of the two actions, hence $i \in \{a, b\}$.

3 Analysis of the game

Our first result shows that the players never fully share the outcome of their, irrespective of the organizational structure.

Proposition 1. *There exists no fully revealing equilibrium under either centralisation or delegation.*

To understand the intuition, note first that a player can only affect the decision-maker's choice when the latter is uninformed; as an informed decision maker's best response is always to choose the right action. By contradiction, suppose a fully revealing equilibrium existed under delegation. Were the principal to truthfully reveal that she is uninformed, if uninformed agent would choose action a while if informed the agent always chooses the mutually optimal action. Then, the uninformed principal would deviate and recommend action b, contradicting the existence of a fully revealing equilibrium. A symmetric argument holds for centralisation.

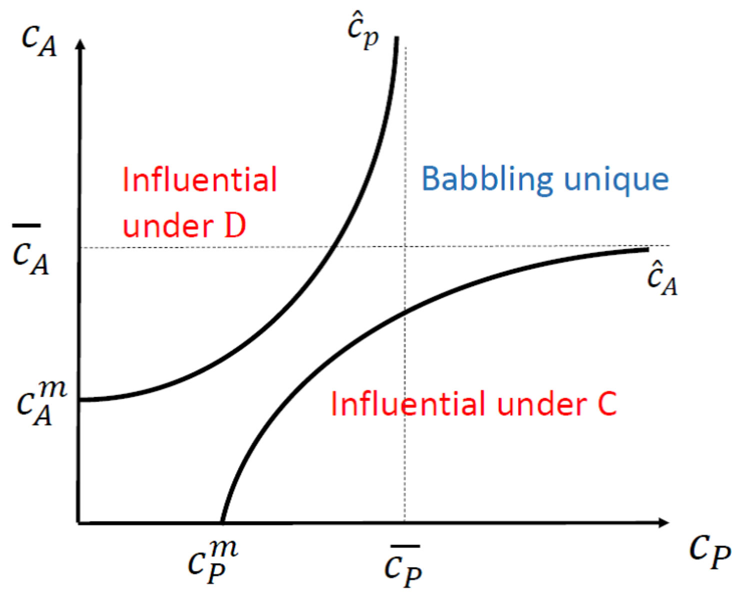

Figure 2: Characterisation of equilibria

3.1 Outcomes under delegation.

Under delegation, two possible equilibria can arise, depending on c_A and c_P, the players' efficiencies in obtaining information, as follows.

Lemma 1. *Whenever $c_P \leq \hat{c}_P(c_A)$, under delegation an influential equilibrium exists where*

$$\hat{c}_P(c_A) = \frac{p^2(1-\beta)\beta w}{p+\beta-1}\Big(1 - \frac{(1-p)(1-\beta)w}{c_A}\Big). \tag{3.1}$$

The respective efforts of the principal and agent are:

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

Whenever $c_P > \hat{c}_P(c_A)$, the unique equilibrium under delegation is a babbling one, in which $e_P = 0$ and:

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

The above lemma shows that an influential equilibrium exists if and only if the principal is sufficiently efficient in information acquisition compared to the agent, and exerts a sufficiently high effort to rend her recommendation credible. The agent then follows the principal's recommendation whenever uninformed.

In the influential equilibrium, the principal's communication strategy is as follows: if she learns that the state is $\mathcal{A}$, she sends the message m_a while if she learns that the state is $\mathcal{B}$ or does not learn anything, she sends the message m_b. Whenever informed, the agent chooses a mutually optimal action regardless of the message. Whenever an uninformed agent receives m_a, he is certain about the state and he chooses action a. If, however, the uninformed agent receives m_b, he will choose the action b if and only if he believes this message is more likely to result from acquired information than the principal's bias.

On the other hand, whenever $c_P > \hat{c}_P(c_A)$, a *babbling* equilibrium is the unique outcome, in which only the agent exerts any effort and always chooses action a when uninformed. The principal cannot 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 anyways. Hence, unable to affect the agent's decision, the principal exerts no effort at all. As customary in games of cheap talk, a babbling equilibrium always exists, but it unique only for $c_P \geq \hat{c}_P(c_A)$. In case of multiplicity of equilibria, the principal's preferred equilibrium could be either babbling or influential, where the benefit of babbling equilibrium is that the agent exerts higher effort when he is the only one to do so.

The constraint 3.1 relaxes as c_A increases. This is due to the strategic substitutability of the effort levels: a less efficient agent exerts less effort in equilibrium, which in turn incentivizes the principal to exert more effort. For the principal to be able to persuade an agent, she must be exerting a high enough effort, hence be sufficiently efficient relative to the agent. Indeed, the inefficiency of the agent provides credibility to the principal in equilibrium.

Finally, note that the RHS of 3.1 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 bound on the principal's efficiency for her recommendation to be credible.

3.2 Outcomes under centralisation

This is the organizational structure in which the principal keeps decision-making power. As in the case with delegation, there are two possible outcomes.

Lemma 2. *Whenever $c_A \leq \hat{c}_A(c_P)$, an influential equilibrium under centralisation exists where*

$$\hat{c}_A(c_P) = \frac{(1-p)^2(1-\beta)\beta w}{(\beta - p)}\Big(1 - \frac{pw(1-\beta)}{c_P}\Big). \tag{3.2}$$

The respective efforts of the principal and agent are:

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

Whenever $c_A > \hat{c}_A(c_P)$, the unique equilibrium under centralisation is a babbling one, in which $e_A = 0$ and:

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

The results are symmetric to the case under delegation: an informative equilibrium exists if and only if the agent is sufficiently more efficient in information acquisition than the principal, in which case the principal follows the agent's recommendation whenever uninformed. The agent's communication strategy consists of two signal-contingent messages. If the agent learns that the state is $\mathcal{B}$, he sends the message m_b to the principal. In all other instances he sends the message m_a. Upon receiving m_a, the uninformed principal cannot distinguish whether the agent is informed or not but follows the recommendation.

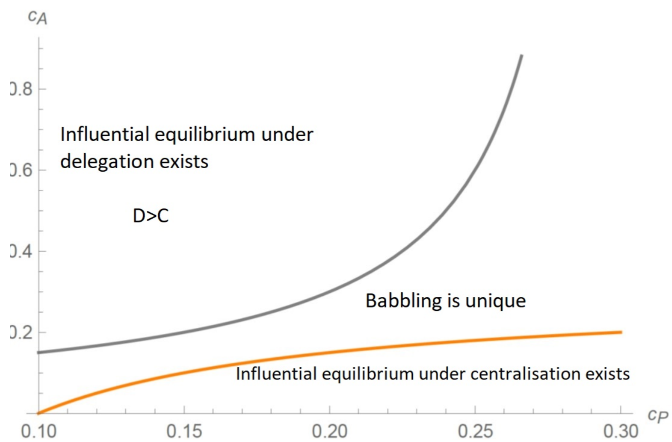

Figure 3: Characterisation of equilibria for parameter values $w = 0.5$, $\beta = 0.6$, $p = 0.3$.

Whenever $c_A > \hat{c}_A(c_P)$, the agent can no longer influence an uninformed principal, hence a babbling equilibrium in which only the principal exerts any effort is unique.

In case of equilibrium multiplicity under centralisation, the principal's preferred equilibrium is always the influential one: the principal cannot be worse-off by getting a recommendation as if it were the case, she would simply ignore it.[15]

4 Optimal organizational form

Throughout the analysis we maintain the following assumption on the minimal values of the costs:

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

The immediate consequence of the above assumption is summarized in the following lemma.

Lemma 3. *Under Assumption 1, effort levels are interior under any organizational form.*

As shown in the proof of lemma 3, maximum effort levels arise when either the principal or the agent is taking the decision on their own (i.e. babbling equilibrium is played), leading to Assumption 1. It is straightforward to verify that $\hat{c}_A$ is increasing and concave in c_P, and

[15]**Further note that** as $c_P \to \infty$, we get the maximum $c_A(c_P)$ 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.

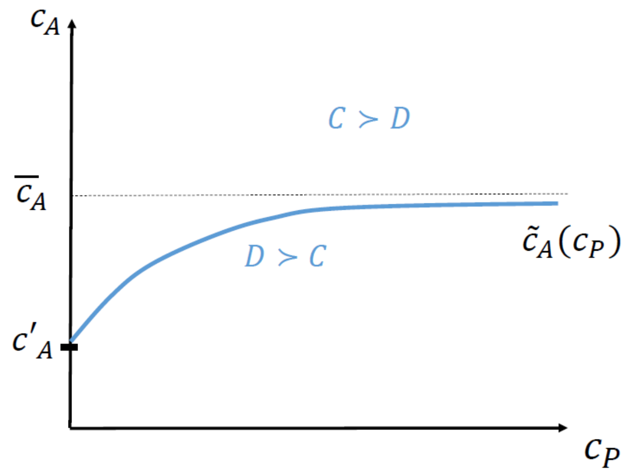

Figure 4: Optimal organizational structure under babbling.

$\hat{c}_P$ is increasing and concave in c_A. Using Assumption 1, we get the minimum values of these: $c_P^m = \beta(1-p)w$ when $c_A = (1-p)(1-\beta)w$ and $c_A^m = \beta p w$ when $c_P = p(1-\beta)w$ respectively and these are denoted in Figure 2.

Proposition 2. *When no influential equilibrium exists under either organizational structure hence babbling is unique, the principal will delegate if and only if the agent is sufficiently efficient, namely if:*

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

and centralise otherwise.

Figure 4 shows the curve separating the regions where centralisation versus delegation is optimal under the assumption that babbling equilibrium is played in either case. Realize that, as $c_P \to \infty$, the right hand side of 4.1 converges monotonically to $\bar{c}_A$; which is also the maximum c_A for influential equilibrium under centralisation to exist. By delegating, the principal avoids any cost of information acquisition and increases agent's effort while at the same time losing decision-making power. Hence, when babbling is considered, delegation is optimal only if the agent is very efficient- resonating with the trade-off in Aghion and Tirole (1997) and the literature on delegation, of that between loss decision-making power versus incentivizing the agent to become informed. However, the trade-off changes significantly when we consider the existence of influential

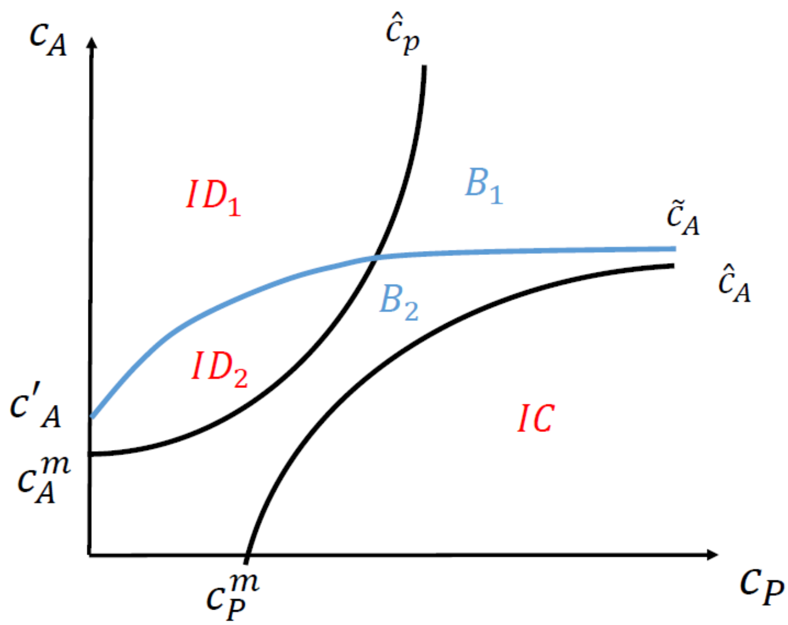

Figure 5: Optimal Organizational Structure. B_1 and B_2 are the babbling regions, in ID_1 and ID_2 informative equilibrium under delegation exists, in IC informative equilibrium under centralization exists.

equilibria.

Figure 5 provides all the different regions in terms of the optimal organizational structure, and the and the next proposition 3 provides the main result about the optimality of delegation.

Proposition 3. *Whenever influential equilibrium exists under delegation (the regions ID_1 and ID_2 in figure 5), delegation strictly dominates centralisation and the principal incurs no loss of authority from delegating.*

The idea of the proof is very 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 payoff of 0. The principal's payoff in the influential equilibrium under delegation is:

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

Comparing both expected payoffs above, we see that under delegation the principal can always secure a higher payoff by exerting the same effort as under centralisation. The principal benefits from agent's additional effort while at the same time keeping the decision making authority thanks to her persuasive recommendation.

Lemma 4. *If an influential equilibrium exists simultaneously under delegation and centralization, delegation strictly dominates centralization in terms of principal payoff.*

In figure 2 and 5, we implicitly made the assumption that the influential equilibria under delegation and centralization do not co-exist. Hence, in proposition 3 we simply compared influential equilibrium under delegation to babbling under centralization. However, lemma 4 shows that even if the curves of $\hat{c}_P$ and $\hat{c}_A$ do cross for certain parameters hence influential equilibria co-exist, it wouldn't affect the main result about the optimality of delegation in proposition 3.

It is clear that delegation is optimal whenever an influential equilibrium exists. However, a question might arise as to whether babbling equilibrium under delegation may dominate the influential equilibrium for the principal. When we replace $c_P = c_P^{min}$, the RHS of 4.1 becomes

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

Since

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

we have $c_A^{min} < c'_A < \bar{c}_A$, and therefore the RHS of 4.1 starts at c'_A and converges monotonically, in a concave way, to $\bar{c}_A$ as c_P goes to infinity. As a result, as shown in Figure 5, there is a region of overlap in which both influential and babbling equilibria under delegation dominate centralisation. Corollary 1 below is a direct consequence of Propositions 2 and 3:

Corollary 1. *In region ID_2, babbling equilibrium under delegation dominates babbling under centralisation. Only in this region, babbling equilibrium may dominate influential equilibrium under delegation in terms of principal's payoff.*

The corollary deals with the multiplicity of equilibria in ID_1 and ID_2 to find whether babbling equilibrium under delegation may be preferred by the principal to influential equilibrium. We can ignore the region ID_1, as in this region centralisation dominates delegation when babbling is considered. Hence, ID_2 is the only region in which babbling under delegation dominates babbling under centralisation and the influential equilibrium under delegation exists as well. Realize that this Corollary doesn't affect the optimality of delegation but only verifies principal's optimal equilibrium under delegation given the multiplicity.

Finally we consider the region IC, in which influential equilibrium under centralisation exists while the unique equilibrium under delegation is a babbling one. The question is whether the principal may still find it optimal to delegate in this region as delegating hence committing to no effort may be beneficial.

Proposition 4. *In the region IC, an influential equilibrium under centralisation exists while babbling is the unique equilibrium under delegation. Inside this region, delegation dominates influential equilibrium under centralisation for the principal 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

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

while otherwise centralisation dominates delegation.

First, if an influential equilibrium exists under centralisation, then it strictly dominates babbling equilibrium under centralisation, as the principal could always ignore the agent's recommendation. On the other hand, principal's benefit from delegation which leads to babbling comes from the commitment to not exerting any effort which raises the agent's incentives to exert effort. This may be optimal when the agent is very efficient. Indeed, if the parameter values satisfy

$\beta - 2p + \beta p > 0$, we have $2(1-\beta)(1-p)w > \bar{c}_A$ and centralisation is optimal in the overall region described in Proposition 4.

5 Optimal choice of agent

Let us discuss the choice of agent by the principal as a function of the agent's efficiency.

We will focus on figures 2 and 5. First,when $c_P \geq \bar{c}_P$, the principal would never hire an agent with c_A that falls into region B_1: babbling is unique and centralization dominates delegation in this region, making an agent unnecessary. Hence, the only situation in which the principal may benefit from an agent is one with c_A such that the pair will fall into region B_2 or IC. In either case, the principal could not influence the agent under delegation. It is easy to see that, the more efficient the agent is, better it is for principal: whether the influential equilibrium under centralization is played or babbling under delegation, the principal's payoff is increasing in the agent's efficiency. To conclude, when the principal is inefficient, it will be optimal to hire a sufficiently efficient agent to whom either the principal delegates decision or of whom he would follow the recommendation in case of not delegating.

Second, when $c_P^m < c_P < \bar{c}_P$, i.e. principal's efficiency is intermediary; then all 4 regions in figure 5 are attainable depending on the choice of agent. In this case, either the most efficient type of agent such that influential equilibrium under delegation is feasible ($c_P = \hat{c}_P$), or the most efficient type of agent possible such that c_A, c_P fall into the region IC would be the best one for the principal. Hence, in this region, the principal would like to hire the most efficient agent possible.

When $c_P < c_P^m$, an influential equilibrium under centralisation never exists; i.e. no agent can influence a principal who holds decision power. Hence, the only situation where an agent is hired would be if delegating authority is optimal. Either babbling or influential equilibrium under delegation can be attained depending on the choice of agent, corresponding to regions ID_1, ID_2 and B_2. In the region ID_1 and ID_2, the principal's payoff is increasing as c_A goes down: whether it is babbling or influential equilibrium, a more efficient agent is better. However, if in region ID_2, influential equilibrium under delegation dominates babbling under delegation, then when c_A just goes down below the curve $\hat{c}_P$, the principal's payoff decreases as the influential equilibrium ceases to exist. However, once in region B_2, as the agent's cost decreases the principal's payoff increases. Hence, there is a non monotonicity in principal's payoff with respect to agent's efficiency. If it is optimal for the principal to also be involved in information acquisition, then the optimal choice of agent will lie on the $\hat{c}_P$ curve, and otherwise, the optimal choice of agent is the one with the minimum c_A and babbling equilibrium under delegation is played. To conclude, for a succifiently efficient principal, the presence of an agent is only beneficial if an influential equilibrium under delegation exists or if the agent is efficient enough that delegating is optimal even though babbling is the outcome.

6 Welfare

We now consider the question of allocation of decision making power to maximize the overall welfare. This could be the problem of a manager allocating decision-making power among several employees in order to incentivize them to acquire and share information. Hence, lets consider the problem of a principal who is deciding whom to allocate decision making authority among two agents, and cares about their overall welfare. The question is, when there are more than one agent, whom should the

Proposition 5. *Whenever the relative costs of the agents are such that influential equilibrium can exist (regions ID_1, ID_2 and IC in figure 5), 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 (B_1 and B_2), then the relatively efficient agent must hold decision-making power.*

Allocating authority to the less efficient party is the welfare optimal thing to do whenever an influential equilibrium exists, which 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 delegation when an influential equilibrium under delegation exists. On the other hand, when the relative efficiencies of the principal and agent are similar, or both of them are rather inefficient that making babbling the unique equilibrium (B_1 and B_2), then it is optimal to give authority to the party that is relatively efficient in order to maximize the overall welfare.

7 Extensions

7.1 Generalizing the cost function

To keep the analysis tractable, our baseline model assumes a specific cost function, $\frac{c_i e^2}{2}$. Here we show that our results continue to hold for any pair of cost functions $c_i(e)$ for $i \in \{P, A\}$ that satisfy $c', c'' > 0$ and $c'(0) = 0$, together with the conditions that ensure effort levels are interior. The only difference is in how we define the equilibrium effort levels. If we take the influential equilibrium under delegation, the effort levels are given by:

$$c'(e_A) = (1 - e_P)p\beta w$$
$$c'(e_P) = (1 - e_A)(1 - \beta)pw$$

while the required effort level of the principal for influential equilibrium to exist under delegation has not changed. As shown in the proof of Lemma 1, it is still the case that:

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

Hence, the condition for the existence of an influential equilibrium under delegation is identical. The condition $c'(0) = 0$ implies that mutual effort is optimal if possible compared to babbling where only the decision maker exerts effort, hence Proposition 5 also carries over to any cost function which satisfies these mild conditions. We conclude that for a broad range of cost functions our results continue to hold.

7.2 Generalizing the signal structure

Our baseline model assumes that information acquisition either results in a perfectly revealing signal or in a completely uninformative signal. We now show that our results extend to setups where learning doesn't take the binary nature of a perfectly revealing signal or no learning at all. Let's suppose effort results in one of 2 possible signals, s_H and s_L which can each take two values $\{a, b\}$ such that when the state is $\mathcal{A}$, $s_H = a$ with probability q (otherwise b) and $s_L = a$ with probability r (otherwise b), where $q > r > 0.5$ and similarly when the state is $\mathcal{B}$.[16]. In this case, for effort e, signal s_H arrives with probability e and the signal s_L arrives with probability $(1-e)$. For the results to hold, we need to assume that q is sufficiently high so that, when $s_H = a$, independent of the value of s_L both parties want to choose action a, and the opposite is true when $s_H = b$. For this, the following conditions must hold:

$$Pr(\omega = \mathcal{A}|s_H = a, s_L = b) = \frac{pq(1-r)}{pq(1-r) + (1-p)(1-q)r} = \frac{pq(1-r)}{pq + r(1-p-q)} > \beta$$

and:

$$Pr(\omega = \mathcal{B}|s_H = b, s_L = a) = \frac{(1-p)q(1-r)}{(1-p)q(1-r) + p(1-q)r} > \beta$$

so that both the agent and the principal agree that the optimal action is the one indicated by s_H. In addition, the signal s_L alone must not be sufficiently informative to switch one away from their prior biased action:

$$(1-\beta) \leq Pr(\omega = \mathcal{A}|s_L = a) \leq \beta$$

$$(1-\beta) \leq Pr(\omega = \mathcal{B}|s_L = b) \leq \beta$$

Let's now establish the condition for the existence of the influential equilibrium under delegation. The principal's communication strategy is as follows: upon receiving signal s_H, she sends a truthful

[16]Realize that, the realisation of a signal is identical for both the agent and principal, if they were to both acquire the same signal.

message, while whenever he gets s_L, she sends m_b irrespective of the realization of the signal. Whenever the agent observes the signal s_H, he follows his signal, whereas upon observing the signal s_L, he always follows the principal's recommendation. In particular, when the agent acquires $s_L = a$, he must choose b if the principal sends m_b, so that his posterior about the state $\omega = \mathcal{A}$ [?] is

$$Pr(\omega = a|s_L = a, m_b) = \frac{pr(e_P(1-q) + (1-e_P))}{pr(e_P(1-q) + (1-e_P)) + (1-p)(1-r)(e_P q + (1-e_P))} \geq \beta$$

which implies:

$$e_P \geq \frac{pr(1-\beta) - (1-p)(1-r)\beta}{pqr(1-\beta) - (1-q)(1-p)(1-r)\beta}$$

To conclude, as long as there is one signal that is sufficiently informative and another one which is sufficiently uninformative, our main results will continue to hold.

7.3 Generalizing preferences

Our results hold in any setup where, conditional on the state, there is a mutually optimal action and, given the initial common prior about he state, the players disagree over the optimal action. To illustrate, consider the following payoff matrix where the first entry is the agent's payoff:

	$\theta = a$	$\theta = b$
$\omega = \mathcal{A}$	$1-\beta, 1-\gamma$	$0, 0$
$\omega = \mathcal{B}$	$0, 0$	β, γ

There is a common prior on the state space where each player assigns probability p to the state $\mathcal{A}$. The initial condition that ensures that the principal prefers action b and the agent prefers a before any information has been obtained, is

$$\beta < p < \gamma$$

The following proposition generalizes the existence of influential equilibrium to this setup.

Proposition 6. *An influential equilibrium under delegation exists when the principal is sufficiently efficient, namely:*

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

and the principal finds it strictly optimal to delegate without losing any authority.

For any efficiency level of the agent, the principal's condition is more stringent the higher is γ, as higher γ decreases the principal's equilibrium effort.

7.4 Differing priors

In the following we show that our main results and intuitions continue to hold in a setup where the state- and action-contingent are identical and the preference difference arises only due to differing priors:

	$\theta = a$	$\theta = b$
$\omega = \mathcal{A}$	β, β	$0, 0$
$\omega = \mathcal{B}$	$0, 0$	β, β

In addition, the prior's p^A and p^P are respectively the agent's and the principal's initial prior that the state is $\mathcal{A}$ such that $p^A > 0.5 > p^P$. Given the initial prior, the agent prefers action a while the principal prefers action b.

We look at influential equilibrium under delegation in which whenever the principal has signal a she sends m_a and sends m_b otherwise.

Lemma 5. *An influential equilibrium under delegation exists when:*

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

[discussion?]

Hence, results of our paper extend to a setup where the difference in preferences is due to different prior beliefs.

7.5 Verifiable information

We now change the assumption in our benchmark model of cheap talk and consider verifiable information in which case an acquired signal can be credibly disclosed. As it is not certain that a signal arrives, it is not trivial that signals are always disclosed. We find that both full disclosure and semi disclosure equilibria may exist.

Proposition 7. *There exist full disclosure equilibria under both centralisation and delegation. 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 under centralisation in the cheap talk game.*

In the full disclosure equilibrium, upon no disclosure, the uninformed decision maker takes their ex-ante preferred action. This means, under centralisation, when no information is acquired by either sides, the principal will choose action b. Hence, the type of decision in this case is identical to that in the 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 the principal's preferred action is chosen by the agent. In addition, equilibrium efforts are also identical; as signal only affects the outcome if it turns out to suggest action a. This means, the same outcome as in the verifiable information is achieved under cheap talk game in our benchmark.

Proposition 8. *There exist partial disclosure equilibria in which the sender only discloses the type of signal which is contrary to their initial bias and always hides the other signal. In absence of disclosure, the uninformed receiver chooses the sender's preferred action. The existence condition and effort levels in this type of equilibrium are as in the influential equilibria in the cheap talk game.*

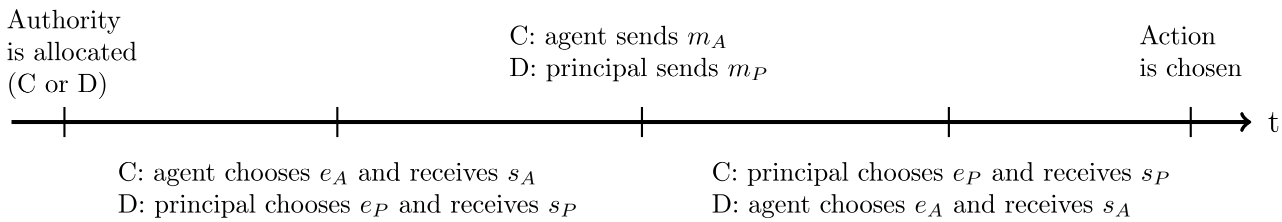

Figure 6: Timing of Events

Consider the partial disclosure equilibrium under delegation in which the principal always discloses signal a, while if she gets signal b she hides it. Then, an uninformed agent will choose action a upon disclosure of this signal, while upon no disclosure, he will choose action b if it is very likely that the principal is informed. The partial disclosure equilibrium under centralisation works in a similar fashion. We find that the conditions for the partial disclosure equilibrium to arise are the same as in our benchmark influential equilibria in cheap talk. On the other hand, full disclosure equilibria always arise.

To conclude, we have shown that non verifiability of information does not necessarily lead to less informative outcomes than verifiable disclosure whenever influential equilibria arise.

7.6 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 9. *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.[17]

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

[17] 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.

communication.

Proposition 10. *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.[18]

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 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

[18] 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.

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[19].

Proposition 11. *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 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.

[19]Those notations are used in the proof.

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 12. *Influential equilibrium under delegation dominates centralisation with truth-telling whenever:*[20]

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

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.

8 Conclusions

This paper studies how relative abilities of information acquisition affects the optimal allocation of decision-making power within an organization. Our baseline results suggest that for two-sided information acquisition and influential communication to take place, the relatively inefficient party should be endowed with decision-making power while the more efficient party maintains real authority. This authority is in form of a recommendation which the decision maker follows whenever uninformed himself. Crucially, there exists disagreement between the parties in the absence of decision-relevant information which is resolved upon the arrival of information. As a result, a suf-

[20]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.

ficiently efficient principal optimally delegates to a sufficiently inefficient agent, providing stronger incentives for the agent to acquire information while keeping real authority as she is able to persuade the agent to follow her recommendation.

Another point we emphasize is that the credibility of communication in the influential equilibrium under delegation makes delegation credible. We so account for the criticism in the literature about credibility of delegation given that the principal could revoke authority when he thinks that the agent acts against her 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 endogenous information acquisition, influential communication only happens when the two parties are sufficiently different in terms of their abilities to get information. This is because, given the substitutability of efforts, when the two of them are sufficiently similar in their abilities of obtaining information, neither of the them alone would exert sufficiently high effort to make a persuasive recommendation. This has implications for who may be allocated decision making power in an organization where multiple agents in different layers of hierarchy are involved in decision making process. This is more likely the case 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, Sadun and Van Reenen (2012)). Our results suggest it would be useful 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.

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9 Appendix

Proof of Proposition 1: Suppose, by contradiction, that there exists a truthful equilibrium. When the principal is informed, it is optimal to truthfully reveal her signal. Consider the case when the principal is not informed after effort is exerted. Given that the only situation in which the agent's decision can be influenced is when the agent is uninformed, the principal conditions her strategy on this event. If the principal truthfully reveals that she is uninformed, agent will choose a due to his prior bias. This gives the principal a payoff of $p(1-\beta)-(1-p)\beta < 0$. If the principal deviates to recommend b when uninformed, the agent will instead take action b which gives the principal a payoff of 0. As there is a profitable deviation for the principal, a truthtelling equilibrium cannot exist. The corresponding case under centralisation is symmetric.
Q.E.D.

Proof of Lemma 1 : First, consider the influential equilibrium. After receiving m_b the agent has posterior $\tilde{p} = \frac{p(1-e_P)}{1-e_P p}$ that the state is $\mathcal{A}$ and so the posterior:

$$1-\tilde{p} = \frac{1-p}{1-pe_P}$$

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

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

which requires:

$$e_P \geq \frac{\beta + p - 1}{\beta p} \tag{9.1}$$

The condition says that an influential equilibrium under delegation only exists if the principal's equilibrium effort is high enough to induce a high enough posterior belief of the agent that state is $\mathcal{B}$. Note that the RHS of 9 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 when uninformed, and therefore the principal must be exerting higher effort in order to induce the uninformed agent to switch away from action a.

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

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

The agent only chooses action a if the principal recommends it or if he himself learned the state is $\mathcal{A}$. In all other cases, either due to his signal or due to a "noisy" recommendation the agent chooses action b which yields a pay-off 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

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

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 e_P we rewrite the condition 9 to find the condition for the existence of an influential equilibrium in terms of the principal and agent's cost:

$$\hat{c}_P = \frac{p^2(1-\beta)\beta w}{p+\beta-1}\left(1 - \frac{(1-p)(1-\beta)w}{c_A}\right) := \hat{c}_P. \tag{9.2}$$

Whenever $c_P > \hat{c}_P$, the principal is not efficient enough to 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, unable to affect the agent's decision, and given effort is costly, she exerts no effort at all, $e_P = 0$. In that case the agent maximizes:

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

leading to:

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

Thus, the agent's effort is increasing in the probability of acquiring signal b which would switch his decision, and the increase in his pay-off from rightly doing that. We call this type of equilibrium *babbling under delegation* as there is no informative communication and the principal isn't involved in information acquisition. As it is the case for cheap talk games, this equilibrium always exists while for $c_P > \hat{c}_P$, it is unique. *Q.E.D.*

Proof of Lemma 2: Given the agent's equilibrium effort e_A, upon receiving m_a the principal's posterior 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:

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

which, when replacing $\bar{p}$, leads to:

$$e_A \geq \frac{\beta - p}{(1-p)\beta}. \tag{9.3}$$

The principal follows the agent's recommendation if there is a sufficient probability that the agent is informed. Notice the parallel to 9: in both cases the player who communicates must exert a sufficiently high equilibrium effort for the decision maker to believe that the recommendation is more likely to be based on information rather than on the ex-ante bias.

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, the condition for the agent's message to be influential becomes:

$$c_A \leq \frac{(1-p)^2(1-\beta)\beta w}{(\beta - p)}\Big(1 - \frac{pw(1-\beta)}{c_P}\Big) = \hat{c}_A. \tag{9.4}$$

Thus, for the agent to be credible, his cost of information acquisition has to be sufficiently low relative to the principal's. As equilibrium efforts are substitutes, the principal's inefficiency makes the agent exert more effort which in turn makes him more credible.

When $c_A > \hat{c}_A$, the agent's effort will not be high enough for his recommendation to be influential; i.e. the uninformed principal will choose action b regardless of the message sent by the agent. As a result, the agent optimally 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.

Q.E.D.

Proof of Lemma 3:

We show that the conditions for effort to be interior in the babbling equilibria are sufficient to ensure effort is always interior.

In the babbling equilibrium under centralisation, the condition for $e_P \leq 1$ is:

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

In the influential equilibrium under delegation, if we replace the above value as the minimum $\hat{c}_P(c_A)$, we get the minimum c_A for which this type of equilibrium can exist:

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

which also ensures that $e_A \leq 1$ in this type of equilibrium. The influential equilibrium under delegation exists only for $c_A \geq \beta p w$, which together with $c_P \geq p(1-\beta)w$ ensures that $e_A, e_p < 1$. In the babbling equilibrium under delegation, the condition for $e_A \leq 1$ is

$$c_A \geq (1-p)(1-\beta)w$$

In the influential equilibrium under centralisation, if we replace this minimum value of c_A as the minimum $\hat{c}_A(c_P)$, we get the minimum c_P for which this type of equilibrium can exist:

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

which also ensures that $e_P \leq 1$ in this type of equilibrium. The influential equilibrium under centralisation exists only for $c_P \geq \beta(1-p)w$, which together with $c_A \geq (1-p)(1-\beta)w$ ensures that $e_A, e_P < 1$. Hence, the minimum values of c_A and c_P to ensure effort levels are interior are given by the conditions for efforts in babbling equilibria, as suggested in Assumption 1.
Q.E.D.

Proof of Proposition 2: First, the delegation pay-off of the principal is given by:

$$p(1-\beta)w - (1-e_P)(1-p)\beta w$$

which simplifies to:

$$p(1-\beta)w + \frac{(1-p)^2(1-\beta)\beta w^2}{c_A} - (1-p)\beta w. \tag{9.5}$$

The centralisation pay-off of the principal is given by:

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

which, when replacing e_P is:

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

which simplifies to:

$$\frac{(1-\beta)^2p^2w^2}{2c_P} \tag{9.6}$$

Now, the difference between delegation and centralisation pay-off under babbling (9.5)-(9.6) simplifies to:

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

The derivative with respect to c_A is:

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

hence it is decreasing in c_P. The derivative with respect to c_P is:

$$2c_A(-\beta+p) + (1-\beta)2\beta(1-p)^2$$

hence 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:

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

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

Q.E.D.

Proof of Proposition 3: Under the assumption that in regions ID_1 and ID_2, babbling is unique under centralization, we need to compare the principal's pay-off in babbling equilibrium under centralisation which is:

$$p(1-\beta)we_P - \frac{e_P^2}{2}c_P \tag{9.7}$$

and the principal's pay-off in the influential equilibrium under delegation which is:

$$(e_P + (1-e_P)e_A)p(1-\beta)w - \frac{e_P^2}{2}c_P \tag{9.8}$$

The only difference in the pay-off functions is $(1-e_P)e_Ap(1-\beta)w$ in the influential equilibrium under delegation. As the principal could replicate the same effort in the influential equilibrium under delegation as that in the equilibrium under centralisation without affecting agent's effort, it is easy to see that influential equilibrium under delegation is strictly better than babbling under centralisation.

Q.E.D.

Proof of Lemma 4:

We will consider the pay-off from influential equilibrium under centralization and that under delegation. In centralization, we have the effort levels:

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

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

Under delegation:

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

$$e_P^D = (1-e_A^D)(1-\beta)pwc_P$$

For identical $e_P^D = e_P^C$, we have $e_A^D > e_A^C$. For identical $e_A^D = e_A^C$, we have $e_P^C > e_P^D$. We can conclude that in equilibrium we will have:

$e_P^C > e_P^D$ and $e_A^D > e_A^C$

Now, we can write the difference in principal's payoff in delegation and centralization:

$$\pi^D - \pi^C = p(1-\beta)(e_A^D + (1-e_A^D)e_P^D) - \frac{e_P^{D^2}}{2}c_P - \frac{e_P^{D^2}}{2}c_P - (1-\beta)p + (1-p)\beta(1-(e_A^C + (1-e_A^C)e_P^C)) + \frac{e_P^{C^2}}{2}c_P$$

which simplifies, by replacing $\frac{e_P^{D^2}}{2}c_P = p(1-\beta)(1-e_A^D)\frac{e_P^D}{2}$ and $\frac{e_P^{C^2}}{2}c_P = (1-p)\beta(1-e_A^C)\frac{e_P^C}{2}$ to:

$$(1-p)\beta - p(1-\beta) + p(1-\beta)(e_A^D + (1-e_A^D)\frac{e_P^D}{2}) - (1-p)\beta(e_A^C + (1-e_A^C)\frac{e_P^C}{2})$$

Now, we know that if $e_P^D = e_P^C$ (if the principal exerts the same amount of effort in both cases, fixing the agent's effort), then we have $e_A^D + (1-e_A^D)\frac{e_P^D}{2} = x > e_A^C + (1-e_A^C)\frac{e_P^C}{2} = y$ given that $e_A^D > e_A^C$. Rewriting the above:

$$\pi^D - \pi^C = (1-p)\beta(1-y) - (1-\beta)p(1-x)$$

given $(1-p)\beta > (1-\beta)p$ and $x > y$, we get that $\pi^D > \pi^C$.

Proof of Proposition 4: Denote by e_A^C and e_P^C the effort levels in the influential equilibrium under centralisation and e_A^D the effort level of the agent in babbling equilibrium under delegation. First, consider the principal's payoff in the influential equilibrium under centralisation:

$$p(1-\beta)w - (1-e_P^C)(1-e_A^c)(1-p)\beta w - \frac{e_P^{C^2}}{2}c_P, \tag{9.9}$$

Replacing e_P^C, the payoff simplifies to

$$p(1-\beta)w - (1-e_A^C)(1-p)\beta w(1-\frac{e_P^C}{2}). \tag{9.10}$$

The principal's payoff in the babbling equilibrium under delegation is

$$p(1-\beta)w-(1-e_A^D)(1-p)\beta w \tag{9.11}$$

The condition for the influential equilibrium under centralisation to dominate babbling under delegation becomes:

$$e_A^C+\frac{e_P^C(1-e_A^C)}{2}\geq e_A^D \tag{9.12}$$

which further simplifies to:

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

This further simplifies to:

$$\frac{e_P^C}{2}-\frac{(1-p)(1-\beta)w}{c_A}(\frac{3}{2}e_P^C-\frac{e_P^{C2}}{2})\geq 0$$

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

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

The above condition is equivalent to:

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

which is going to be satisfied for e_P^c and c_A large enough, which is equivalent to large enough c_A and low enough c_P. When $c_A>3(1-\beta)(1-p)w$, then for any c_P, influential equilibrium under centralisation dominates delegation. Additionally, whenever $c_A<2(1-p)(1-\beta)w$, the condition can never be satisfied, given that $e_P^c\leq 1$. 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 use the principal's effort in the influential equilibrium under centralisation obtained earlier, we get:

$$c_P \leq \frac{2(1-\beta)^2\beta(1-p)^3w^3}{c_A(3(1-\beta)(1-p)w - c_A)} \tag{9.13}$$

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

$$c_P > \frac{p^2(1-\beta)\beta w(c_A - (1-p)(1-\beta)w)}{c_A(p+\beta-1)} = \frac{p^2(1-\beta)\beta w}{p+\beta-1}\Big(1 - \frac{(1-p)(1-\beta)w}{c_A}\Big) := \hat{c}_P. \tag{9.14}$$

Hence, it must be that either

$$\hat{c}_P < c_P < \frac{2(1-\beta)^2\beta(1-p)^3w^3}{c_A(3(1-\beta)(1-p)w - c_A)} \tag{9.15}$$

or

$$c_A > 3(1-\beta)(1-p)w \tag{9.16}$$

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

Delegation is optimal when $c_A < 2(1-\beta)(1-p)w$, 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.

Considering the comparative statics, the derivative of the RHS of 9.13 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, as is satisfied for $c_A > 2(1-p)(1-\beta)w$ (otherwise the principal prefers to delegate no matter what is c_p), we see that the threshold 9.13 has to increase in c_A.

Q.E.D.

Proof of Proposition 5: We will keep the notation A and P for the two agents for simplicity. Now, consider the case of agent authority. In the influential equilibrium under delegation, we have the following overall welfare (principal's and agent's summed):

$$\Pi = (e_A + (1 - e_A)e_P)p(\beta w + (1 - \beta)w) - \frac{e_A^2}{2}c_A - \frac{e_P^2}{2}c_P. \tag{9.17}$$

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

$$\Pi = p(\beta w + (1 - \beta)w) - (1 - e_A)(1 - p)(\beta w + (1 - \beta)w) - \frac{{e_A}^2}{2}c_A. \tag{9.18}$$

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

$$\Pi = p(\beta w + (1 - \beta)w) - (1 - e_A)(1 - e_P)(1 - p)(\beta w + (1 - \beta)w) - \frac{e_A^2}{2}c_A - \frac{e_P^2}{2}c_P \tag{9.19}$$

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

$$e_P p(\beta w + (1 - \beta)w) - \frac{e_P^2}{2}c_P. \tag{9.20}$$

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 9.17 and 9.20 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 9.19 and 9.18:

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

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

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 the state is $\mathcal{B}$. At the effort stage, anticipating e_P, the agent chooses e_A to maximize

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

and the principal chooses e_P to maximize

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

The equilibrium efforts are

$$e_P^* = \frac{p(1-\gamma)(1-e_A)}{c_P}, \; e_A^* = \frac{p(1-\beta)(1-e_P)}{c_A}.$$

The condition for a persuasive recommendation is

$$\bar{p} \leq \beta$$

where $\bar{p}$ is

$$\frac{(1-e_P)p}{1-e_P p}$$

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

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

Q.E.D.

Proof of Lemma 5**:**

The posterior of the agent upon receiving the message m_b is:

$$1-\tilde{p}_A = \frac{1-p_A}{1-p_A e_P}$$

where:

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

The condition for the uninformed agent to choose b upon m_b is $(1-\tilde{p}_A) \geq 0.5$ that simplifies to:

$$e_P \geq 2 - \frac{1}{p_A}.$$

When we replace e_P, we get the condition in the lemma.

Q.E.D.

Proof of Proposition 7: First, we consider delegation. First both exert effort, then the principal reveals her signal whenever informed. Either the agent is informed or follows the principal's signal, while if neither the principal nor the agent have a signal, the agent chooses project a. Neither player has any profitable deviation.

At the effort stage the agent is maximizing over e_A:

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

His best response is:

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

The principal is maximizing the following expression over e_P:

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

Her best response is:

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

Solving for both best responses yields the equilibrium effort levels:

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

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

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 us consider centralisation. By the same argument, there exists a unique equilibrium under centralisation. The strategy profile is as follows: first, both players exert effort, then the agent discloses his signal 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 the following expression 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 the following expression 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:

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

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

Comparing the above efforts with the influential equilibrium under delegation in the cheap talk game, we can see that the effort levels are identical. It is possible to verify that the payoffs are identical in the two games.

Q.E.D.

Proof of Proposition 8:

Now, we show the existence of partial disclosure equilibria in the verifiable information game. Consider the delegation case. The principal discloses whenever she has acquired signal a, and doesn't disclose anything whenever she has signal b or no signal. The agent's best response is, whenever he is informed, to choose the action corresponding to state. Whenever she isn't informed, upon disclosure of a he will choose action a. Upon no disclosure, he will choose action b if and only if the agent's posterior, $(1-\tilde{p})$ satisfies the following:

$$1-\tilde{p}=\frac{(1-p)}{(1-p)+p(1-e_P)}\geq\beta$$

which leads to:

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

which is identical to equation in the cheap talk benchmark. It is clear the principal doesn't have any option when no signal arrives. In addition, as long as the uninformed agent takes action b upon no disclosure, then the principal cannot benefit from deviating from the strategy of hiding signal b. In addition upon receiving signal a, it is also optimal for the principal to disclose it.

In this partial disclosure equilibrium, the principal's optimal effort is given by:

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

which leads to the same effort level as in our cheap talk benchmark:

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

The partial disclosure equilibrium under centralisation can be shown in a similar fashion; hence we will skip.

Q.E.D.

Proof of Proposition 9: 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

$$e_A^{d,t}=\frac{(1-p)(1-\beta)w}{c_A}. \tag{9.21}$$

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

$$c_A\leq\frac{(1-\beta)\beta(1-p)^2w}{\beta-p}:=\overline{c}_A. \tag{9.22}$$

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

$$p(1-\beta)w - (1-e_P^{d,t})(1-e_A^{d,t})(1-p)\beta w - \frac{(e_P^{d,t})^2}{2}c_P. \tag{9.23}$$

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

$$p(1-\beta)we_P - \frac{(e_P)^2}{2}c_P, \tag{9.24}$$

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

$$e_P^{c,t} = \frac{p(1-\beta)w}{c_P}. \tag{9.25}$$

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

$$c_P \leq \frac{\beta(1-\beta)p^2 w}{\beta + p - 1} := \bar{c}_P. \tag{9.26}$$

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

$$e_A^{c,t} = \frac{(1-e_P^{c,t})\beta p w}{c_A}. \tag{9.27}$$

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

$$c_Ac_P(\beta-p)+(1-\beta)\beta w(c_P(2p-1)-(1-\beta)p^3w)\geq0$$

that can be rewritten as

$$c_P\Big[c_A(\beta-p)+(1-\beta)\beta(2p-1)w\Big]-(1-\beta)^2\beta w^2p^3\geq0. \tag{9.28}$$

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 (9.28) can ever be positive). Then, the inequality becomes:

$$(1-\beta)\beta p^2w(c_P-(1-\beta)pw)\geq0$$

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

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

and so (8) can only be satisfied if

$$\frac{(1-\beta)p^2 w\beta}{\beta+p-1} - (1-\beta)pw \geq 0 \tag{9.29}$$

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 (9.28) is satisfied with equality, then we have

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

Further, if we use c_A^{min} where (9.28) is satisfied with equality, then we have

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

Moreover, if we write the condition (9.28) 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:

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

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 (9.28) 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 11: 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

$$\overline{p}_A = \frac{p(1-e_P)}{1-pe_P} \tag{9.30}$$

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

$$e_P^{d,r} \geq \frac{p-(1-\beta)}{\beta p} \tag{9.31}$$

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

$$e_A^{d,r} = \frac{p(1-e_P)\beta w}{c_A(1-e_P p)}. \tag{9.32}$$

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

$$e_P^{d,r} = \frac{(1-\beta)(1-e_A^{d,r})pw}{c_P}. \tag{9.33}$$

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

$$c_P \leq \frac{p^2(1-\beta)(1-e_A^{d,r})\beta w}{\beta+p-1} := \hat{c}_P. \tag{9.34}$$

The principal's expected payoff is

$$p(1-\beta)w\left[e_P^{d,r} + (1-e_P^{d,r})e_A^{d,r}\right] - \frac{(e_P^{d,r})^2}{2}c_P. \tag{9.35}$$

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

$$e_P^{c,r} = \frac{(1-\overline{p})\beta w}{c_P}. \tag{9.36}$$

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

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

we obtain two roots, where the correct root is

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

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

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

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

yields the solution:

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

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

Before we obtained that influential equilibrium under centralisation exists for

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

using the solution for e^c_P we obtain the condition for centralisation with rubberstamp to exist that is

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

Q.E.D.

Proof of Proposition 12: 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:

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

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

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:

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

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

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

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

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

$$(e_A^{d,r} - e_A^{c,t}) + \frac{(1-\beta)pw}{2c_P}(e_A^{d,r2} - 2e_A^{d,r} + e_A^{c,t}).$$

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:

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

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

$$(1-\beta)pw \geq 2c_P(1-k). \tag{9.37}$$

To see when (9.37) 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 (9.37) 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

$$e_P^{d,r} = \frac{1}{p} - \frac{\beta w}{c_A}. \tag{9.38}$$

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 $\frac{\beta pw}{1-p} < \bar{c}_A$ 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 (9.38) 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 (9.37) 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 (9.37) 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 figure 11.

Note 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 (9.37) 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

$$\beta(p) = \frac{p(4(p-2)p+5) - \sqrt{(p-2)(p(4p(p(2(p-3)p+7)-5)+9)-2)} - 2}{2p(2(p-2)p+3)-4}. \tag{9.39}$$

Thus, we conclude that if (9.39) 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 (9.39) 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.

10 Figures

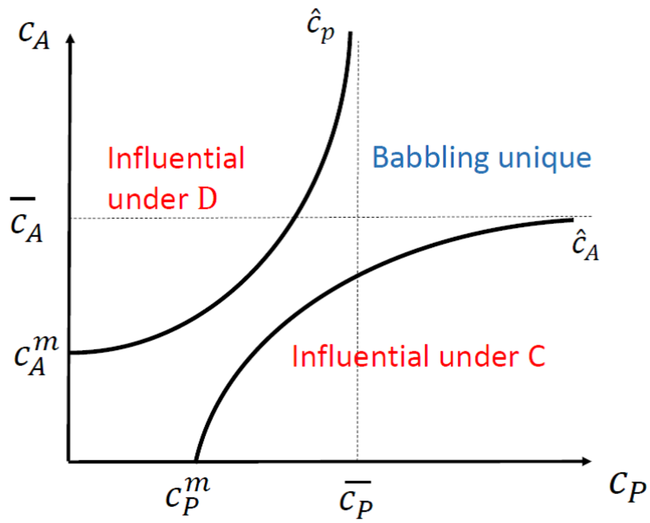

Figure 7: Characterisation of equilibria

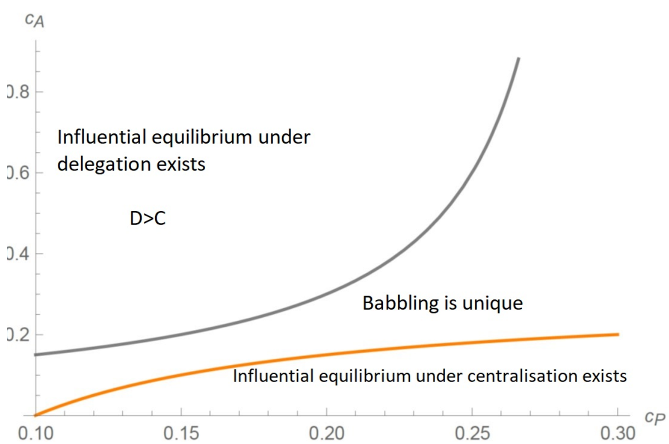

Figure 8: Characterisation of equilibria for parameter values $w = 0.5$, $\beta = 0.6$, $p = 0.3$.

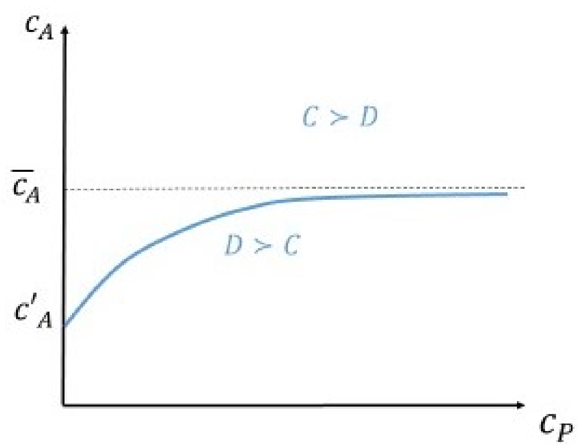

Figure 9: Centralisation versus delegation under babbling.

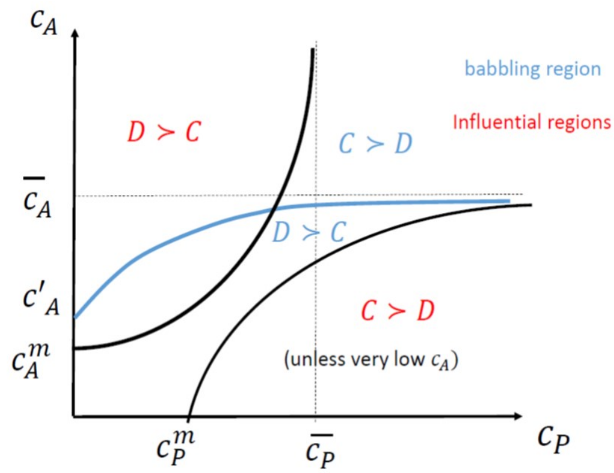

Figure 10: Optimal Organizational Structure

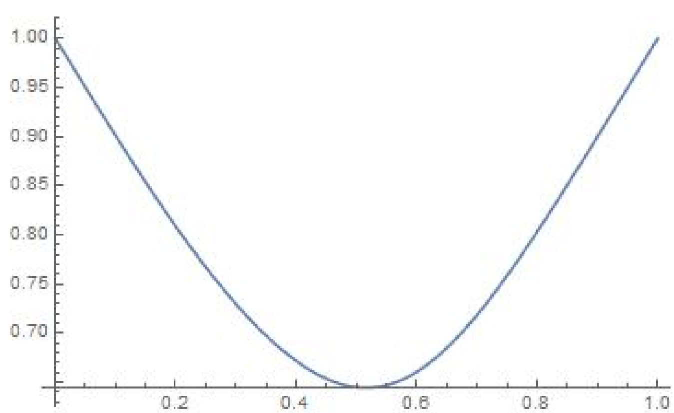

Figure 11: Illustration in proof of Proposition 11