Transfer of Authority within Bureaucracy

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Abstract Bureaucracy is featured by vertical hierarchical structure in which the decision maker usually lacks direct access to the informed agent, and the span of discretionary authority decreases top down. In this paper we analyze the performance of delegation mechanism in three-level hierarchies. The minister delegates authority to a biased senior officer, then the senior makes further delegation decision. It's shown that the efficiency is attained if and only if the senior's bias lies between the DM and the sender. On the other hand, given the bias of the senior, the optimal junior should lie between the mediator and the DM. We also show that under certain conditions the loyal officer doesn't get promotion, and complete delegation to the senior and the hierarchical structure may arise as the optimization outcome of the minister. We then compare the performance of delegation with communication (mediator cheap talk), and reverse the conclusion in Dessein (2002) that delegation ex ante dominates informative cheap talk and show that the inability to access informed party restrict the attractiveness of delegation to the minister.

Key words Hierarchy, Delegation, Cheap Talk, Bureaucracy, Mediator

1 Introduction

In bureaucratic organization the top-level decision-maker needs a chain of mediator to deliver the commands and orders to the informed party. It's usually that neither can the expert communicate directly with the DM, nor may the DM command arbitrary subordinates, i.e., command and communication are not skip-level. For example, the minister in department keeps the control on policy decision and leaves the senior bureaucrats, e.g, under-secretaries, with the discretion over administrative decisions. And the latter

would further assign authority over more specific affair to the junior officers, e.g., deputy secretaries. It's noteworthy that the span of discretionary authority is decreasing top down, and in many cases the minister is unable to skip the senior to authorize the juniors. The question this chapter addresses thus is: how does the lack of direct access to the informed party affect the allocation of control rights?

To answer this question, using the classical Crawford and Sobel (1982, henceforth, CS) cheap-talk model, we analyze organizational design in a three-layer minister/senior/junior hierarchies. All players want to adapt to the underlying state, though they also gain different private benefit (bias). Only the junior is informed about the true state, the minister chooses between delegating noncontractable decision right to the senior and keeping control rights when the junior communicates his information via "mediator cheap talk" (Goltsman et al, 2009, henceforth, GHPS). In other words, the minister (DM) has to control the junior (sender) via a strategic senior (mediator). We investigate the *hierarchical delegation* which refers to the situation that the minister not only relegates some control rights to the senior, but also allows him to further delegate the decision right to the junior within his authority. We focus on the interval delegation, i.e., the minister let the senior to make any decision from a single interval.

The *efficient delegation set* obtained in minister-junior direct interaction (Holmstrom 1977, Alonso and Matouschek 2008, henceforth AM), i.e., the second-best optimal outcome, is implementable if and only if the senior's bias lies between the minister and the junior, e.g., conservative senior bureaucrat and more conservative juniors. However, if the senior is opposite-biased, e.g., more conservative senior vs. radical junior, he prefers lower ceiling on the action set of the junior, so efficient delegation set is not implementable. Moreover, if the senior is more biased than the junior, e.g., more conservative senior vs. conservative junior, he would like to truncate the menu of actions at the bottom, which is in contrast with the interest of minister. However, if the senior and the junior are determined simultaneously, the loyal person may be assigned to junior position if the other bureaucrat's bias is not too large in that the loyal officer can directly benefit the minister in adaptation in the informed bottom-level

We also examine the optimal selection of the junior if the minister cannot change the senior but has some voices in choosing the entry-level junior. We show that the optimal selection of junior bureaucrat will be the outcome of compromise between the minister and the senior, in the sense that the optimal junior lies in middle between the ideal points of these two parties. Furthermore, we investigate the delegation scheme when the minister doesn't have the relevant knowledge about the conflict of interest of the junior. We show that the minister may optimally forgo the skip-level control of the unacquainted juniors, and grant an acquainted knowledgeable senior with full authority. Thus both the hierarchical structure of commands and orders and the complete delegation can arise endogenously thanks to the asymmetric information between the minister and the senior.

Then we compare the performance of delegation and communication in hierarchy. By communication we mean that the minister keeps decision right and hear the junior via a strategic senior. The opposite biased senior can improve efficiency, which is of his own interest, by filtering information flow, i.e., using a specific garbling of information to relax incentive compatibility constraint. Thus mediator cheap talk can generate higher payoff to the minister relative to direct communication (Ivanov, 2009, Ambrus et al, 2009). We are then led to reverse the influential conclusion in Dessein (2002) that delegation dominates cheap talk whenever there exists an informative communication equilibrium. It's shown that for some range of preference misalignment, delegation strictly *underperforms* cheap talk. Because that delegation is equivalent to that the minister commits to a particular decision rule (rubberstamp the recommendation from subordinates), the inability of direct interaction limits the available decision rules to the minister because the implementation has to be subject to the incentive of the senior. Thus when the available action rules via hierarchical delegation are worse than those under communication, the minister may entirely forgo delegation.

2 Model

An organization is composed of three players: a minister (she, denote as player $D(ecision)M(aker)$), a senior, and a junior (he, denote as player $m(ediator)$ and $s(ender)$, respectively). The utility of each player is of quadratic form as the classical CS model:

$$U\left(\theta, y, b_i\right) = -\left(\theta - y + b_i\right)^2, i = DM, m, s \tag{1}$$

Thus their payoffs depend on the true state $\theta \in \Theta = [0, 1]$, the action undertaken $y \in Y = \mathbb{R}$, and their private benefits b_i. Each player wants to adapt to the true state though to different extent, i.e., the ideal action is $\theta + b_i$. Without loss of generality, we normalize $b_{DM} = 0$ and use b_s, b_m to measure the discrepancy of interest between officers and the minister, e.g., the bureaucrats may want more budget than needed to enlarge the size of subordination. For the sake of simplicity, we use $U_i\left(\theta, y\right)$ to refer the utility of player i.

The minister has the right to take action, and only the junior would be informed about the true state θ, but he could not communicate directly with the minister, neither the minister can allocate the authority directly to the junior. In other words, the senior has full control of the information transmission between the minister and the junior. The senior and the minister have uniform prior on Θ.
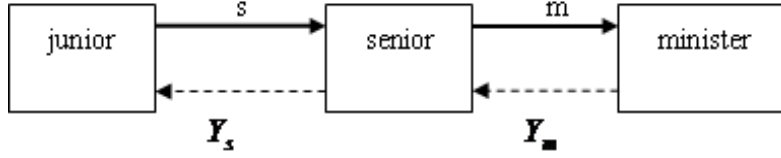
Figure 1 Timeline under communication and delegation (The solid and
    dashed line represents communication and delegation, respectively)

Now we specify the timing of this game under delegation and communi-
cation in Figure 1. The minister first assigns two agents to the senior and
the junior positions, and only the junior learns the true state. With a little
abuse of notation, here we also use m and s to denote the message sent by
the senior and the junior, respectively. If the minister engages in communi-
cation, as the solid line in Figure 1, the junior first delivers message from
the signal space S to the senior, and the senior in turn chooses m from the
message space M and send to the minister. The strategy for the junior thus
is $\mu_s : \Theta \rightarrow \Delta S$, and for the senior is $\mu_m : S \rightarrow \Delta M$. The minister forms
a posterior about the true state conditional on the message received from
the senior, and chooses his ideal action $y : M \rightarrow Y$. The optimal response
thus is $y = E[\theta|M]$. To get rid of multiple equilibria problem common
in cheap talk game[1], we would focus on the most informative equilibrium,
i.e., the Pareto-dominance one. In Section 4 we will focus on hierarhical
communication.

Alternatively, if the minister chooses delegation, she gives the senior
full control over the interval $Y_m \subset Y$, e.g., the amount of budget he can
choose. The senior can ask the junior to send message from the signal space
S, and implement his best response $y_m = \underset{y \in Y_m}{\arg \max} - (E[\theta|S] - y + b_m)^2$.
Otherwise, the senior can subcontract, i.e., delegate decision right, with the
junior by granting him the list of actions $Y_s \subset Y_m$, as the dashed line in
Figure 1.

2.1 Benchmark: direct interaction

I start from the benchmark case that the DM can delegate to the sender
directly, By delegating authority to the informed party, the DM allows the
agent to implement his preferred action from a prescribed set (finite or in-
finite), thus this is in effect equivalent to making commitment to a decision
rule. In an influential paper Dessein (2002) shows that complete delegation
in which the informed party chooses whatever action he prefers dominates
direct communication whenever informative communication equilibrium ex-
ists.

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[1] Babbling equilibrium (Uninformative communication equilibrium) always ex-
ists in cheap talk game, in which the DM would always implement the *ex ante*
optimal action $E[\theta] = \frac{1}{2}$

The DM forges the flexibility to make decision and gains in information transmission. GHPS (2009) establishes that the second-best optimal outcome can be attained by the interval delegation scheme a la Holmstrom (1977), in which the informed party is given control over a limited interval of Y.

Lemma 1 *If the DM can delegate authority to the informed party directly, then the optimal delegation set is $[0, 1 - b_s]$ if $0 \leq b_s \leq \frac{1}{2}$, and the action chosen is*

$$y(\theta) = \begin{cases} \theta + b_s, if\ \theta \in [0, 1 - 2b_s] \\ 1 - b_s,\ otherwise \end{cases}$$

If $b_s > \frac{1}{2}$, the optimal delegation set consists of only the DM's ex ante optimal action $\frac{1}{2}$.

The optimal delegation set of action is an interval $Y^* = [0, 1 - b_i]$, which is determined by the degree of conflict of interest between the decision maker and the informed party. The optimal delegation set would be truncated on the top. Optimal delegation seeks the balance between the loss of control right and the gain of information. In low state the latter effect outweighs, thus the informed party is allowed to act according to his interest. In high state the former effect dominates and the decision maker keeps *de facto* control by setting up an upper bound $(1 - b_s)$. This optimal delegation would serve as the *efficient delegation set* for our analysis on hierarchical delegation since it attains the highest payoff under any mechanism in which the DM can make commitment.

The previous work by AM (2008) establishes the conditions for delegation in more general environment. Formally, they specify the property of optimal delegation set, which is restated in current environment as the following:

Lemma 2 (AM 2008) *For any interval $[y_1, y_2] \subset Y$, the intersection of optimal delegation set $Y_s \cap [y_1, y_2]$ is a connected set.*

This lemma states that on any interval, the optimal delegation set assigns an interval or one point or no decision on it. Thus if two discrete actions are given to the agent, then the DM would find out that EU_{DM} increases by adding the actions between these two to the delegation set.

3 Hierarchical Delegation

Under hierarchical delegation, there is no direct interaction between the DM and the informed sender, e.g., the minister usually cannot directly contact

with the junior bureaucrats[2]. The procedure is the minister delegates control over Y_m to the uninformed senior, and the latter not only can talk with the junior, but could delegate the junior with the authority over an interval $Y_s \subseteq Y_m$. Thus the implemented delegation set is subject to the incentives of the mediator. I would focus on the case that $|b_m|, |b_s| \leq \frac{1}{2}$. I would use $\Delta \equiv b_s - b_m$ to represent the divergence of conflict between sender and mediator.

Due to the existence of mediator, the delegation rule available to the DM thus is subject to the incentive compatibility of mediator. So the DM is unable to commit to whatever decision rule. The mediator acts as if a mechanism designer whose set of available actions is restricted to Y_m, and make delegation decision based on the relative difference of bias Δ.

3.1 Implemented delegation set

We first look at the situation that the senior is intermediately biased, i.e., $b_s > b_m > 0$.

Proposition 1 *If the senior is granted with an interval of decision, i.e., Y_m is an interval, then the highest available alternative to the sender $\overline{y_s} = \min\{1 - \Delta + b_m, \sup\{y \mid y \in Y_m\}\}$*

This proposition demonstrates the impact of conflict of interest between the minister and the senior. If the senior is granted with large discretion power, then he would act in his own interest, and the delegation set implemented ($[0, 1 - \Delta + b_m]$) differs from the efficient one ($[0, 1 - b_s]$), as shown in Figure 2. However, it also suggests that the minister could control the loss from this divergence of ideal actions by truncating the delegation set, i.e., imposing upper-bound $1 - b_s$ on Y_m. The efficient delegation set would be implemented in hierarchical structure.

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[2] The senior bureaucrats may actively prevent the direct link between his subordination and supervision. The behavior of Sir Humphrey Appleby, the permanent undersecretary in the fictional Department of Administrative Affairs in the BBC series *Yes, Minister*, vividly illuminates this point.
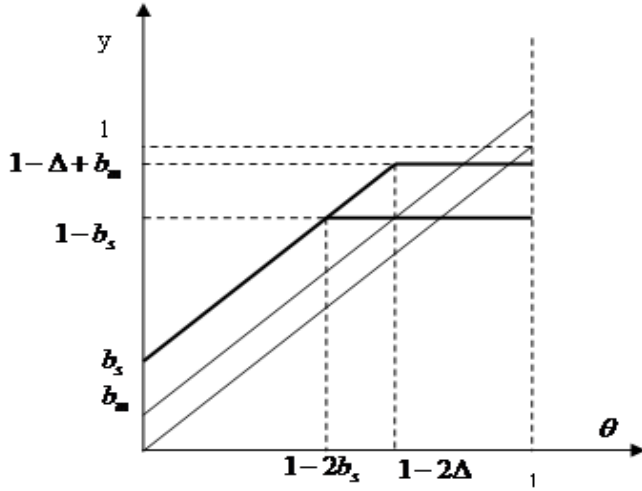
Figure 2. Property of optimal delegation set from DM and the mediator standpoint, respectively. The bold line depicts the action chosen as function of state θ.

Corollary 1 *If two officers are both positive biased and the senior is less biased, i.e., $b_s > b_m > 0$, then the efficient delegation set Y^* is implemented by imposing* $\sup\{y \,|\, y \in Y_m\} = 1 - b_s$

Therefore, even though the mediator is biased, the minister still can implement her optimal outcome by appointing a less biased mediator and truncating the delegation set. In other words, given the conflict of interest among the bottom-level workers, the agent with less intensity should be assigned to higher level in hierarchies. The implication to promotion decision thus is the minister should fill the undersecretary position with the person whose preference is aligned, e.g. more "loyal" or "like-minded".

However, this results crucially depends on that the senior is intermediately biased. If the senior is more biased, or two agents are of opposite direction of bias, then this implementation of efficient outcome fails.

Proposition 2 *If the two bureaucrats are opposite biased or the senior is more biased than the junior, then the efficient delegation set would never be implementable, i.e., $Y_s \neq Y^*$.*

We demonstrate the failure of implementable efficient delegation set in the following figures. In Figure 3(a), when two agents are of opposite direction of bias, the elements of efficient delegation set are everywhere higher than those in Y_s, so $Y_s \subset Y^*$ if $Y^* \subset Y_m$. Thus the minister has no way to force the senior to authorize the junior to take any higher action than $1 - \Delta$. In particular, for meaningful delegation we need these two agents are

not too extremely biased when they have opposite interest, namely $\Delta < \frac{1}{2}$. On the other hand, as shown in Figure 3(b) when the senior is more biased, though the minister prefers to truncate the junior's behavior in high state, the senior is inclined to restrict the junior's discretion in low state. Thus any action lower than $-\Delta$ would not be authorized by the senior. Thus the minister and the senior differ in the direction in controlling the informed party.
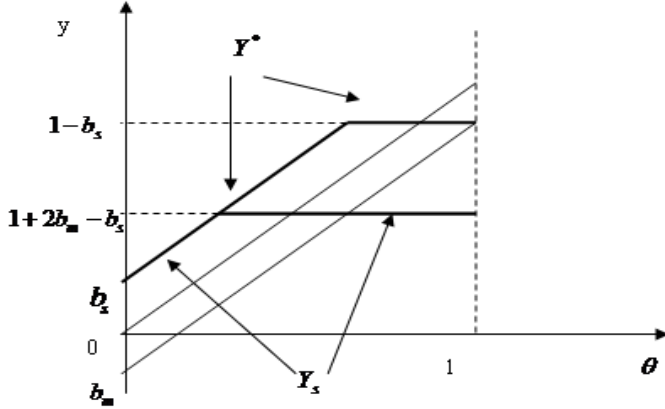

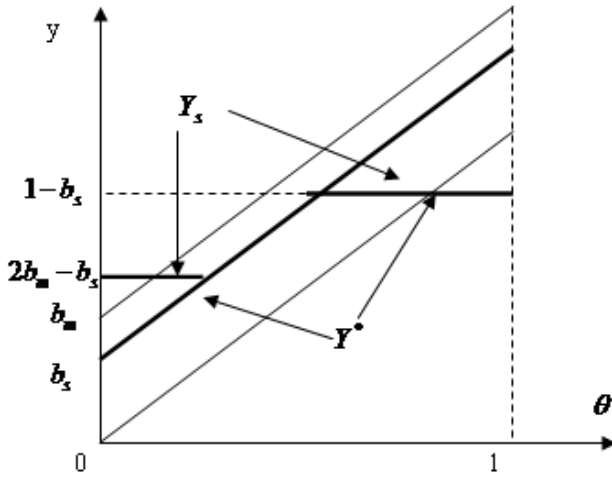Figure 3(a). The delegation set with opposite biased agents

Figure 3(b). The delegation set with extremely biased mediator

Finally, we fully characterize the optimal implemented delegation set under different bias of agents and the expected payoff to the minister. We should keep in mind that when either $|\Delta| \leq 1/2$ or $|b_i| \leq 1/2$ fail, the minister prefers to take ex ante optimal action $\frac{1}{2}$ and there is no information gain from delegation, the expected payoff thus would be $-\frac{1}{12}$. To focus on

the issue of interest and for the sake of simplicity, we assume that $\frac{1}{2} \geq b_s \geq 0$ (the case of $b_s < 0$ is perfectly symmetric), and there is no limitation on b_m.

Theorem 1 *The optimal implemented delegation set prescribes the alternatives available to the informed junior. Formally, it satisfies:*

$$Y_s = \begin{cases} [0, 1 - b_s], & \text{if } \frac{1}{2} \geq b_s > b_m \geq 0 \\ [0, 1 + 2b_m - b_s], & \text{if } b_s > 0 > b_m \text{ and } \Delta \in \left[0, \frac{1}{2}\right] \\ [2b_m - b_s, 1 - b_s], & \text{if } b_m > b_s > 0 \text{ and } |\Delta| \in \left[0, \frac{1}{2}\right] \\ \frac{1}{2}, & \text{otherwise} \end{cases} \qquad (2)$$

and the minister's expected utility is

$$EU_{DM}^{HD} = \begin{cases} (\frac{4}{3} b_s - 1) b_s^2, & \text{if } \frac{1}{2} \geq b_s > b_m \geq 0 \\ -b_s^2 + \frac{8}{3} b_m^3 - 4 b_m^2 b_s + \frac{4}{3} b_s^3, & \text{if } b_s > 0 > b_m \text{ and } \Delta \in \left[0, \frac{1}{2}\right] \\ -\frac{8}{3} b_m^3 + 4 b_s b_m^2 - b_s^2, & \text{if } b_m > b_s > 0 \text{ and } |\Delta| \in \left[0, \frac{1}{2}\right] \\ -\frac{1}{12}, & \text{otherwise} \end{cases}$$

$$(3)$$

The expected payoff to the senior officer is

$$EU_m^{HD} = \begin{cases} -\Delta^2 (1 - 2b_s) - \frac{2b_s}{3} \left(b_s^2 + 3b_m^2\right), & \text{if } \frac{1}{2} \geq b_s > b_m \geq 0 \\ -\Delta^2 + \frac{4}{3} \Delta^3, & \text{if } b_s > 0 > b_m \text{ and } \Delta \in \left[0, \frac{1}{2}\right] \\ \frac{\Delta^3}{3} - \Delta^2 (1 - 2b_m) - \frac{(b_s + b_m)^3}{3}, & \text{if } b_m > b_s > 0 \text{ and } |\Delta| \in \left[0, \frac{1}{2}\right] \\ -\frac{1}{12} - b_m^2, & \text{otherwise} \end{cases}$$

$$(4)$$

This theorem shows that the discrepancy of interest of the senior is irrelevant to the implementation of optimal delegation scheme as long as it lies between the minister and the junior. Otherwise, the span of discretionary authority of the junior, i.e., the implemented delegation set, would be increasing (decreasing) with respect to the bias of the senior if it's negative (positive). Moreover, $\frac{\partial EU_{DM}^{HD}}{\partial b_m} < 0$ if $b_m > b_s$, and $\frac{\partial EU_{DM}^{HD}}{\partial b_m} > 0$ if $b_m < 0$. Thus in general the more loyal the senior to the minister, the larger gain in delegation. Thus for the minister only the absolute difference in interest matters in selecting senior officers.

An intrigue question is given the conflict of interest of two officers, if the minister can reorganize the department, which one should be assigned to higher position? It differs from promotion decision in that it involves complete reassignment of jobs, instead of promote someone while leave the junior level unchanged. To deal with this question, we assume that both bureaucrats are of positive bias[3], i.e., $b_2 > b_1 > 0$. The minister thus needs to tradeoff between using the more biased junior 2, in which the information

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[3] When they are of the opposite bias, the delegation scheme may not even be chosen by the DM, see Section 4 for the discussion.

loss only occurs on the top, and using the less biased junior 1, where the
minister may gain information in high state on the expense of loss in low
state. We find out that the more biased agent will be assigned to the junior
position only if his bias is sufficiently far from the other agent.

Corollary 2 *The more biased officer 2 will be assigned to the junior position
if $b_2 > \frac{1+\sqrt{1+16b_1}}{8}$.*

Therefore, a moderately biased senior can help controlling the more bi-
ased junior, but the minister can also find out that it may be beneficial to
assign this moderately biased agent to the bottom line and promote the
more biased guy, in order to enlarge the range of implemented delegation
set. While the loyalty in senior position provides the minister with better
control of the informed party indirectly, the loyalty in the informed position
reduce the loss of control directly. The indirect gain in control due to loyalty
cannot compensate the direct loss if the other agent is not very biased.

3.2 Selecting the junior

We have studied the choice of the senior for the minister, given the bias of the
junior. It corresponds to the promotion policy in bureaucratic organization,
and we show that the more loyal bureaucrat should be placed into senior
position.

In reality, however, usually the minister cannot remove the senior offi-
cer. For example, in UK government the permanent undersecretary is the
non-political civil service head of a government department, they report and
advise the Secretary of State, and are answerable to Parliament. However,
the minister may have some voices in screening the entry-level (junior) bu-
reaucrat. In this subsection we explore the selection of the junior given the
preference of the senior and the minister.

We undertake some comparative statics about the expected payoff of
the minister. First, $\frac{\partial EU_{DM}^{HD}}{\partial b_s} \leq 0$ for almost all cases[4], which means that the
minister is harmed by the conflict of interest between the minister and the
informed junior. Second, there exists complementarity between the bias of
the junior and the senior ($\frac{\partial EU_{DM}^{HD2}}{\partial b_s \partial b_m} \geq 0$).

Hence to check the increasingly conservative senior bureaucrat, the min-
ister should either select the less radical one if all candidates are liberal,
or choose optimally conservative one[5] if all just differ in the degree of con-
servatism. But in general, the minister would like to appoint a compromise
junior ($b_m > b_s > 0$).

More interesting results can be obtained if the minister (DM) and the
senior (mediator) have joint control over the selection of junior (sender). To

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[4] If $b_m > b_s > 0$, then $\frac{\partial EU_{DM}^{HD}}{\partial b_s} \leq 0 \Leftrightarrow b_m^2 \leq \frac{b_s}{2}$. If $b_m < 0 < b_s$, then $\frac{\partial EU_{DM}^{HD}}{\partial b_s} \leq 0$
holds for any $b_s \in \left[0, \frac{1}{2}\right]$.

[5] As we derive in footnote 4, it should be $b_s = 2b_m^2$ if $b_m \leq \frac{1}{2}$

focus on issue of interest, we assume that $b_s, b_m \in \left(0, \frac{1}{2}\right)$, i.e., the bureaucrats have the same direction of bias, like conservatism, but differ in the extent. Therefore, the selection of junior will depend on the total expected welfare of the minister and the senior.

Suppose the expected payoff of the minister and the senior enter the total welfare equally. By adding (3) and (4) together we will have

$$W = \begin{cases} \frac{8}{3}b_s^3 - 2b_s^2 + 2b_sb_m - b_m^2 - 4b_s^2b_m, & \text{if } b_s \geq b_m \\ -\frac{4}{3}b_m^3 - 2b_s^2 + 2b_sb_m - b_m^2, & \text{if } b_m > b_s \end{cases} \tag{5}$$

This is a compromise choice between the preferred choice of the minister and that of the senior. To see this, note that if $b_m > b_s$, then $\frac{\partial EU_{DM}^{HD}}{\partial b_s} = 0$ if $b_s = 2b_m^2$. Moreover, $EU_{DM}^{HD}\left(b_s = 2b_m^2\right) > EU_{DM}^{HD}\left(b_s = b_m\right)$. Therefore the minister prefers to choose the junior with the intensity of conflict as $2b_m^2$. On the other hand, the senior's preferred choice is the junior with $b_s = b_m - 2b_m^2$. The analysis above is summarized in the following proposition.

Proposition 3 *The minister and the senior has different ideal junior. The junior that maximizes the joint welfare will be in exact middle position between the minister and the senior.*

The minister has to tradeoff the efficiency loss from the limitation in low state imposed by the senior, and the gain in more information in high state. When the senior bureaucrat is modest conservative, i.e., $b_m \leq \frac{1}{4}$, then the minister prefers to appoint a junior with the preference close to herself. When the senior bureaucrat is very conservative, i.e., $b_m > \frac{1}{4}$, for the minister the loss due to this extreme senior outweighs the gain in loyalty from the junior. This logic reverses for the senior. As the result of compromise, these two parties will reach an exactly middle junior.

3.3 Uncertainty about the preference

In real world it's usually that the top-level leader doesn't know the true preference of the bottom-level workers due to the limited information processing ability or lack of direct access. On the other hand, the middle-level manager may have more precise knowledge about the direct subordinates. This bounded rationality argument provides a rationale for hierarchy (Radner 1993, Bolton and Dewatripont 1994). In our leading example, the minister as an elected politician usually doesn't know the interest of those bottom-level junior bureaucrats, instead, the senior officer has better idea about the intensity of the conflict of interest of subordinates thanks to the relatively stable organization within a department.

We assume that the minister only knows b_m and the distribution of b_s, $F\left(b_s\right)$. To make the problem tractable, we assume that $b_s \sim U\left[0, \frac{1}{2}\right]$, thus the minister only knows the junior is conservative or liberal, but has no idea about the extent of bias. On the other hand, the senior knows b_s perfectly.

Because both agents are of the positive bias, the minister will only choose to ceiling Y_m. Using the logic leading to (2), we have that when the junior is more biased:

$$EU_{DM}\left(\overline{y}\right) = \begin{cases} -b_s^2\left(1 - 2b_s + 2b_m\right) + \frac{(2b_m - b_s)^3 - b_s^3}{3}, \text{ if } \frac{1}{2} > b_s > 1 + 2b_m - \overline{y} \\ -b_s^2\overline{y} + \frac{2}{3}b_s^3 + \frac{1}{3}\left(1 - \overline{y}\right)^3, \text{ if } \frac{1}{2} > 1 + 2b_m - \overline{y} > b_s \geq b_m \\ -\frac{(1 - \overline{y})^3}{3} - b_s^2\left(\overline{y} - 2b_m + b_s\right) - \frac{(2b_m - b_s)^3}{3}, \text{ if } b_m > b_s > 0 \end{cases}$$
$$(6)$$

The minister gains from the ceiling if the junior is more biased than the senior, since it restricts the senior's tendency to relegate more freedom in high state. However, the tight cap precludes possible beneficial adaptation in high state when the junior is like-minded. The optimal delegation scheme balances loss of control and gain in knowledge, albeit now the information is the knowledge about the intensity of preference misalignment. The precise ceiling depends on which scenario above is more likely to occur. Furthermore, the loyal senior enables her to have better control of the informed junior. In the limit case that $b_m = 0$, the senior is perfectly aligned to the minister and she can relegate him full control of action. We calculate the expected payoff to the minister under the uncertainty about the junior's bias, and found out that it's optimal for her to grant complete delegation set when the senior is not too biased[6]. Formally:

Proposition 4 *If the minister has uniform prior about the bias of the junior over the support $\left[0, \frac{1}{2}\right]$, then:*

1. *It's optimal to her to set $\overline{y}$ such as*
   $$\overline{y} = \begin{cases} 1, \text{ if } b_m < \frac{1}{4} \\ 1 - \frac{\sqrt{3}}{6}, \text{ if } b_m > \frac{1}{4} \end{cases}$$
2. *If the ignorant minister can directly delegate to the junior, she will choose $\overline{y} = 1 - \frac{\sqrt{3}}{6}$.*
3. *For large span of the bias of the senior, it's optimal for the minister to delegate to the senior, instead of delegating to the junior even if she has the opportunity.*

This result provides a rationale for the exclusive concentration on full delegation among researchers (Dessein 2002, Rush et al 2009, Ambrus et al 2010): when the minister is uncertain about the conflict of interest of the informed party, and the discrepancy of interest between the senior and her is not too large, it will be beneficial to delegate all decision right to the senior who has the relevant knowledge about the intensity of conflict.

Moreover, this provides an additional rationale for the emergence of hierarchy. We compare the expected payoff to the minister if she can delegate to the junior directly, though she still doesn't know the exact bias of the

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[6] The quantitative result is obtained by the specification of the prior distribution. However, the qualitative results still remain.

junior. It's shown that if the conflict of interest of the senior is not too large ($b_m < \frac{1}{5}$), then delegating to an informed senior will generate higher expected payoff to the minister than direct delegation. A slightly biased knowledgeable senior provides the minister with the better control of the informed party, thus the hierarchical structure itself exemplifies the tradeoff between the loss of control to the senior and gain in the knowledge of the senior. TThe asymmetric knowledge between the senior and the minister thus leads not only to complete delegation, but also the use of hierarchy to control informed agents.

4 Comparison with Hierarchical Communication

We have established the relationship between the performance of delegation and the preference of agents, and shown that it's ideal for the minister to appoint a loyal senior. In reality, however, usually the selection of the mediator is not made by the decision maker. For example, in the U.S. system of separate powers, the executive (the President) appoints the administrative agency managers, e.g., FDA, while the Congress dictates policy and oversees its implementation. In terms of our model, the decision maker (Congress) can choose neither the mediator (FDA) nor the informed sender (the pharmaceutical company). Alternatively, she would respond by varying the level of oversights.

In this section we cast delegation scheme into a more general environment and ask the specific question: if the minister cannot select any bureaucrats, under what condition the delegation scheme will be chosen? In particular, we compare hierarchical delegation with hierarchical communication given hierarchies and the preference of bureaucrats. This investigation involves job design in hierarchy: should the senior be given control, or just act as a gate-keeper in communication process? We find out that the inability to interact with informed party may reverse the conclusion in previous study that the minister is better off by delegating.

As Mitusch and Strausz (2005) note, the uninformed mediator can improve information transmission upon direct cheap talk by using mixed strategy equilibrium, i.e., mix or conceal some messages. The intuition is also explored by Blume et al (2007), in which noise in communication invalids the monotonicity condition of action with respect to message, thus the minister gains by relaxing incentive compatibility constraint of the junior, which outweighs the loss in information. GHPS (2009) further characterizes the best outcome attainable in any mechanism in the context of cheap talk, and show that it could be implemented by a neutral mediator who randomizes in each state between at most two actions. The highest payoff in hierarchical communication to the minister thus is

$$EU_{DM}^{HC} = -\frac{1}{3}b_s\left(1 - b_s\right)$$

Ivanov (2010) extends this result to the situation of strategic mediator and shows that by appointing a senior with properly opposite bias, the minister can still implement the optimal cheap talk outcome. Furthermore, the intermediately biased senior $(0 < b_m < b_s)$ could not improve efficiency upon direct talk since mixing messages is not in his interest.

Lemma 3 (Ivanov 2010) *For any $b_s \in [0, \frac{1}{2}]$, there exists a mediator with bias $b_m \in (-2b_s, 0]$ and an equilibrium in the game with this mediator that provides $EU_{DM}^{HC} = -\frac{1}{3}b_s\left(1 - b_s\right)$. However, if $b_m \in [0, b)$, the mediator communication could not improve upon direct talk.*

Thus we could compare the maximum efficiency in communication EU_{DM}^{HC} with the outcome of hierarchical delegation. Since $\frac{\partial EU_P^{HD}}{\partial b_m} \geq 0$ when $b_m < 0$, if there is a b'_m such that $EU_{DM}^{HD}\left(b'_m\right) = -\frac{1}{3}b_s\left(1 - b_s\right)$, then we could conclude that for any $b_m > b'_m$, hierarchical delegation strongly dominates mediator cheap talk in the sense it can achieve higher payoff than the maximal payoff attainable in mediator talk. The resulted b'_m turns out to be a nonlinear function of b_s, which is formally defined by the following equation:

$$-b_s^2\left(1 + 2b'_m\right) + \frac{\left(2b'_m - b_s\right)^3}{3} + \frac{5b_s^3}{3} = -\frac{1}{3}b_s\left(1 - b_s\right) \tag{7}$$

The higher dashed line in Figure 4 describes this indifference line.

Unfortunately, as Ambrus et al (2009) shows, there is non-monotonic relationship between the existence k-interval mixed equilibrium and the bias of senior. For example, though two-partition mixed equilibria requires that b_m is "sufficiently" far below zero, 3-partition mixed equilibria can exist when both b_s and b_m are close to 0. Hence there is no one-to-one mapping between the biases of agents and the best attainable outcome. This non-monotonicity in hierarchical communication limits complete characterization about the relative efficiency of two organization modes.

However, we still obtain the striking finding that informative communication may dominates delegation. To illustrate this, we compare the range of values of b_m for the existence of two-interval equilibrium in HC mode and meaningful HD mode (the minister would find out optimal to delegate more than one decision). Note that any meaningful HD requires the following inequality being satisfied:

$$-b_s^2\left(1 + 2b_m\right) + \frac{\left(2b_m - b_s\right)^3}{3} + \frac{5b_s^3}{3} \geq -\frac{1}{12} \tag{8}$$

Namely for the minister delegating more than one decision is better than taking ex ante optimal action.

Figure 4 demonstrates this comparison. The dashed lines represents (7) and (8), respectively. Thus the delegation is meaningful only if b_m lies above the lower dashed line. The trapezium ABCD specifies the range of values of b_m for which the two-partition equilibrium exists[7]. For slightly biased senior (b_m higher than the higher dashed curve OB), delegation strictly dominates mediator cheap talk in the sense that it generates higher expected pay-off than the best attainable under communication. For large biased senior ($b_m \leq -\frac{1}{4}$ but $\Delta \leq \frac{1}{2}$) and less biased junior (the lower triangle DEF), again delegation dominates. However, when the junior becomes more biased and the senior is only modestly biased, like those b_m lies in the shadow triangle BCE, communication would be informative and dominates any delegation scheme.
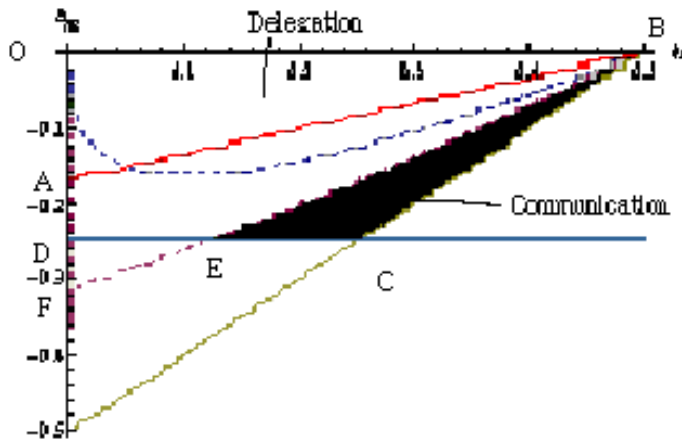

Figure 3. The comparison of expected payoff under HD and HC modes.

Therefore, if the two officers are of same direction of bias and given hierarchy, i.e., both conservative, then the minister should delegate the senior with limited discretion power. On the other hand, if the two bureaucrats are of opposite interest, i.e., conservative senior vs. radical liberal junior, in particular if the senior is slightly conservative but the junior is very radical, it's possible that communication could induce informative talk but delegation is trivial in that only one decision is relegated. The minister may keep control rights and restrict the role of the undersecretary to information processing, instead of delegate decision rights. The following numerical example exemplifies this claim:

Example 1 Suppose $b_s = \frac{1}{3}$, the upper-bound of communication efficiency is $-\frac{2}{27}$, which could be achieved by choosing $b_m = -\frac{1}{9}$. On the other hand,

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[7] It's defined by $0 \geq b_m \geq -\frac{1}{4}$ and $b_s - \frac{1}{2} \leq b_m \leq \frac{b_s}{3} - \frac{1}{6}$.

by (7), if $b_m \geq -0.089$, then delegation strongly dominates communication. Hence, for some range of the senior's bias, for instance, $b_m = -\frac{1}{9}$, communication generates higher expected payoff than delegation.

Therefore we reverse the central conclusion in Dessein (2002) regarding the efficiency of delegation, in which whenever there is informative communication in cheap talk, delegation dominates communication. The basic intuition can be understood using the tool of mechanism design: with commitment power, which is equivalent to delegation, the minister could do no worse than without (cheap talk). Hence the minister should engage in delegation instead of communication. However, we show that this result would not hold when the minister cannot access informed party. It's possible that for some range of bias there is gain in mediator talk but no meaningful delegation scheme.

Because the minister cannot access the junior, i.e., she cannot observe message s, she has to take the incentive of senior into account when making decision based on m. Moreover, any decision rule she commits to has to be in the best interest of senior. In other words, due to the fact that the senior controls information flow, there are only limited action rules available to the minister. When the minister finds out that under any available decision rules the loss of control is too large she may forgo commitment and engage in communication, in which the gain in keeping decision right outweighs the loss in information transmission. The minister is reluctant to commit not due to commitment cost or *ex post* temptation to renege, as previous works suggest. Instead, it's the inability to interact with the informed party directly. As consequence, the possible solution to this problem is not offering commitment device or reputation concerns. Instead, organization design, in particular the layers in organization, matters in solving commitment problem and providing proper incentives for real informed agent.

5 Related Literature

There is a large body of literature in organizational economics which address the benefits of hierarchy. Largely motivated by bounded rationality, the works by Radner (1993), Bolton and Dewatripont (1994), and Geankoplos and Milgrom (1991) are concerned with the role of hierarchy in facilitating information processing, and stress the information aggregation within vertical structure. Based on heterogeneity among agents, another related strand of literature since Garicano (2000) develops "knowledge-based" hierarchy. As complementary, we take hierarchy as given structural characteristic, and address the strategic behavior of agents, analyze the selection of agents and choice between communication and delegation. Therefore our chapter pays more attention to the issues in personal economics such as job design and hiring policy[8]. Moreover, our results that the hierarchy may arise as the

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[8] See Gibbons and Waldman (1999) for a accessible survey on this field.

result of the minister's uncertainty about the junior's personal interest is in accordance with the argument of limited information processing ability.

Tirole (1986) explicitly introduces supervisor into principal-agent relationship to study multiple-layer hierarchies. In his paper the supervisor holds private information about the type of agent, and the focus is the collusion between supervisor and agent. He establishes the equivalence between coalition-proof contract and giving ownership to supervisor, who subcontract with an agent further. We show that when monetary transfer is not feasible, which is common in many bureaucratic organization, the equivalence fails and subcontract cannot implement the optimal delegation scheme.

Based on CS model, Mitusch and Strausz (2005) and GHPS (2009) establish that by hiring a neutral mediator the DM could achieve optimal mechanism to extract information from informed agent. Ivanov (2009) and Ambrus (2009) show that this result is robust to strategic mediator for some range of parameters. On the other hand, Dessein (2002) and AM (2008) analyze the delegation decision based on the classical CS model, and demonstrate the dominance of delegation mechanism over cheap talk. We combine these two strands together to study delegation mechanism via a mediator.

A closely related paper is the recent work by Ambrus et al (2010), who compares the performance of closed rule and open rule in floor-committee-lobbyist hierarchy. In terms of our work, open rule is equivalent to communication, while closed rule is complete delegation to the mediator (committee). Though we ask the similar research questions on the role and choice of the mediator, we have quite different focus. Moreover, they stress full delegation, and they don't allow the mediator (committee) to further delegate decision right, i.e., commit to an action rule. Thus our results on optimal interval delegation is more general. Instead, we can endogenize both hierarchical delegation and complete delegation scheme.

We share with Ambrus and Egorov (2009) the same motivation on understanding the role of bureaucracy, though we address different aspect of bureaucracy (Weber, 1946). The current chapter highlights the structural features like hierarchy and network (strict subordination), instead of procedural paperwork and official activities in their paper.

6 Conclusion

The fact that within hierarchical organization, especially government, the span of discretionary authority decreases top down motivates our research on optimal interval delegation in hierarchy. This chapter contributes to literature by providing a complete characterization of the implemented interval delegation set, and establishing conditions for attaining efficiency in hierarchy. Moreover, we also endogenize the hierarchy structure and complete delegation as response to incomplete knowledge about the conflict of interest. The results that the optimal intermediary in delegation chain should

be moderately biased, and allowing transfer of authority benefits decision maker are intuitive. We also use this framework to show that the HRM practices within bureaucratic organization, i.e., job design, promotion, and hiring policy, are interrelated.

It worthwhile to note that in most parts we study the three-tier hierarchy and ignore the multiple subordinates tree structure, which is a more realistic feature of hierarchy. However, as long as hierarchy is formed based on the consideration beyond strategic information transmission, such as information processing cost (Radner, 1993), heterogenous knowledge (Garicano, 2000) or conflict over hiring and promotion decisions (Friebel and Raith, 2004), our results still hold in multiple subordination structure.

In this work we stress interval delegation, which is in widespread use and realistic in our budget approval example. However, for opposite biased or more biased senior, interval delegation may not be the optimal delegation scheme for the minister. Actually the optimal delegation may take the form of an interval plus a discrete point. We are working on the full charactrization of optimal delegation scheme.

7 Appendix

Available upon request

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