Delegation and Organizational Design*

Axel Gautier Dimitri Paolini †

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†IRES and UCL, Department of Economics. Place Montesquieu, 3. 1348 Louvain-la-Neuve. Belgium. gautier@ires.ucl.ac.be and paolini@ires.ucl.ac.be

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Abstract

This paper concentrates on the question of organizational design under asymmetric information. The design of the organization has two parts: first, communication channels between the members should be established and second, the tasks should be allocated to the party that performs it in the most efficient way. We show that if the decisions are delegated to the agents, the agent's decisions reveal the information they have to the principal. Delegation is then a mechanism to transfer information. Given that delegation is costly, the principal should decide how many decisions she delegates. In this paper, we show that delegation is only partial. The agents do not receive power over all decisions and some agents may receive power will the other will not even if they are identical.

JEL-Classification codes: D23, D82, L22

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1 Introduction

This paper studies the design of organizations under asymmetric information. We consider an organization composed of a principal and subordinate agents. The agents have information, valuable for the organization, that the principal does not have. The organization lasts for several periods and, at each period, one decision for each agent should be implemented. At first, the principal decides of the structure of the organization which governs the process of decision-making in following periods. The question of organizational design is then to choose who in the organization will be responsible for the choice of each decisions.

In a world in which contracts are complete, it would make no difference to the outcome to which party is allocated the right to take decisions, since the contract could specify the necessary actions that should be taken as a function of the relevant circumstances. The question becomes relevant only if we consider a world in which contracts are incomplete. Therefore, our model in incomplete contract model in which monetary transfers and communication between parties are prohibited.[1] The responsible of the organization specifies only who has the right to undertake a given action.

Two key features of the model are asymmetric information and externalities. We assume that there is an initial asymmetry of information between the principal and the agents: each agent possess a piece of private information that the principal does not have. Instead, the principal has some prior about their distributions. The informational parameters affect the preferred action of all the parties.

We suppose that the decision concerning one agent produces an externality that affects the other agent. The value of these externalities is common knowledge.[2] The presence of an intra-agents externality implies that the preferred project of the principal is not the preferred project of the agents. The principal cares about the welfare of all the agents, and hence takes the externality into account while the agents do not. The divergence of interests between the principal and the agents implies that there will be loss of control associated with delegation.

At the first stage of the game, the principal has to decide to delegate some power to the agents or to keep this power for herself.

In a system where the principal keeps all the power for herself, centralization, she can correct the distortion coming from the externalities but she takes what we call "blind decisions", decisions that are not contingent on the agents' private information.

In a system where the principal delegates all the power to the agents (decentralization) if, on the one side, the agents are better informed, on the other side they do not take into account the impact of their decisions on the welfare of the other agents.[3]

In between these two systems, centralization and decentralization, there are other organizations in which decision rights are split between the agents and the principal.[4] In these partially decentralized systems, a new issue arises: the possibility of transferring information from the

[1]The literature on incomplete contracts has typically focused on the question of which party in a collective organization should have the right to undertake certain actions as a function of ownership pattern, authority, institutional agreements, power. See Grossman and Hart (1986), Aghion and Tirole (1997) and Tirole (1999).

[2]So asymmetry of information is only one-dimensional. Armstrong (1994) deals with the case of delegation to an agent when the principal ignores the agent's preferences and a state parameter.

[3]The trade-off between externality correction (or policy coordination) under centralization and better informed decision makers under decentralization is at the root of many papers on delegation (Melumad Mookherjee and Reichelstein (1992), Seabright (1996))

[4]Like in Aghion and Tirole (1997) when the principal could keep 'formal' authority and delegate 'real' authority to the agent.

agent to the principal. By observing the agents' decisions, the principal can improve her prior about the private information and use this new information to take subsequent decisions (and, then correct the externalities). Information transfers play a central role in all the partially decentralized organizations.[5,6]

A similar problem is found in Riordan and Sappington (1987). It studies the problem of delegation in a model in which there are two decisions to be taken, but where the first one is always done by the agent. After the first stage, the principal acquires information about the costs conditions and decide to perform the second stage herself if the correlation between the costs conditions at the two periods is sufficiently high.

Our first result is to show that transferring control rights to the agents is a way to transfer information from the agents to the principal. Delegation is a tool for the principal to extract the agents' information. When an agent takes a decision, his decision signals the information he has in hands to the principal.

The optimal organization has the following features: first, if there is delegation, delegation is only partial. The principal gives control rights over some decisions to the agents and retains control over others. Second, the main goal of partial delegation is to extract agents superior information. Following that, when the principal delegates, she only delegates the first period decisions in order to use the information acquired for the subsequent period decisions. Last, the number of delegated decisions depends on the quality of the signal produced and on the cost of producing signal. The quality of the signal depends on the correlation between the information of the agents. The cost of producing a signal, which is the cost of delegating decisions, depends on the externality exerted by the agent that receives the control over decisions. Following that, symmetric agents could be treated differently in the organization, if one signal, obtained by the delegation of a decision to one agent, brings enough information to the principal. In these cases, the agent selected as delegate is the agent that produces the signal at the lower cost. i.e. the agent that exerts the smallest externality.

We also consider the case in which the agents participate in the design of the organization. We suppose that the agents can refuse the organization proposed by the principal, and if it is refused, the organization does not shut down but, instead, the principal centralizes all the decisions. Participation of the agents imposes additional constraints on the choice of the organization. We show that the agent that suffers the largest externality prefers less delegation than what the principal offers, while the agent that suffers the smallest externality prefers more delegation. The resulting organization will either be the default point (centralization) or imply more power to the agents (than what is needed for information transfer) to force the acceptance of the agents.

To illustrate the model, suppose that the principal is the CEO of a multi-product firms and that the agents are the product managers. Suppose further that the agents have private information about their respective markets. If product policies (pricing, quality, ...) are delegated to managers, they will maximize the value of their divisions, ignoring the consequences of their choice on other divisions. These externality effects could be quite high in the case of substitute products, where lower prices on one market could decrease the profit in other markets, or in the case of compatibility standard between the two products. But, if the CEO coordinates all the policies, she has no access to the information of the agents. Coordination is done at the cost of having a non-informed decision maker. In this context, mechanisms in which decisions

[5] There is also a transfer of information under decentralization but the principal has no possibility of using this information as all decisions are taken by the agents.

[6] We show that in the absence of information transfers in the partially decentralized organizations, all these organizations are dominated either by centralization or decentralization.

are partially delegated could increase the firm value. They have the advantage of transferring information to the CEO and allow coordination of policies once information is revealed. The question then, is to choose how much discretion the CEO should leave to the managers. Giving power has cost in term of policy coordination while retaining too much power may not bring enough information.

An other potential application is in the study of the federalism system of a country. We can interpret the principal like the central government, and the agents like regions, where the information parameter is the regional preferences over policies.

To study the federalist choice, the literature has focused on disparities in the regional preferences, economies of scale in the production of a local public good, on the magnitude of externalities and spillover effects and on the consequences of distortionary local taxation.[7]

Previous works on decentralization have stressed the advantages of policy coordination when regions exert externality on each other (Oates, 1972) or the advantages of having diversified policies across regions when the citizens can shop around and locate in the agent with the policy they like the most (Tiebout, 1956).

Following Seabright (1996), many authors (including this paper) study the problem of decentralization in a country where there are inter-regional externalities and asymmetric information. In Klibanoff and Poitevin (1997), for example, each agent is privately informed of the benefits he gets from the project. In a centralized setting a benevolent, but uninformed, central authority can impose any project size to the agents. Under decentralization, agents bargain to determine the project size.[8]

Our article follow the same line of these articles. It studies the question of costs and benefits of decentralization when policies have to be implemented in different regions. Differently from the rest of the literature, we go beyond the simple trade-off between externalities correction under centralization and informed decision under decentralization and we show that information transfers are crucial in the choice of the federal system.

The paper is organized as follows: in the next section, we present the model. In section 3, we describe the decisions taken by the agents and the principal under all possible organizations. In section 4, we study the optimal organization. In section 5, we extend the model to take the participation of the agents into account. We conclude in section 6.

2 Model

We consider an organization with a principal and two agents. The organization has to take a sequence of two decisions. A sequence is important for the question of information transfer. We model the sequence in the following way: there are two periods and at each period two decisions should be implemented, one concerning agent A and one concerning agent B. We call d_i^l, $i = 1, 2$, $l = A, B$, the decision taken at period i for agent l. The decisions are chosen either by the principal or by the agents. The allocation of power is written in the organization structure (constitution).

2.1 Timing of events

The timing of the game is represented by the following sequence of events:

[7] See the survey by Oates (1991).

[8] See also Ellingsen (1998).

Stage 1: design of the organization

- The principal designs the organization.
- It specifies who is in charge of decisions d_1^l and d_2^l, $l = A, B$.

Stage 2: decisions

- The agents acquire some private information.
- The first decisions d_1^l are taken (and observed).
- The second decisions d_2^l are taken.
- Payoffs are collected.

2.2 Design of the organization

At stage 1, the principal writes down an organizational design that allocates decision right over decisions d_1^l and d_2^l either to the agents or to herself. The organizational design is viewed as an incomplete contract: decisions rights are allocated but the organizational design cannot constraint the choice of the decisions. We also assume that monetary transfers between the principal and the agents or between agents are prohibited.

If we do not consider organization in which decision d_i^A is delegated to agent B and vice-versa, we have 16 possible organization structures:

	Agent A		Agent B	
	d_1^A	d_2^A	d_1^B	d_2^B
1.	c	c	c	c
2.	d	d	d	d
3.	d	c	d	c
4.	c	d	c	d
5.	d	c	c	c
6.	c	c	d	c
7.	c	d	c	c
8.	c	c	c	d
9.	c	d	d	d
10.	d	c	d	d
11.	d	d	c	d
12.	d	d	d	c
13.	d	c	c	d
14.	c	d	d	c
15.	d	d	c	c
16.	c	c	d	d

c = the decision is taken by the principal
d = the decision is taken by the agent

Table 1: possible organizations

2.3 Decision stage

At the decision stage, decisions are taken according to the organizational design. As we consider an incomplete contract model, the parties in charge of the decisions have complete discretion in their choices.

An important feature of the decision stage is asymmetric information between the principal and the agents.

2.3.1 Environmental parameter

We suppose that each agent has a piece of information that the principal does not have. This information is valuable for the organization as it affects the preferred projects of the organization's members.

The information of the agents is represented by a parameter θ. The value of θ determines the preferred projects of the agents and the principal. We could interpret indifferently θ as either economic conditions that affect the cost of implementing a given project or as a parameter affecting the preferences of the agents over projects.

Each agent has one information θ^A and θ^B. Nevertheless, we suppose that each θ is drawn out of a common set $\Theta = \{\theta_1, \theta_2\}$ with $\theta_1 < \theta_2$ and we call $\Delta\theta$ the difference $\theta_2 - \theta_1$.

The agents know the value of θ while the principal only knows the prior distribution. The distribution of (θ^A, θ^B) is represented by a joint probability distribution over $\Theta \times \Theta$. The joint distribution of types on the set $\Theta \times \Theta$ is $\{v_{11}, v_{12}, v_{21}, v_{22}\}$ where $v_{ij} = \mathit{proba}(\theta^A = \theta_i, \theta^B = \theta_j)$. Correlation is not perfect if v_{12} and v_{21} differs from zero.[9]

2.3.2 Decisions

The choice of a decision (d_i^l) represents the choice of a project implemented by the organization. The project differs only in one dimension. We suppose that there is a continuum of possible policies $]0, +\infty)$. In a multi-products firm, the decisions represent the price of each product.

2.3.3 Welfare functions

The agents and the principal have one preferred decision which depends on the informational parameter.[10] Their utility is a quadratic function of the distance between the preferred decision and the actual decision. In addition to this, each agent exerts an externality on the other. This means that the decision of agent A affects the utility of agent B and vice-versa.

More specifically we assume that the agents' preferences over decisions are described by the following utility functions:

$$\begin{aligned}
U^A &= \alpha^A d_1^A - \frac{(\theta^A - d_1^A)^2}{2} + \alpha^A d_2^A - \frac{(\theta^A - d_2^A)^2}{2} - \gamma(d_1^B + d_2^B) \\
U^B &= \alpha^B d_1^B - \frac{(\theta^B - d_1^B)^2}{2} + \alpha^B d_2^B - \frac{(\theta^B - d_2^B)^2}{2} - \xi(d_1^A + d_2^A)
\end{aligned}$$

To each decision is associated a linear benefit and quadratic cost. The cost being function

[9] Except the case of perfect negative correlation when $v_{11} = 0 = v_{22}$.

[10] The preferred project d_1 is the same as the preferred project d_2. We assume that the projects have the same importance (for example d_1 and d_2 are the same decisions taken at two different times).

of θ. Linear benefits and quadratic costs imply that the utility reaches a unique maximum for $d_i^l = \alpha^l + \theta$, $i = 1, 2$, $l = A, B$ which is agent's preferred project.

The externality[11] exerted by one agent on the other is linear and measured by the parameters γ and ξ. We make the following assumption:

Assumption 1 $\gamma^2 \geq \xi^2$

Having an agent that exerts a larger externality than the other (agent B under this assumption) affects the organizational choice and particularly the choice of one delegate under partial delegation.

The aim of the principal is to maximize the total welfare which is the sum of the agents' utility:

$$U^P = U^A + U^B$$

2.3.4 First best

Under full information, the principal would implement the following decisions that maximize total welfare:

$$d_1^A(\theta^A) = d_2^A(\theta^A) = \alpha^A + \theta^A - \gamma \quad (1)$$

$$d_1^B(\theta^B) = d_2^B(\theta^B) = \alpha^B + \theta^B - \xi \quad (2)$$

The selected organizational design by the principal will be the one that gives the highest welfare, the one for which the decisions are closest to the first best.

Before going to the choice of the optimal organization, we describe in the next section the decisions of the principal and the agents under the 16 possible organizational structures.

3 Decisions of the principal and the agents

At the decision stage, decisions are taken according to the organizational design. The principal decisions depend on the information she has on the parameters θ. In an incomplete contract setting, where communication is not feasible, the only information the principal could have come from the observation of the decisions delegated to the agents.

3.1 Decisions of the principal

Suppose, for a while, that the decisions of the agents perfectly signal their information to the principal (we will prove that it is indeed the case in proposition 1). From this point of view, delegating decisions is a way to transfer information from the agents to the principal. If she has delegated no decisions (centralization), the principal receives no information.[12] If the principal delegates d_1^l to both agents, she has two pieces of information while if she has delegated only d_1^l to agent l, the principal has one piece of information. We analyze in turn these three cases.

[11] That could be positive or negative.

[12] It would also be the case if the principal delegates but the agents pool on their decisions. In this case, the observation of the agents' decisions does not increase the information of the principal.

3.1.1 The Principal has received no signal

If the principal has no signal, she bases her decisions on the expected value of θ ($E\theta$) rather than on its true value. But the principal internalizes the externalities imposed by one agent to the other. The decisions that maximize uninformed principal's welfare are:

$$d_1^A = d_2^A = \alpha^A + (v_{11} + v_{21})\theta_1^A + (v_{21} + v_{22})\theta_2^A - \xi \tag{3}$$

$$d_1^B = d_1^B = \alpha^B + (v_{11} + v_{12})\theta_1^B + (v_{12} + v_{22})\theta_2^B - \gamma \tag{4}$$

3.1.2 The Principal has received two signals

When the principal has a signal over both states of the world, she will take the first best decisions (given by equations 1 and 2) for both agents. With two pieces of information, the principal implements the first best in period 2.

3.1.3 The Principal has received one signal

If the principal delegates d_1^l to agent l, and if d_1^l signals θ^l to the principal, the principal becomes informed about θ^l but also improves her information about θ^k, $k \neq l$ if there is correlation between the information.

With one signal obtained by delegating d_1^l, the principal implements the first best in period 2 for agent l and bases her decision d_2^k on a better information than the prior distribution of θ^k.

For example, if the principal delegates just d_1^A to agent A, she becomes informed about θ^A. She does not become informed about θ^B but improves the prior distribution of θ^B. The posterior distribution of θ^B given that the principal has observed $d_1^A(\theta)$ is:

$\mu(\theta^B = \theta_1 \mid \theta^A = \theta_1) =$	$\frac{v_{11}}{v_{11}+v_{12}}$
$\mu(\theta^B = \theta_2 \mid \theta^A = \theta_1) =$	$\frac{v_{12}}{v_{11}+v_{12}}$
$\mu(\theta^B = \theta_1 \mid \theta^A = \theta_2) =$	$\frac{v_{21}}{v_{21}+v_{22}}$
$\mu(\theta^B = \theta_2 \mid \theta^A = \theta_2) =$	$\frac{v_{22}}{v_{21}+v_{22}}$

Table 2: Posterior distribution of θ^B after receiving a perfect signal over θ^A.

And hence, with one signal received from agent A, the principal takes the decisions d_2 given by:

$$d_2^A(\theta) = \alpha^A + \theta - \xi \tag{5}$$

$$d_2^B(.|\theta^A = \theta_1) = \alpha^B + \frac{v_{11}}{v_{11} + v_{12}}\theta_1 + \frac{v_{12}}{v_{11} + v_{12}}\theta_2 - \gamma. \tag{6}$$

$$d_2^B(.|\theta^A = \theta_2) = \alpha^B + \frac{v_{21}}{v_{21} + v_{22}}\theta_1 + \frac{v_{22}}{v_{21} + v_{22}}\theta_2 - \gamma. \tag{7}$$

With one signal received from agent A, the principal implements the decision d_2^A that corresponds to the first best, and a decision d_2^B closer to the first best than an non-informed principal (if there is correlation between the θs). And the decision d_2^B is closer to the first best, the higher is the correlation between the two parameters θ^A and θ^B. In the limit case of perfect correlation ($\theta^A = \theta^B$), one signal is enough to implement the first best in period 2.

3.2 Agents decisions

Now we analyze the choice of the agents when they receive control rights. If the agents take a decision that differs when θ differs, the principal can acquire information about their private information. If, on the contrary, they take the same decision whatever θ, the principal learns nothing by observing agents decisions. When the agents choose a decision, they also choose which information they want to transfer to the principal.

3.2.1 The agent l has control over d_2^l

Consider first the cases in which the agent has control right over the decision d_2. As the game will end after the choice of d_2, the agent will select his preferred project:

$$d_2^l(\theta^l) = \alpha^l + \theta^l \tag{8}$$

3.2.2 The agent l has control over d_1^l

Now consider the cases in which the agent has control right over d_1. Two situations should be distinguished: those in which the information transferred by the agent could be used by the principal and those in which information transfer plays no role.

Information transfer matters only if the principal could use the information to take subsequent decisions. This is the case when d_1 is delegated to one or two agents and there is some d_2 chosen by the principal.[13]

In all the other cases, even if the principal learns something by observing a decision taken by the agent, she has no possibility to use it. When information transfer does not matter, the agents will therefore select the decisions that corresponds to their preferred projects:

$$d_1^l(\theta^l) = \alpha^l + \theta^l \tag{9}$$

In all these cases, where there is no issue of transferring information, delegating a decision already has advantages: the decision taken by the agent is based on the true value of θ rather than on its expected value, but delegation is also costly because the externality is not taken into account by the person in charge of the decision (this is also the case when d_2 is delegated).

Now we turn to the organization structures where information transfer matters. When one agent decides in the first period and the principal has some power in period 2, he anticipates that he could transfer information to the principal with his decision, and he will make a strategic decision that maximizes his welfare in both periods.

The game played by the agent and the principal is a signalling game, where the choice of d_1^l is used by the principal to extract information. As equilibrium concept we use the Bayesian-Nash equilibrium and we apply the intuitive criterion (Cho and Kreps, 1987) to refine the set of equilibria.

The following proposition constitutes a key element when we deal with delegation of a decision.

Proposition 1 *Under delegation of d_1^l, the only equilibrium that survives the intuitive criterion is the least costly separating equilibrium.*

[13]This is the case in organizations 3, 5, 6, 10, 12, 13, 14, 15 and 16.

Proof. See appendix A ■

The reasoning behind the proof of proposition 1 is the following. Consider a pooling equilibrium in which an agent selects the same decision whatever his private information. The fact that both types select the same decision implies that, if the principal is in charge of d_2, she will not be informed[14], and hence the decisions will be those of an uninformed principal. And this implies a utility loss for the agent in state θ_2 (in the case $\gamma, \xi > 0$). We apply the intuitive criterion to show that the agent in state θ_2 could deviate from the pooling decision to another decision that signals his type. The type of agent that suffers from pooling can switch to another decision and thereby signal his type. And hence, no pooling equilibria survive the intuitive criterion.

Applied to the separating equilibria, the intuitive criterion selects as sole surviving equilibrium, the least costly separating equilibrium.

Proposition 1 implies that delegation of d_1 is a way for the principal to acquire information.[15]

To simplify the analysis, we make the following hypothesis:

Assumption 2 $\Delta\theta^2 \geq \gamma^2$

This assumption implies that the least costly separating equilibrium selected by the intuitive criterion is:

$$d_1^l(\theta) = \alpha^l + \theta \tag{10}$$

In the signalling game literature, this type of equilibrium is called free lunch signals equilibrium when selecting his preferred decision is enough for the agent to signal his type.[16]

We could summarize the previous discussion by establishing that under assumption 2, when the agents receive control right, they will select their preferred project, and this choice reveals their information to the principal.

4 Optimal organization

Delegating decisions has advantages as well as costs. If the principal delegates a decision to one of the agents, this decision is taken by an informed party, but the agent does not take the externality he exerts into account. Moreover, by observing the decision taken by the agent, the principal gets one piece of information and could use it if she has to take other decisions. The decision to delegate or not will be based on a trade-off between the value of information and the cost linked to the externality.

4.1 Perfect correlation

To start with the problem of the optimal organization, we will assume perfect correlation between the preferences of the two agents.

Assumption 3 $v_{12} = v_{21} = 0$

[14]Or imperfectly informed if d_1 was also delegated to the other agent and that decision signals the other agent's information.

[15]If it was not the case, the principal is better off if she keeps control right over all decisions, as she could take the externality into account. If the principal anticipates that the agents will not transfer information, there will be no delegation at all in these cases.

[16]Indeed, when assumption 2 is not satisfied, the principal prefers centralization to delegation (see after propositions 2 and 3)

The distribution of types is then represented by probabilities v_1 and $v_2 = 1 - v_1$, which are the probability that $\theta = \theta_1$ and $\theta = \theta_2$.

In the case of perfect correlation, one signal is enough for the principal to be informed about the preferences of both agents. And only one piece of information is necessary to implement the first best decisions for both agents in period 2. If we just concentrate on the problem of information transfer, there is no need to duplicate the production of signals by delegating more than one decision.

As both agents produce signals of the same quality, the principal should delegate the decision to the agent that produces the signal at the lowest possible cost. The cost of producing a signal is, for the principal, the fact that, when a decision is delegated, the agent does not take the externality into account. The cost of producing one signal is then the cost of not taking into account the externality.[17] And hence, the signal is produced at the lowest cost if the decision is delegated to the agent that exerts the smallest externality (agent A if $\gamma \geq \xi$).

But if the principal delegates just d_1^A to agent A, only three decisions are taken on the basis of the true information, one decision, d_1^B, is still taken by a non informed principal. While if the principal delegates the first decision to both agents, all the decisions are taken by an informed party but the externality is not taken into account in period one. And hence, the decision to delegate a second decision depends on the trade off between the value of having an informed decision maker and the cost of having no externality correction for that decision. For this reason, delegating the first decision to both agents may still be optimal even if the second signal is useless.

From the previous discussion, it becomes clear that there are only three organizations[18] worth to be considered: centralization, delegation of d_1^A to agent A and delegation of d_1^A and d_1^B to A and B.

Under perfect correlation, the optimal organization is given in the following proposition and represented hereafter in figure 1.

Proposition 2 *The optimal organization is: centralization for* $v_1 v_2 \Delta\theta^2 < \frac{\xi^2}{3}$*, delegation of* d_1^A *to agent A for* $v_1 v_2 \Delta\theta^2 \in \left[\frac{\xi^2}{3}, \gamma^2\right]$*, and delegation of* d_1^A *and* d_1^B *to agent A and B for* $v_1 v_2 \Delta\theta^2 > \gamma^2$

Proof. See appendix B ■

Figure 1: Optimal organization under perfect correlation.

In a technical point of view, proposition 2 is easy to understand: when a decision is based on the expected value of θ rather than on its true value, the welfare is reduced by $v_1 v_2 \Delta\theta^2$, but when a decision is corrected for the externality, the welfare is increased by ξ^2 or γ^2. If we compare delegation of d_1^A and centralization, three decisions are based on the true value of θ (all but d_1^B) but the externality for B is not corrected because agent A selects his preferred decision

[17] When the externality is not taken into account for one decision, the utility of the principal is reduced (compared to the first best) by ξ^2 or γ^2.

[18] In the case where $\gamma = \xi$, we have also to consider delegation of d_1^B to agent B.

d_1^A. Delegating d_1^A dominates centralization if: $3v_1v_2\Delta\theta^2 \geq \xi^2$. When we compare delegation of d_1^A and delegation of d_1^A and d_1^B, there is one more decision is based on θ rather than $E\theta$ but the externality is not corrected for d_1^B. hence, delegation of d_1^A only is optimal if: $v_1v_2\Delta\theta^2 \leq \gamma^2$.

An important consequence of proposition 2, is that symmetric agents will be treated asymmetrically within the organization. The principal will select one delegate that will be responsible for the production of the signal and keeps control of the decisions concerning the other agents.[19] The delegate selected by the principal will be the agent that exerts the smallest externalities on the others.[20] The delegate is the agent that has the preferences closest to those of the principal. Following this result, delegation is limited within organizations. There is only one agent that receives control rights, and delegation is limited to first period decisions. Delegation is limited because a major features of delegation is signal production.[21] The optimal organization is the organization that transfers information at the lowest possible cost. The possible duplication of signal, when it is optimal to delegate d_1 to both agents, is due to the fact that the production of a second signal by agent B, signal that is useless in term of information transfer, may make the decision d_1^B closest to the first best than in the absence of it. This case appears when information has a great value ($\Delta\theta$ is large). The delegation of a second decision depends on a simple trade-off between the benefit of an informed decision maker and the value of the externality, without considering any benefits linked to information transfer.

Now we turn to the case of imperfect correlation between the preferences of the agents to check the robustness of this result.

4.2 Imperfect correlation

When correlation is not perfect, the distribution of preferences is given by a joint distribution $\{v_{11}, v_{12}, v_{21}, v_{22}\}$ over $\Theta \times \Theta$. We will measure correlation by a parameter $\rho = |v_{11}v_{22} - v_{12}v_{21}|$. To simplify expressions we will assume that: $v_{11} = v_{22} = v_{ii}$ and $v_{12} = v_{21} = v_{ij}$. Our correlation measures can be rewritten as: $\rho = |v_{ii}^2 - (\frac{1}{2} - v_{ii})^2| = |v_{ii} - \frac{1}{4}|$. The correlation parameter ρ takes value in between 0 (no-correlation) and $\frac{1}{4}$ (perfect correlation).

With imperfect correlation, one piece of information is not enough to implement the first best decision for both agents in period 2. By delegating just d_1^l, the principal only revises her prior about θ^k. The quality of the signal produced by the agent when one decision is delegated depends on the degree of correlation. When correlation is high, the decision d_2^k implemented by the principal after she had observed d_1^l is close to the first best, while when ρ is small, the decision is close to the decision of an uninformed principal. In the two agents case, the quality of the signal does not depend on the choice of the delegate.[22] And hence, if the principal prefers to have only one piece of information, she will delegate d_1 to the agent that produce the signal at the lowest cost.

To implement the first best in period two, the principal needs two pieces of information i.e delegate the first decision to both agents. When the principal duplicates the production of signals, there is now a benefit in term of information transfer. The need of two signals rather

[19] This result extends to organizations with N agents.

[20] In the case of perfectly symmetric agents ($\gamma = \xi$), A or B could be chosen indifferently as delegate.

[21] In the absence of information transfer, there are no benefits associated with delegation.

[22] The main difference between this framework and the $N > 2$ agents case is that with two agents, both are as able to produce a signal of a given quality and hence, when the principal delegates, she selects the delegate that produce the signal at the lowest cost. In the N agents framework, some agents may have a higher ability to produce signal. Those agents not necessary be the agents that produce the signal at the lowest cost. Therefore, the choice of delegate(s) depends on their ability to produce signal, and the signal production cost (externality).

than one will depends on the quality of the signal (ρ).

When the principal has no pieces of information (centralization) or two pieces of information (delegation of d_1 to both agents), correlation plays no role and the decisions are identical whatever the value of ρ. Correlation only matters when the principal has only one piece of information (delegation of d_1^A or d_1^B).

As in the case of perfect correlation, there are only three organizations that worths to be considered: centralization, delegation of d_1^A and delegation of d_1^A and d_1^B. We already established in appendix B that centralization dominates delegation of d_1^A and d_1^B if: $\Delta\theta^2 \leq \gamma^2 + \xi^2$.

By comparing the principal's welfare in the two situations, we can show that delegation of d_1^A dominates centralization if:

$$(1 + 8\rho^2)\Delta\theta^2 \geq 2\xi^2$$

and delegation of d_1^A dominates delegation of d_1 to both agents if:

$$2\gamma^2 \geq (1 - 8\rho^2)\Delta\theta^2$$

And the following proposition is immediate:

Proposition 3 *The optimal organization is: centralization for $\Delta\theta^2 \leq \frac{2\xi^2}{1+8\rho^2}$, delegation of d_1^A to agent A for $\Delta\theta^2 \in [\frac{2\xi^2}{1+8\rho^2}, \frac{2\gamma^2}{1-8\rho^2}]$ and delegation of d_1^A and d_1^B to A and B for $\Delta\theta^2 \geq \frac{2\gamma^2}{1-8\rho^2}$.*

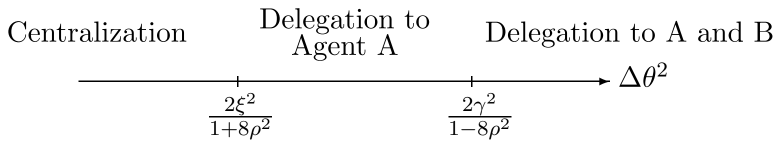

Figure 2: Optimal organization under imperfect correlation.

Proposition 3 looks similar to proposition 2. The main difference is that the parameter space where the optimal organization is to delegate just d_1^A now depends on the quality of the signal send by the agent. When correlation decreases, the quality of the signal send by agent A decreases and hence, delegating just one decision brings a lower utility. This fact is summarized in the corollary:

Corollary 1 *When ρ decreases, the parameter space in which delegating just d_1^A is the optimal organization decreases.*

Proof. $\frac{\partial}{\partial\rho}\frac{2\xi^2}{1+8\rho^2} < 0$ and $\frac{\partial}{\partial\rho}\frac{2\gamma^2}{1-8\rho^2} > 0$ ■

Moreover, $\frac{\xi^2}{1+8\rho^2}$ is always smaller than $\frac{\gamma^2}{1-8\rho^2}$, and so there is always a parameter space in which delegating d_1^A is optimal except in the limit case where $\rho = 0$ and $\gamma = \xi$.

Comparative static results are represented in figure 3:

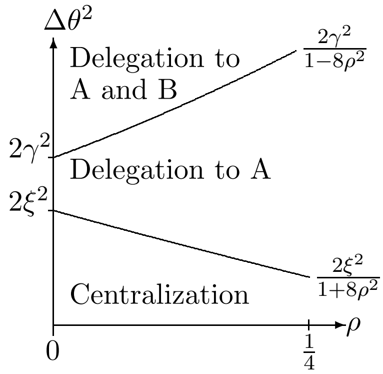

Figure 3: Optimal organization under imperfect correlation.

The results of proposition 2 seem to be robust. When one considers that the agents do not have the same information, and hence cannot transmit two information with one signal, delegation remains limited to first period decisions. The choice of delegating d_1 to one or two agents depends on the importance of the externality and the quality of the signal.

5 Agents participation in the design of the organization

So far, we have only discussed the principal's preferred organization. In this section, we discuss the cases in which the agents participate, together with the principal, in the choice of the organizational structure. In many organizations, the design of the organization is not imposed by one party but results from an agreement between organization's members with conflicting interests.[23] The choice and the efficiency of an organization depends on who decides the repartition of control rights.[24]

Participation of the agents in the design of the organization can be done in a variety of ways. Here we will assume that the principal still design the organization, but to be implemented, the proposed organization should be accepted by both agents. The proposed organization will be rejected if one of the agents rejects it.[25]

If one agent refuses the principal's proposal, the proposed organization is not applied, and the default point is centralization.[26] The agents will accept the organization proposed by the principal if their utility is at least as big as in the centralization case.

Another important point is that the agents accept or refuse the organization before they learn the value of θ. For Aghion and Bolton (1992) and Laffont (1999), the allocation of power in the constitution is done without knowing the conditions under which decisions will be taken. We make a similar hypothesis an consider that the design of the organization takes place under symmetric but incomplete information. And hence, the principal cannot learn anything by observing the acceptance of the agents[27] and the only signal the principal could have come from delegation of d_1 to agent(s).

When agents participate in the design of the organization, the first stage of the game is modified in the following way:

Stage 1: design of the organization

- The principal designs the organization.
- It specifies who is in charge of decisions d_1^l and d_2^l, $l = A, B$.

[23]Regions in the choice of a constitution (Alesina and Spolaore (1997)), unions in the case of firms.

[24]In Alesina and Spolaore, there is too much decentralization (too many countries) when the countries have the power to determine their size.

[25]The unanimity rule necessary could be justified by the strong interdependence between the decisions of agents A and B. In the choice of the optimal organization, we cannot separate the choice to delegate decision(s) to A and to B. For example delegating just d_1^A is not equivalent for agent B to centralization, as the decisions d^A differs in the two organizational modes. If the organization should be accepted with a simple majority (one agent and the principal or the two agents), there are no cases in which the principal's proposed organization described in proposition 3 is refused.

[26]Assuming that the default point is centralization is convenient to study the conditions that leads to the decentralization of a (previously) centralized organization.

[27]There is no learning by refusal as in Laffont and Martimort (1997).

- The agents accept or reject the proposed organization.

  The organization is accepted if there is unanimity.

  If it is rejected, centralization is applied.

In proposition 3 we have shown that when the principal delegates, she delegates either d_1^A or d_1^A and d_1^B. The following lemmas describe when these two organizations are accepted by the agents.

Lemma 1 *Agent A always accepts delegation of* d_1^A.
Agent A accepts delegation of d_1^A *and* d_1^B *only if:*

$$\Delta\theta^2 \geq 4\gamma^2 - 2\xi^2$$

Proof. See appendix C ■

Compared to centralization, agent A always prefers delegation of d_1^A. But if in addition, the principal also delegates d_1^B to agent B, this is refused by agent A if the externality he suffers from agent B is large. The principal would like to delegate d_1 to both agents if $\Delta\theta^2 \geq \frac{2\gamma^2}{1-8\rho^2}$. But as $\frac{2\gamma^2}{1-8\rho^2}$ is smaller than $4\gamma^2 - 2\xi^2$ whatever ρ[28], the principal could not implement delegation of d_1^A and d_1^B when $\Delta\theta^2 \in [\frac{\gamma^2}{1-8\rho^2}, 4\gamma^2 - 2\xi^2]$. This case is represented in figure 4.

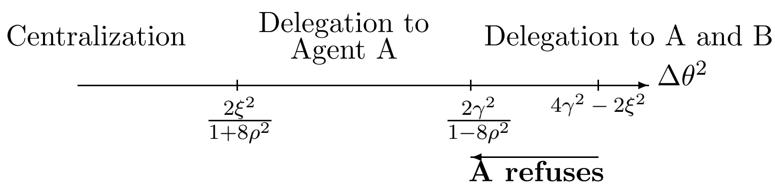

Figure 4 : Optimal organization refused by agent A

Lemma 2 *Agent B accepts delegation of* d_1^A *only if:*

$$\Delta\theta^2 \geq \frac{\xi^2}{2\rho^2}$$

Agent B accepts delegation of d_1^A *and* d_1^B *only if:*

$$\Delta\theta^2 \geq 4\xi^2 - 2\gamma^2$$

Proof. See appendix C ■

Delegation of d_1^A and d_1^B is not a problem for agent B. When the principal prefers this solution, agent B accepts it: $4\xi^2 - 2\gamma^2 \leq \frac{2\gamma^2}{1-8\rho^2}\ \forall\rho$.

If $\rho = 0$, agent B is always better off under centralization than with delegation of d_1^A. When ρ increases, the signal of agent A has a higher quality and agent is more likely to accept delegation of d_1 to agent A. However, even with perfect correlation, there are still values of $\Delta\theta^2$ for which agent B refuses delegation of d_1^A. Agent B refuses the principal's preferred organization for $\Delta\theta^2 \in [\frac{2\xi^2}{1+8\rho^2}, Min(\frac{2\xi^2}{2\rho^2}, \frac{2\gamma^2}{1-8\rho^2})]$. This is represented in figure 5.

For $\Delta\theta^2 \in D \equiv [\frac{2\xi^2}{1+8\rho^2}, Min(\frac{2\xi^2}{2\rho^2}, \frac{2\gamma^2}{1-8\rho^2})] \cup [\frac{2\gamma^2}{1-8\rho^2}, 4\gamma^2 - 2\xi^2]$, the optimal organization of proposition 3 is refused by one agent. Now we concentrate on the choice of an organization that is not refused by the agents for those parameters only.

[28]Except in the limit case of perfect correlation $\rho = \frac{1}{4}$ and $\xi = \gamma$, in which the agent A always accepts the principal's proposal.

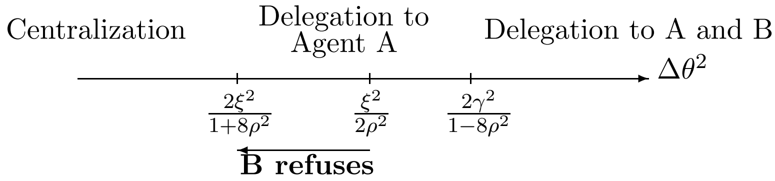

Figure 5 : Optimal organization refused by agent B

The agents A and B have a completely different attitude toward the proposed organization of the principal. Agent A, that suffers the largest externality, prefers less delegation than what the principal offers, while agent B prefers more delegation. Agent A accepts an organization where he controls d_1^A if the principal controls d_1^B, while agent B accepts an organization where d_1^A is delegated to A only if he also receives control over d_1^B.

To solve this puzzle, the principal has two solutions, either she delegates less (centralization), or she delegates more. Delegating less is not a problem because it corresponds to the default point and therefore is always accepted by the agents. If the principal wants to delegate d_1^A, she has also to delegate d_1^B in order to be accepted by B. But then it is refused by A. To be accepted by A, the principal can give more power to agent A, by delegating also d_2^A. By delegating more to A, the principal can 'buy' the acceptance of A. When the optimal organization is rejected by the agents the principal delegates either nothing or all decisions but d_1^B. Proposition 4 summarizes this fact.

Proposition 4 *For $\Delta\theta^2 \in D$, when at least one agent refuses the organization of proposition 3, it is optimal to delegate delegate d_1^A, d_1^B and d_2^A if (i) both agents accept it and (ii) $\Delta\theta^2 \geq 2\xi^2+\gamma^2$. Otherwise, centralization is optimal.*

For $\Delta\theta^2$ outside D, the optimal organization is the same as in proposition 3

Proof. See appendix D ■ The conditions that ensure that delegation of d_1^A, d_1^B, d_2^A is accepted by both agents are also discussed in appendix D.

Participation of the agents in the design of the organization has three consequences. First, the overall efficiency decreases. As we add participation constraints on the choice of the principal, when these constraints are relevant, the organization is less efficient. The efficiency loss are unequally distributed among agents. There is one agent that increases his utility while the utility of the other decreases. Participation in the organizational design cannot benefit to both agents. Second, the agent that suffers the largest externality may receive more power. This agent wants less delegation than what the principal proposes. And hence, to accept delegation, the principal should offer him more power. Third, participation of the agent in the process of organization design process, leads either to less delegation, when the principal retains all the control rights or to more delegation when the principal delegates three decisions instead of one or two. If we measure the degree of decentralization by the number of decisions out of the principal control, the agent participation implies either a greater agent control or a greater principal control.

6 Conclusions

This model sheds lights on one major determinant of the organizational structure: the role of information transfers between the different level of the organization. If information is perfectly shared among all the members, the assignment of tasks to the agent who is able to perform it at the lowest possible cost is an easy problem. When information is spread among the members of the organization, the design of the organization has two parts: first tasks should be allocated to the agent that do it in the most efficient way and second, the organization should organize communication channel to transfer information to the agent that needs it.[29]

In this paper, we have shown that a way to transfer information from the subordinates to the responsible of the organization is to delegate decisions. When delegation is used as a communication channel, the optimal organization is partially delegated. In this kind of organizations, power is not concentrated in the hand of one person but rather split between the agents and the principal.

In these partially decentralized organization, agents have 'real' authority[30] over decisions. Under the incomplete contract hypothesis, that implies that decisions cannot be contracted for, agents have discretion in the choice of their decisions. The source of power of the subordinate is their information. Delegation takes its roots in asymmetric information within the organization. We have shown that, in addition to the benefits of a better informed decision maker under delegation, it also has the advantage of channelling information to the top of the organization.

A Proof of proposition 1

The proof of proposition 1 is standard and is directly derived from Cho and Kreps (1987). Cho and Kreps define the intuitive criterion in the following way:
A Bayesian-Nash equilibrium fails the intuitive criterion if the equilibrium payoff of the agent in one state of the world (θ_i) is greater with the equilibrium strategy than with any other strategy. And it exists a strategy $\tilde{s}$ such that the equilibrium payoffs in the other state of the world (θ_j) are smaller than those with the strategy $\tilde{s}$ once the principal is convicted that $\tilde{s}$ could not have been chosen by the agent in state θ_i.

To proof proposition 1, we first describe the equilibria in the signalling game. An equilibrium consists in a collection of decisions taken by the agents and the principal according to the organizational structure and beliefs of the principal, beliefs that should be consistent with the Baye's rule. Once the equilibria are computed, we apply the intuitive criterion.

To understand the proof, two key elements have to be mentioned. First, the decisions taken by agent l do not affect the decisions taken by the other agent. To understand this, consider an organization where d_1 is delegated to agents A and B. Suppose that the decision of the agent B signals some information to the principal. The principal uses this information to take the decision d_2^B. This decision affects the payoffs of A through the externality. But for agent A, there is no possibility to modify d_2^B by sending more or less of information. And hence, the decisions taken by B affect the payoffs of A but not his decisions. Therefore, we can view the signalling game as two separated games between one agent and the principal. Second, when the externalities γ, ξ are positive, the agents always prefers that the principal takes a decision smaller than the first best decision.[31] In other words, the agents prefer that the principal corrects as little as possible for the externality. A direct consequence of this is that the agent in state θ_1 always prefers that the principal becomes informed about the state of the world. While in state

[29] Radner (1993) and Dewatripont and Bolton (1994) show that the structure of an organization is chosen in order to minimize the costs of proceeding and transferring the information from the subordinates to the top. The resulting structure is typically a pyramid with multiple levels in the hierarchy.

[30] Aghion and Tirole (1997).

[31] In the case of negative externalities, the agents prefer decisions greater than the first best decisions and the reasoning is the same.

θ_2, the agent may prefer that the principal do not become informed or becomes only partially informed.

Result 1 *No pooling equilibria survives the intuitive criterion.*

Consider any pooling equilibrium. The agent in state θ_1 is worse-off than in the case where he could signal his type.[32]

We can show that to any pooling equilibrium, we can associate a decision $\tilde{d}_1$ such that:
(i) In state θ_2, the agent prefers the pooling equilibrium to $\tilde{d}_1$, whatever the beliefs associated with $\tilde{d}_1$
(ii) In state θ_1, the agent prefers $\tilde{d}_1$ to the pooling equilibrium if the principal is convicted that $\mu(\theta_1|\tilde{d}_1) = 0$.

Then if in state θ_2 the agent never deviates to $\tilde{d}_1$, the intuitive criterion imposes that the beliefs associated with $\tilde{d}_1$ changes to $\mu(\theta_1|\tilde{d}_1) = 1$. And consequently, the agent will quit the pool in state θ_1 and no pooling equilibria survive the intuitive criterion.

Result 2 *The only separating equilibrium that survives the intuitive criterion is the least costly separating equilibrium (Riley outcome).*

In a separating equilibrium, the agent implement is preferred decision in state θ_1. An equilibrium is separating if $d_1^l(\theta_1)^* = \alpha^l + \theta_1$ and $d_1^l(\theta_2)^*$ satisfied the following incentive constraint (IC):

$$U^l(d_1(\theta_1)^*, d_2(\theta_1) = \alpha^l + \theta_1, \theta_2) \leq U^l(d_1(\theta_2)^*, d_2(\theta_2) = \alpha^l + \theta_2, \theta_2) \qquad (IC)$$

From the constraint (IC), we can derive the set of separating equilibria (call this set D). These equilibria are supported by pessimistic out-of-equilibrium beliefs: $\mu(\theta_2|d_1^l \neq d_1^l(\theta_2)^*) = 0$.

The intuitive criterion applied to the set D of separating equilibria will refine all the out-of-equilibrium beliefs. These updated beliefs become $\mu(\theta_2|d_1^l \in D) = 1$. And hence a rational agent selects the decision $d_1^l(\theta_2)$ that maximizes U^l under the constraint (IC) i.e selects his preferred decision within D. This decision is the agent preferred project in state θ_2 if $\xi, \gamma \leq \Delta\theta$.

B Proof of proposition 2

$$U^P(delegation\, d_1^A) - U^P(centralization) > 0 \Leftrightarrow v_1 v_2 \Delta\theta^2 > \frac{\xi^2}{3}$$

$$U^P(delegation\, d_1^A) - U^P(delegation\, d_1^A\, and\, d_1^B) > 0 \Leftrightarrow v_1 v_2 \Delta\theta^2 < \gamma^2$$

$$U^P(delegation\, d_1^A\, and\, d_1^B) - U^P(centralization) > 0 \Leftrightarrow v_1 v_2 \Delta\theta^2 > \gamma^2 + \xi^2$$

[32]Except in the case of perfect correlation where $v_{12} = v_{21} = 0$ and the principal has received a signal from the other agent. In this case, there is no reason for the agent to pool on d_1^l.

C Proof of lemmas 1 and 2

$$U^A(delegation\, d_1^A) - U^A(centralization) = \frac{1}{4}(\Delta\theta^2 + 2\xi^2) > 0$$

$$U^A(delegation\, d_1^A\, and\, d_1^B) - U^A(centralization) = \frac{1}{4}(\Delta\theta^2 + 2\xi^2 - 4\gamma^2)$$

$$U^B(delegation\, d_1^A) - U^B(centralization) = 2\rho^2\Delta\theta^2 - \xi^2$$

$$U^B(delegation\, d_1^A\, and\, d_1^B) - U^B(centralization) = \frac{1}{4}(\Delta\theta^2 + 2\gamma^2 - 4\xi^2)$$

D Proof of proposition 4

For the principal, delegation of d_1^A, d_1^B and d_2^B, dominates centralization if:

$$U^P(delegation\, d_1^A\, d_1^B\, d_2^A) - U^P(centralization) > 0 \Leftrightarrow \Delta\theta^2 > 2\xi^2 + \gamma^2$$

Agent A accepts the delegation of the three decisions if:

$$\Delta\theta^2 \geq 4\gamma^2 - 4\xi^2$$

And Agent B accepts if:

$$\Delta\theta^2 \geq 8\xi^2 - 2\gamma^2$$

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