INFORMATION ACQUISITION IN REPEATED RELATIONSHIPS

Axel Gautier[1] & Dimitri Paolini[2]

[1]CEREC, FUSL & CORE (Belgium). Address for correspondence: CORE Voie du Roman Pays 34, B1348 Louvain-la-Neuve, Belgium. Email: gautier@core.ucl.ac.be.
[2]DEST - Università "G. D'Annunzio", Pescara (Italy) & IRES - UCL (Belgium)

Abstract

This paper presents a new rationale for delegation. In a repeated relationship, when the principal gives up at time t the control over an action to the better informed agent, the decision taken by the agent signals his private information to the principal. The revelation of information is valuable to the principal only in a context of repeated relation where the principal can use the information at time $t+1$ to take another decision. In this paper, we present an example where delegation occurs only if the relation lasts for more than one period. In a single period context, if the agent has a bias in favor of one project, he does not have incentives to select a project that is not his preferred one; hence he does not disclose his private information and delegation is not valuable. While in a repeated relationship, it becomes costly for the agent to keep the principal non-informed and this counterbalances the agent's bias for one project. Shared-control (partial delegation) is then the preferred organizational structure when the interaction is repeated. Moreover, shared-control dominates an alternative mechanism where the principal centralizes all the decisions and the information is transfered through a message game.

INFORMATION ACQUISITION IN REPEATED RELATIONSHIPS

Introduction

Economics of organizations concentrate on the design of incentive schemes to align the interests of the organizations' members and to promote the organizations' goals. Beyond explicit monetary incentives such as performance related to pay scheme, the organization of the decision making process is by itself part of the incentive package. In particular, giving power to a subordinate affects the global performance of an organization. In this paper, we present a model that compares two organizational structure: delegation where the subordinate receives power from his supervisor and centralization where the supervisor retains the power. Obviously, when the subordinate has authority, the supervisor tries to limit the discretion of the delegate, especially when it is known that the delegates does not share the preferences of his supervisor. We explore a model where decisions should be repeatedly taken. In this case, the supervisor limits the power of the agent by allowing him to take a limited number of decisions. Delegation is then a shared control situation where the power is split between the two parties. We show that delegation to a subordinate even with biased preferences, could be the preferred organizational structure and lead to the first best outcome.

Model overview and results

This paper considers the problem of task delegation under asymmetric information. An organization composed of a supervisor (the principal, she) and a subordinate (the agent, he) should repeatedly select investment projects. The subordinate has superior information about the best project choice and he does not share the objectives of his supervisor who acts in the interest of the organization. The agent is biased toward some types of projects. In particular, there is one project that gives a larger private benefit to the agent. Such a divergence of interests between the two parties arises for example when the agent has a preference for empire and prefers to manage a larger firm (Jensen, 1986) or when a specific project leaves a larger private benefit to the agent.

To introduce delegation, we follow the incomplete contract literature[1] and assume that the principal and the agent cannot contract on the agent's private information and on the decisions.[2] However, control over the action is contractible. The project's choice is then a transferable control action[3]: an action than cannot be contracted for, neither ex-ante nor ex-post, but for which the control could be transferred. The contract signed between the principal and the agent then specifies who has the right to select the investment project at time t. Delegation in this context refers to a situation where the agent receives the control.

In a single period context, delegation of the project's choice to the agent entails a loss of control. Delegation is costly because the agent does not share the preferences of his supervisor. When the agent receives the control, he selects his preferred investment project ignoring the consequences on the principal's welfare. However, the benefit of an informed decider could countervail the loss of control. Despite the cost, it might still be efficient to delegate because the agent has superior information. The choice of delegating the task to the agent depends on the trade-off between the loss of control when the agent decides and the loss of information when the principal decides (Dessein, 2002). When the principal retains control, there is no bias in the decision but the principal is not or imperfectly informed. Under centralization, the agent could transmit part of his hidden information through non contractible messages.

In a two-period context, where the organization invests repeatedly in projects, there is an additional benefit of delegation: it becomes a way to transfer information from the agent to the principal. Delegation is efficient when the control over decisions is shared between the agent and the principal: the agent selects the project at time t, the principal at time $t+1$. Moreover, by observing the agent's decision, the principal learns (part of) the agent's hidden information. With shared control, the principal becomes informed if the agent's decision is contingent on his private information.

If, in the one period model, the agent always selects his preferred project, replicating this strategy in a repeated relationship is costly for the agent. When the agent always selects, whatever his private information, the same decision at t, the principal does not acquire information. Selecting his preferred project at t is costly if the decision of a non-informed principal at $t+1$ hurts the agent. Hence, the agent might not select his preferred project in the period one, in order to signal his private information to the principal. In this case, delegation is valuable as it implies a transfer of information from the agent to the principal (Gautier and Paolini, 2002).

Moreover, if the agent does not take a decision contingent on his private information, the principal is weakly better off if she retains control as she could replicate the agent's choice. The revelation of information is not only a property of delegation in repeated context, it is also a necessary condition for delegation to occur.[4]

The contribution of this paper is to give an example where delegation is not valuable in a single period context, but is valuable when the interaction is repeated. This example illustrates that in repeated relationships, delegation is valuable for the principal only because she acquires the agent's hidden information. Delegation is also preferred to an alternative mechanism where the agent transfers his private information through message and the principal then decides. Communication in the alternative mechanism is not complete: the principal imperfectly learns the agent's information. Hence, the principal prefers to learn the information by giving up control.

Related literature

In the standard principal agent theory, following the revelation principle (Myerson, 1982), delegation is always weakly dominated by a grand contract between the principal and all the agents. To speak about delegation in a principal agent setting, one needs to relax some assumption of the revelation principle. Melumad, Mookherjee and Reichelstein (1992) relax the assumption of perfect communication between the principal and the agents. When information transmission is noisy, delegation to one agent reduces the need of communication and improves the organization performance despite the divergence of interests between both parties. Laffont and Martimort (1998) assume that communication between the principal and the agents is imperfect and that side contracting between agents is feasible. When several agents have the possibility to collude against the principal, partial delegation to one agent reduces the stake of collusion.

Aghion and Tirole (1997), Dessein (2002), de Garidel-Thoron and Ottaviani (2000), Gautier and Paolini (2002) and this paper assume that the contracts are incomplete. Incomplete contracting refers to situations where some variables cannot be part of the contract. A variable cannot be contracted upon, when it cannot be verified by a party outside the contracting relation (a court or a judge for example). If a third party cannot verify that a task has been correctly performed by an employee (and the circumstances under which this task has been performed), the contract governing the employer-employee relationship cannot specify a pay contingent on the achievement of this specific task. Non verifiability by outsiders could come from a prohibitive cost of writing a detailed contract. If the task performed by the employee has multiple dimensions, describing all of them in a contract would be extremely costly. Moreover, verifying if the task has been performed adequately would be even more costly. A prohibitive cost of writing detailed contracts is a justification for the incomplete contract hypothesis (Tirole, 1999).

A large part of the theory of organizations is built on the incomplete contract hypothesis. Explaining delegation, in particular, often relies on the hypothesis that the tasks performed by the delegate cannot be described in a comprehensive contracting framework.[5] In the incomplete contract models, delegation is associated with an effective control over the decisions: the delegate has the freedom to pick any action from an allowed set. While in a complete contract framework, even if the agent performs a task himself, he does not have any authority since everything has been specified in the contract.[6]

Dessein (2002) considers a one period principal agent relationship where both parties disagree on a project choice. The agent has a systematic bias and prefers larger projects than the principal. The relation takes place under asymmetric information. The agent has a piece of private information: he knows a state of the world parameter that the principal ignores. The state of the world determines the optimal project (for both the principal and the agent). Project choice and the state of the world parameter cannot be contracted upon, hence, the only feasible contract is to decide who decides. When the principal delegates the project choice to the agent, delegation is costly since a biased agent selects a project that is not the principal's preferred one. Because of the agent's bias, delegation is associated with a *loss of control*. However, the agent is better informed and this countervails the loss of control. If the principal retains control and asks the agent to advise her about the project choice, communication by the agent is imperfect i.e. he does not truthfully report the state of the world. Communication associated with a centralized decision by the principal is a cheap talk game. Following the Cheap Talk literature (Crawford and Sobel, 1982), communication is noisy. Hence, the principal will not acquire the agent's private information with a message game and communication is associated with a *loss of information*. Delegation dominates when the loss of control is lower than the loss of information. In other words, delegation is efficient when loss of control are relatively small, that is when the agent's bias is not too large.

de Garidel-Thoron and Ottaviani (2000) also compares delegation to a better informed agent with strategic communication. He shows that reducing the agent's discretion by limiting his possible choices to a subset of the possible decisions increases the principal's utility. The reason is that reducing the agent's discretion countervails the agent's bias toward some types of projects and hence decreases the associated loss of control. Roider (2003) has a similar point: restricting the agent's discretion is meant to rule out extreme choices and thereby improves the organization performance. Armstrong (1994) considers the case where the agent has a multi-dimensional private information. The principal ignores both the preferences of the agent and the state of the world. Delegation with reduced agent's discretion is also the optimal organizational structure.

Gautier and Paolini (2002) and Legros (1993) study delegation in a two period model. In both papers, delegation is a learning process: by giving up control to the better informed agent in the first period, the principal learns part of the agent's private information. If in a single period model like Dessein (2002), the agent selects his preferred project whenever he receives control, it is not so when the interaction is repeated. In multi period relations, the decisions taken at the earlier stages have an informational content. The principal acquires information by observing the actions of the better informed delegate. Hence, when he chooses his action, the agent takes into account that his decision signals his private information to the other party. Delegation is then a signaling game between the agent and the principal (Spence, 1973). The first mover, the delegate, takes a decision based on his private information. Then, the principal observes the decision, revises her prior beliefs about the agent's hidden information and takes a second period decision. Delegation in first period becomes a signaling game only if the interaction is repeated. This is the main difference between repeated and single period models: it is only in the first case that the decision of the agent is strategic. When the relation lasts for one period only, the agent selects his preferred project whenever he has received the control. When the relation is multi-period, the agent trades off the immediate benefit of taking his preferred decision with the potential adverse effect it could have on the principal's information.

Legros (1993) considers the following problem: a politician delegates a policy choice to a delegate (a state agency for example) with unknown preferences. After observing the choice of the delegate, the politician either re-elects the same delegate or selects another delegate from the initial set. Legros

(1993) shows that the agent partially hides his private information, in order to increase his probability of being selected as a delegate at the next period. If a delegate is too extreme in the first period, he has very little chance of being the next period delegate, hence he prefers to hide his information in the first period and he mimics less extreme delegates. The equilibrium in the signaling game is a partial pooling equilibrium. Second period delegation is used as a disciplining device. Even though the decisions cannot be contracted upon, the agent might be rewarded (or punished) for not being too extreme in first period by receiving control in second period too.

Gautier and Paolini (2002) consider the problem of Dessein (2002) in a repeated context. They analyze the equilibrium of the following signaling game: at a first stage, a better informed agent takes a decision, then, the principal observes the first decision and takes another decision. The agent has a bias toward larger projects and both decisions affect the welfare of the two parties. When there is a continuum of possible projects, delegation in the first period leads to a complete transfer of information if the state of the world can take two values. It means that the agent acts differently in the two states and the principal learns the true state of the world by observing the agent's decision. With more than two possible states of the world values, the equilibrium is not always separating (the agent could take the same action in two different states) but delegation always improves the prior knowledge of the principal. In technical terms, it means that the full pooling equilibrium where the agent selects the same decision in all states of the world does not exist. The results of Gautier and Paolini (2002) rely on the use of refinements of the Bayesian-Nash equilibrium and in particular the Cho and Kreps (1987) intuitive criterion.

This paper studies a similar problem in a simplified framework where the number of possible projects is limited. In this case, delegation to the agent is not always informative. The principal does not acquire any information if the relation lasts for a single period. With two periods, the principal learns information only if the agent's bias is not too large. It is only when the relation is repeated for a sufficiently long period that delegation is always informative.

Aghion and Tirole (1997) consider a problem where the information structure is endogenous. Both the principal and the agent have to perform an effort to learn information about potential projects. After the learning stage, a decision is taken either by the principal or the agent according to the contract. The incentive to acquire information increases when the party receives more control. For example, the agent has more incentives to be informed if he has both formal and real authority meaning that there is no threat that the principal overrules the agent's decision.

Aghion *et al.* (2001, 2003) show that a shared control over two decisions enhances cooperation between the parties. Two parties can either cooperate or not. If they do not cooperate, the party that has control implements his preferred project. In a shared control situation where the principal takes the first decision and the agent the second, the two parties prefer to cooperate as none of them could implement his preferred project. Cooperation could be achieved only if the control is shared. Similarly in this paper, shared control between the principal and the agent is meant to achieve information transfer from the better informed agent to the principal.

Applications

To illustrate our model, consider the following two examples:

Example 1: Manager-Shareholders relationship. Managers are supposed to act in the interests of the shareholders. However, since Berle and Means (1932), it is commonly agreed that ownership (shareholders) and control (managers) have different objectives. In practice, shareholders often transfer the effective control over the firm to the managers and rubber stamp most of the manager's main decisions. A reason for that is the managerial superior information about the firm and its environment. Contracts usually fail to reconcile the interests of the two parties. Thereby, to maximize the firm's value, shareholders have to decide which decisions they do leave to managers and which decisions they keep in hand. Whether or not shareholders rubber stamp the managerial decision depends on the information they have, and presumably the available information depends on the managerial past actions. For example, if the manager decides to acquire another firm in a new business segment, shareholders will allow the manager to diversify the firm as they do not have the necessary information. But, if the manager suggests additional acquisitions in the same field, shareholders have at that time more information to assess on benefits of such a merger and will exercise more control on this second merger decision. This shared control situation with information transfer is precisely what we describe in this paper.

Example 2: Advisors: Many organizations such as firms, governments or international organizations delegate research to experts like consulting firms or universities while they have resources to produce it. We can explain such a delegation by the fact that even if the consulting firms and/or universities have a different objective from those of the government (for example valuable academic research vs support to decisions), they have a better knowledge of the 'state of research' in some particular field. Part of this expertise is transmitted through the research output and the deciders can use it as a basis for their subsequent research that can be oriented more toward support to decisions.

The model

We consider an organization composed of a principal and an agent. The organization should select an investment project that affects the welfare of both members.

There are three possible investment projects. One, denoted by S, is a safe project, the two others, denoted R_1 and R_2, are risky. The projects' characteristics (risk and return) are common knowledge. The project yielding the highest return, however, depends on the underlying economic environment. We represents this environment by a state of the world parameter θ which belongs to a set $\Theta \equiv \{\theta_1, \theta_2\}$. Only the agent knows the true value of θ, but it is common knowledge that $\Pr(\theta = \theta_1) = \eta_1$ and $\Pr(\theta = \theta_2) = \eta_2 = 1 - \eta_1$.

Asymmetric information is a key feature of organizations. Under full information, there is no reason to delegate the project's choice to the agent[7]; it is only because the agent is better informed that delegation could be valuable. There are plenty of examples of asymmetric information in organizations. In manager-shareholders relationship, the firm's manager, as an insider, has access to information that shareholders do not have. In multi-division firms, divisional managers, due to their greater proximity with their market, have private information about products, markets and investment opportunities. In employer-employee relationship, the employee acquires through on the job learning information that the employer does not have.

Asymmetric information is not problematic by itself. If the information could be efficiently transmitted to the decision maker, delegation is again useless. Information will not flow efficiently within the organization when either proceeding information is costly or noisy[8] or when the members of the organization have conflicting objectives. In fact, there is no reason to assume that all the members of an organization share the same preferences. For example, in the manager shareholders relation, the manager does not necessarily selects the investment project that maximizes the shareholders' wealth. There are plenty of evidences that managers have preferences for empires. When shareholders want to maximize firms' value, managers have incentives to cause their firms to grow beyond the optimal size.[9] In this article, we will assume that in addition to asymmetric information, the principal and the agent disagree over the best project choice.

The returns of the risky projects depend on the economic environment θ while the safe project S has a return independent of θ. Whatever the state of the world, the safe project returns $s > 0$. The risky projects can either succeed or fail. When a project succeeds, it returns $v > s$ and it returns nothing when it fails. The probabilities that a project succeeds or fails depend on the state of the world θ.

The project R_i succeeds in state θ_i with a probability p and fails with the corresponding probability $(1-p)$. In the other state θ_j, the probability of success of project R_i is q. We assume that project R_i is more likely to succeed in state θ_i than in state θ_j: $p > q$. Conversely, failure of project R_i is more likely when $\theta = \theta_j$: $(1-q) > (1-p)$. The expected return of a risky project R_i is pv in state θ_i and $qv < pv$ in state θ_j.

We assume that in state θ_i, project R_i has the highest expected return and project R_j the lowest one:

Assumption 1: $pv > s > qv$.

The principal is supposed to be risk neutral. We assume that the utility is tied to the expected project return. Shareholders, for example, collect the final value of the firm. Hence, risk neutral shareholders want the firm to select the project with the highest expected return.

We denote by $U^P(y, \theta)$ the principal's utility in state θ when project $y \in S, R_1, R_2$ is implemented. Assumption 1 implies that in state θ_1, the principal' utility is such that:

$$U^P(R_1, \theta_1) > U^P(S, \theta_1) > U^P(R_2, \theta_1) \tag{1}$$

Similarly, assumption 1 also implies that in state θ_2, the $U^P(., \theta_2)$ is such that:

$$U^P(R_2, \theta_2) > U^P(S, \theta_2) > U^P(R_1, \theta_2) \tag{2}$$

If the principal is unaware of the true state of the world but only knows its prior distribution (η_1, η_2), we assume that her preferred project is the safe project:

Assumption 2: For $i, j = 1, 2$: $s > \eta_i pv + (1 - \eta_i)qv$.

Assumption 2 implies that for $\theta_i = \theta_1, \theta_2$:

$$U^P(S, \theta) > \eta_i U^P(R_i, \theta_i) + \eta_j U^P(R_i, \theta_j) \tag{3}$$

Hereafter we will refer to the first best situation when the principal manages to implement the project R_i in state θ_i.

The agent derives a private benefit that depends on the realized state of the world and the project's choice. The agent's preferences do not correspond with those of the principal. The agent has a systematic bias in favor of one project, say project R_1. We interpret the agent's bias as follows: there is one project that systematically leaves larger private benefits to the agent. These benefits could be for example, a higher visibility and thereby larger future employment (and pay) prospects, project R_1 could be easier to achieve for the manager due to a specific human capital linked to this project or the private benefits is simply on the job consumption.

Hence, in state θ_1, the agent's preferences correspond with those of the principal since they both prefer project R_1. Moreover, we assume that in state θ_1, the worst project for the agent is R_2.

If $U^A(y, \theta)$ represents the agent's utility in state θ when project $y \in \{S, R_1, R_2\}$ is implemented, we have the following preference relation in state θ_1:

$$U^A(R_1, \theta_1) > U^A(S, \theta_1) > U^A(R_2, \theta_1) \tag{4}$$

In the other state θ_2, due to the large private benefit, the agent's preferred project is R_1. But the next best choice of the agent is the principal's preferred project:

$$U^A(R_1, \theta_2) > U^A(R_2, \theta_2) > U^A(S, \theta_2) \tag{5}$$

For the agent, the preferred project is R_1 in both states. What changes from state to state is the worst project.

The agent is assumed to be liquidity constrained. Otherwise, the problem would have a simple solution where the agent buys the firm from the principal for a fixed upfront payment.

Delegation matters only if there is no complete contract governing the relation between the principal and the agent. Indeed, if it is possible to contract on the economic environment and on the actions, the following revelation mechanism where the principal designs a contract which associate to any report of the agent the corresponding action and payments leads to the first best project choice. However, it is costly for the principal since she has to transfer money to the agent. Hence, our non contractibility assumption is equivalent to a liquidity constraint for the principal.

We suppose that the state of the world parameter θ and the project choice cannot be contracted for, neither ex-ante nor ex-post. However control over the decision is contractible. The project choice is then a transferable control action (Aghion *et al.*, 2001)

Last, note that complete contract would not always be useful when the interaction is repeated because the principal will manage to implement the first best with a delegation contract. Before analyzing the repeated interaction model, we analyze a single period interaction.

Delegation and communication in a single period relationship

Suppose that the principal-agent relationship lasts for a single period. In this framework, there are two possible contracts: (1) **A-Control**: the principal delegates the project's choice to the agent and (2) **P-Control**: the principal retains control and chooses the project. Under P-Control, the agent could communicate information before the principal decides. Messages are not contractible. Hence, communication under P-Control is a recommendation or an advice from the agent to the principal.

If the principal transfers control to the agent, the latter selects the project knowing the state of the world parameter θ. Given the contract incompleteness, the agent cannot be rewarded or punished for his project choice. Thereby, in each state of the world, he selects the project which brings the largest payoff. When $\theta = \theta_1$, the agent's preferred project is R_1. When $\theta = \theta_2$, the agent's preferred project is R_1 too (by assumption). Hence, under A-Control, project R_1 is selected in both states θ_1 and θ_2.

Given that under A-Control, the agent's choice is independent of his private information, the principal is weakly better-off if she retains the control. Indeed, the principal could replicate the agent's choice under P-Control.

However, under P-Control, the principal will not select the risky project R_1, as the agent would do, but rather the safe project S. Ignoring the value of θ, the principal has a higher payoff if she selects the safe project. In a single period relation, facing a better informed subordinate is not sufficient to delegate the control because the agent has a bias in favor of one project. The agent's private information is not sufficient to make delegation valuable.[10]

Under P-Control, the principal could construct an alternative mechanism where she asks the agent to send a message before she selects a project. The principal and the agent plays a message game before the principal decides on the project. Following our assumption on the impossibility to base contracts on the state of the world realization, the agent cannot be rewarded nor punished for sending a "wrong" message. This kind of message game is a cheap talk game[11] where the informed agent sends a possibly noisy message based on his private information to the principal. Unlike the Spence (1973) signaling game, it costs the agent nothing to send a message.

Since the state of the world can only take two values, we analyze without loss of generality a cheap talk game where the agent could send two possible messages. We call them m_1 and m_2. Message m_1 (resp. m_2) means that the agent advises the principal that the sate of the world is θ_1 (resp. θ_2).

Suppose that, whatever the agent is doing in state θ_2, the agent sends the message m_1 in state θ_1. Indeed, it is in the interest of the agent in state θ_1 is to send a single message to inform the principal that the state of the world is θ_1. In the other state θ_2, if the agent also sends a single message (m_2 in this case), the principal learns the true value of θ and she implements the first best. By transferring the true information, the agent is better off in both states compared to the non-informed principal case where the safe project is always implemented.

But in state θ_2 the agent can increase his utility further by randomizing over the two possible messages. Consider the following strategy: in state θ_2, the agent sends the message m_1 with probability σ and m_2 with probability $(1-\sigma)$. In state θ_1, the agent selects the message m_1 with probability 1. When the principal observes the message m_2, she is sure that $\theta = \theta_2$ and then she selects the project R_2. When the principal observes m_1, she revises her prior beliefs (using the Baye's rule). After receiving the message m_1, the principal's beliefs over the states of the world are: $Prob(\theta = \theta_1 | m_1) = \frac{\eta_1}{\eta_1 + \sigma\eta_2}$

and $Prob(\theta = \theta_2|m_1) = \frac{\sigma\eta_2}{\eta_1+\sigma\eta_2}$. Given these posterior beliefs, the principal selects the project R_1 if:

$$\frac{\eta_1}{\eta_1 + \sigma\eta_2} U^P(R_1, \theta_1) + \frac{\sigma\eta_2}{\eta_1 + \sigma\eta_2} U^P(R_1, \theta_2) \geq U^P(S, \theta) \tag{6}$$

Otherwise, the principal selects the safe project after observing m_1.

Condition (6) will be satisfied for σ sufficiently small. Therefore, for the agent in state θ_2, it is optimal to select the highest probability σ^* such that (6) is satisfied with equality. This optimal value σ^* is strictly positive given that (i) the left-hand side of (6) is decreasing in σ and (ii) for $\sigma = 0$, (6) is satisfied. With this strategy, the payoff of the agent in state θ_2 is

$$(1 - \sigma^*)U^A(R_2, \theta_2) + \sigma^* U^A(R_1, \theta_2) > U^A(R_2, \theta_2) \tag{7}$$

The agent in state θ_1 cannot improve his utility by sending other combinations of the two messages, hence his equilibrium strategy is to always send message m_1.

The equilibrium in the message game involves randomization in state θ_2. It implies that the principal does not learn the true information. With cheap-talk game, the principal improves his knowledge of the unknown parameter θ but his information remains incomplete. This result is standard in cheap talk games (Crawford and Sobel, 1982). Under P-Control, the agent introduces noise in his message and the principal is not able to implement the first best.

Like in Dessein (2002) and de Garidel-Thoron and Ottaviani (2000), there is a loss of control under A-Control and a loss of information under P-Control. However, in our framework A-Control is never optimal.

Delegation and communication in repeated relationship

If, in the context of this model, delegation is not valuable in a single period, this section demonstrates that the principal could achieve the first best with a delegation contract when the relation is repeated twice. If instead of selecting a single investment project, suppose the organization invests repeatedly in projects. We consider a twice repeated version of the single period model. In period one, the organization selects a first investment project within $\{S, R_1, R_2\}$, and in period two, a second investment project is chosen within the same set. There is no reason to assume that the organization should select the same project in both periods but we suppose that a common state of the world parameter applies for these two periods.[12] Given that θ is time invariant, the first best choice implies that the same project would be selected in both periods. In particular, the first best is to implement project R_1 (resp R_2) in both periods when the state of the world is θ_1 (resp. θ_2). A change of project would mean that new information has become available before the organization selects the second project i.e. the project selected in first place was the wrong project.

Before the first period, the principal decides who will be in charge of the project choices. It means that the principal allocates the control over the projects before the first project choice.

The payoffs associated with the each project are described in equations (1) to (5). With a discount factor $\delta \leq 1$, the choice of projects y_1 and y_2 in periods one and two in state θ brings about a utility such that : $U^k(y_1, \theta) + \delta U^k(y_2, \theta)$, $k = A, P$.

Without communication, like in the basic model, if the principal keeps control over the two decisions (P-Control), she does not acquire information about the true state of the world and therefore, she selects twice the safe project. Similarly, if the agent receives the control over the two decisions (A-Control), he chooses twice the risky project R_1. Hence, like in the one period model, there is no reason to give full control to the agent in the repeated context since the principal could replicate the agent's choices.

But, when the interaction is repeated, the contracting possibilities extend and the control could also be shared between the principal and the agent. In a **Shared-Control** situation, where the agent selects the first investment project and the principal selects the second, the principal can acquire information by observing the agent's choice. Indeed, if the principal transfers the control, and if the agent invests differently in the two states, the principal learns the agent's private information by observing the project choice. The Shared-Control situation is a signaling game: the first mover (the agent) takes a decision that signals information to the principal who then revises his prior beliefs about the state of the world when taking the second decision. However, opposed to the cheap talk game, signaling the state of the world through the project choice is not cheap anymore.

Consider the choice of the agent in state θ_1. With Shared-Control, the agent's payoff associated with the choice of his preferred project R_1 in period one depends on the choice in the other state. If the agent also selects the preferred project R_1 in state θ_2, his payoff is $U^A(R_1, \theta_1) + \delta U^A(S, \theta_1)$. Alternatively if the agent selects a project in $\{R_2, S\}$ in state θ_2, his payoff is $(1+\delta)U^A(R_1, \theta_1)$ since the choice of R_1 now signals to the principal that the state of the world is θ_1.

If instead of selecting project R_1, the agent selects his second preferred project S, the highest payoff for the agent is: $U^A(S, \theta_1) + \delta U^A(R_1, \theta_1)$ when the choice of S signals that the state is θ_1. If we compare the lowest payoff when the agent chooses R_1[13] with the highest payoff when he chooses S, the best choice for the agent is R_1 if:

$$U^A(R_1, \theta_1) + \delta U^A(S, \theta_1) \geq U^A(S, \theta_1) + \delta U^A(R_1, \theta_1)$$

$$\Leftrightarrow (1-\delta)U^A(R_1, \theta_1) \geq (1-\delta)U^A(S, \theta_1) \tag{8}$$

which is true given equation (4) for all $\delta \leq 1$. Hence, in state θ_1, the agent has a dominant strategy R_1.

Consider next the choice of the agent in state θ_2. If the agent selects his preferred project R_1, the principal does not acquire information, as we just established that the agent always selects the project R_1 in state θ_1. In a Shared-Control situation, the choice of R_1 in state θ_2 gives a payoff equals to: $U^A(R_1, \theta_2) + \delta U^A(S, \theta_2)$. If, instead of selecting his preferred project, the agent selects the second preferred project R_2, the principal learns the true state of the world after observing the agent's decision since the agent takes different decisions in the two states. The project choice then signals the state of the world to the principal and the principal, which is now informed, selects his preferred project in period two. With Shared-Control, the choice of R_2 by the agent in the first period is followed by a choice of R_2 by the principal and the agent's associated payoff is: $(1+\delta)U^A(R_2, \theta_2)$.

In state θ_2, the agent prefers to disclose his information (choosing project R_2) than hiding it (choosing project R_1) if:

$$(1+\delta)U^A(R_2, \theta_2) \geq U^A(R_1, \theta_2) + \delta U^A(S, \theta_2) \tag{9}$$

or differently if:

$$\delta(U^A(R_2,\theta_2) - U^A(S,\theta_2)) \geq U^A(R_1,\theta_2) - U^A(R_2,\theta_2) \tag{10}$$

The agent discloses his private information if the benefit of an informed principal in period two (the left hand side of (10)) is larger than the cost of informing the principal (the right hand side of (10)). To inform the principal, the agent renounces to select his preferred project, hence he incurs a cost.

Hence, in a Shared-Control situation, in state θ_2, the agent selects project R_2 if condition (9) holds and project R_1 otherwise.

Compared to the basic model, there is now a benefit associated with delegation: the principal learns the agent's hidden information if (9) holds. Hence delegating the first project choice to the agent could become valuable. Repeating the interaction modifies the agent's choice in state θ_2.

The signaling game under Shared-Control has another separating equilibrium where in state θ_1 the agent selects S and in state θ_2, he selects R_1 if:

$$U^A(S,\theta_1) + \delta U^A(R_1,\theta_1) \geq U^A(R_1,\theta_1) + \delta U^A(R_2,\theta_1)$$

But this second equilibrium is Pareto dominated. Moreover, it does not survive the Cho and Kreps (1987) intuitive criterion.[14]

Proposition 1 *If condition (9) holds, the principal shares the control with the agent and the first best is implemented. If (9) does not hold, the principal retains control.*

In a single period context, the principal never delegates the project choice to the agent; when the interaction is repeated, transferring the control to the agent is valuable if the controlling party (the agent) transfers information to the non-informed party (the principal). Information is transferred, despite the agent's bias in favor of one project, when the loss associated with keeping the principal ignorant is large compared to the loss associated with canceling the choice of the preferred project to signal the hidden information. Sharing control creates incentives for the agent to disclose his private information. Note also that if there is no information transfer, the principal retains control.

Information transfer is a new rationale for delegation but also a necessary condition for shared-control in a repeated relationship.

Like in the one period model, a mechanism in which the principal centralizes and relies on a message from the agent fails to inform the principal. Again, the agent randomizes his message in state θ_2. Hence, this alternative mechanism brings about a lower utility if (9) holds, but improves the principal's decisions if she retains control.

If the relationship lasts for $T > 2$ periods, the incentives to disclose information under shared control increase. Indeed, in a T times repeated interaction, there is an immediate benefit of hiding information in state θ_2, but there is a future cost: for the $T-1$ remaining periods, the principal remains non informed and implements the safe project. Repeating the interaction then increases the cost of keeping the principal ignorant (the left hand side of (10) increases) . Thereby, for T sufficiently large, the equilibrium in the signaling is always a separating equilibrium. To be separating, the following condition (similar to (9)) should hold:

$$\sum_{t=0}^{T} \delta^t U^A(R_2, \theta_2) \geq U^A(R_1, \theta_2) + \sum_{t=1}^{T} \delta^t U^A(S, \theta_2) \tag{11}$$

The left hand side is the agent's utility when he signals that $\theta = \theta_2$ by taking selecting the project R_2, the right hand side is the agent's utility when he hides his information in the first period and let the principal takes the safe project in the remaining periods. Clearly, for large values of T, the condition is always satisfied.

Conclusions

In this paper, we show that delegation in repeated relationship is efficient only when the supervisor improves his knowledge of the unknown state of the world parameter. The principal gives up the control to the agent when she can learn the agent's private information. Without learning, delegation in repeated relations is valueless. Information acquisition is then a new rationale for delegation.

In the single period model, the agent does not use his private information and the principal then does not hand over control. The repetition of the interaction creates incentives for the agent to disclose his private information. It is because the agent may suffer from the ignorance of the principal that he has incentives to disclose his private information when receiving control.

The paper presents a simple example where delegation does not occur in a single period model but is the preferred organizational structure when the relation lasts several periods. In our example, the principal can implement her preferred project in both periods with shared control. Hence delegation does not cost anything for the principal. In more complicated frameworks like Dessein (2002) or Gautier and Paolini (2002), under delegation, the agent does not select the principal's preferred project and a loss of control results from delegation. But delegation in repeated relationships remains valuable only if the principal improves his knowledge of the state of the world parameter by observing the agent's decision. A necessary condition for delegation is then the existence of a separating equilibrium in the signaling game when the agent controls the first decision.[15] A separating equilibrium exists if the utility function satisfies the single-crossing property.[16]

Delegation is robust when we consider an alternative mechanism, compatible with the partial contracting set-up, where the principal centralizes all the decisions and the agent communicates a message before the principal decides. In this mechanism, communication is cheap-talk game. The equilibrium in cheap-talk is usually not separating (Crawford and Sobel, 1982, Dessein, 2002). Hence, the principal is not completely informed with the cheap-talk game, whereas he is fully informed with delegation if the equilibrium is separating.

References

Aghion, P., Dewatripont, M., & Rey, P. (2002). On Partial Contracting. *European Economic Review, 46,* 745-753.

Aghion, P., Dewatripont, M., & Rey, P. (2003). Transferable Control. *Journal of the European Economic Association,* forthcoming.

Aghion, P., & Tirole, J. (1997). Formal and Real Authority in Organizations. *Journal of Political Economy, 105,* 1-29.

Armstrong, M. (1994). Delegation and Discretion. Southampton University Discussion paper 9421, Southampton UK.

Berle, A., & Means, G. (1932) *The Modern Corporation and Private Property.* MacMillan, New York.

Cho, I.K., & Kreps, D. (1987). Signaling Games and Stable Equilibria. *Quarterly Journal of Economics, 12,* 179-221.

Crawford, V., & Sobel, J. (1982). Strategic Information Transmission. *Econometrica, 50,* 1431-52.

de Garidel-Thoron, T., & Ottaviani, M. (2000). The Economics of Advice. University College London.

Dessein, W. (2002). Authority and Communication in Organizations. *Review of Economic Studies, 69,* 811-838.

Fudenberg, D. & Tirole, J. (1991). *Game Theory.* Cambridge, MA: MIT Press.

Gautier, A., & Paolini, D. (2002). Delegation and Information Revelation. Bonn Graduate School of Economics, Universität Bonn, Discussion Paper No. 18/2002.

Jensen, M. (1986). Agency Costs of Free Cash Flow, Corporate Finance and Takeovers. *Journal of Finance, 76,* 323-329.

Laffont, J. J., & Martimort, D. (1998). Collusion and Delegation. *The RAND Jorunal of Economics, 29,* 280-305.

Laffont, J. J., & Tirole, J. (1988). The Dynamics of Incentive Contracts. *Econometrica, 56,* 1153-1175.

Legros, P. (1993). Information Revelation and Repeated Delegation. *Games and Economic Behavior, 5,* 98-117.

Melumad N., Mookherjee, D., & Reichelstein, S. (1992). A Theory of Responsibility Centers. *Journal of Accounting and Economics, 15,* 445-484.

Myerson, R. (1982). Optimal Coordination Mechanism in Generalized Principal-Agent Problems. *Journal of Mathematical Economics, 10,* 67-81.

Radner, R. (1993) The Organization of Decentralized Information Processing. *Econometrica, 61,* 1109-1146.

Roider, A. (2003). Delegation of Authority as an Optimal (In)complete Contract. Bonn Graduate School of Economics, Universität Bonn, Discussion Paper No. 8/2003.

Spence, M. (1973). Job Market Signaling. *Quarterly Journal of Economics, 87,* 355-374.

Tirole, J. (1999). Incomplete Contracts: Where do we stand? *Econometrica, 67,* 741-781.

Zabojnik, J. (2002). Centralized and Decentralized Decision Making in Organizations. *Journal of Labor Economics, 20*, 1-22.

Notes

[1]Tirole (1999).

[2]Contractibility would make the problem a standard adverse selection problem.

[3]Aghion, Dewatripont and Rey, (2002).

[4]Gautier and Paolini (2002) use the properties of signaling games to show that when the agent receives control, the decision he takes signals his private information i.e. the signaling game has a (unique) separating equilibrium.

[5]Roider (2003) is an exception. In his model, a simple delegation of authority is a solution to a complete-contracting problem with contractible actions both ex-ante and ex-post and unlimited transfer payments.

[6]Aghion and Tirole (1997) distinguish formal and real authority. Formal authority is conferred by contract or ownership, but it does not necessarily confer real authority that is effective control.

[7]Except for Zabojnik (2002) who finds that delegation may be optimal even if the principal is better able to choose a project. This results comes from the hypothesis that the agent's effort and the accuracy of project choice are complements.

[8]Radner (1993) and Melumad *et al.* (1992).

[9]Jensen (1986).

[10]In Dessein (2002), there is not a single project preferred in all states but an agent bias for projects larger than the principal's preferred one. In this context, if the principal delegates, there is a trade-off between the size of the bias and the benefits of an informed decider and delegation could be optimal in the single-period model.

[11]Crawford and Sobel (1982).

[12]This assumption is standard in dynamic incentive contract models (Laffont and Tirole, 1988). For

our argument, we only need that the state of the world parameters are correlated in both periods, so that the information learned in the first period could be used in the second period.

[13]The lowest payoff is considered to be the case for which the principal does not acquire information after observing R_1. Payoffs would have been lower if the principal associates with the choice of R_1 posterior beliefs such that $\Pr(\theta = \theta_1 \mid R_1) = 0$. We discuss the robustness of these beliefs later.

[14]Gautier and Paolini (2002) use the intuitive criterion to show that delegation always implies an information transfer when there are two states of the world and the set of feasible projects is a continuous interval.

[15]Gautier and Paolini (2002) prove the existence and the uniqueness of the equilibrium when there are two states of the world.

[16]For uniqueness conditions, see Fudenberg and Tirole (1991).