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Abstract

An interesting issue in organizations consists of understanding how agents worried about adaptation and cooperation take the decision of acquiring costly information about their unknown conditions when they have individual motives in organizations.

The present work shows that incentives to acquire information depend greatly on the individual motives of agents, and also on if actions taken are complements or substitutes. Moreover, the uncertainty about the conditions that agents face plays an important role.

Key Words: Strategic complementarity, strategic substitutability, information transmission, informational structures, commitment, beliefs.
JEL Classification: D23; D72; D82; D83; L23; M11

Content

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Chapter 1

Motivation

The need for cooperation and adaptation is an important issue in the literature about information transmission in organizational environments and in the theory of firms. Organizations can be considered as entities formed by several divisions. Divisions are led by managers who are in charge of implementing different tasks to achieve a local goal. Thus, each manager wants to perform well in his own task, or, in other words, to adapt his actions to his local context. By doing so, each manager individually helps the organization to achieve its ultimate goal of profit maximization.

Importantly, because of the nature of organizations, the actions that managers choose must be taken in a cooperative way. First, actions are interdependent and must be taken in a context where the managers want to deal with their own local conditions. Secondly, there are situations in which the managers behave strategically due to the existence of rewards, incentives or individual satisfaction in the accomplishment of their local objectives. In most of the settings in the literature, authors consider a very similar timing of events. At first, nature determines the local conditions of each division. Each manager privately learns the true value of the local condition of his division. After this, each manager sends strategically a free-of-cost message to influence the beliefs of other managers. Finally, each manager takes an action to maximize his expected utility.

In a different approach, the present work allows a CEO to choose a regime of information transmission in the first stage of the game. Later, the managers privately decide to acquire costly information or not. After this, and depending on the information regime chosen by the CEO, both managers communicate or not with each other. Finally, the managers take actions simultaneously. The present work also considers that each manager has individual motives to adapt his action to his local condition. These individual motives can be considered as a need for recognition or satisfaction that each manager receives when he prioritizes the adaptation of his actions to his local conditions. In this sense, each manager is biased towards the problem of adaptation. Also, each manager can acquire information about his ex-ante unknown local conditions. For example, by means of market research, implementation of a new technique in the production division, external services of consultancy or any kind of expenditures made by a specific manager with the objective of acquiring information about the local conditions of his division.

The main objective of this work is to understand how managers worried about adaptation and cooperation take the decision of acquiring costly information about their unknown local conditions when they have individual motives in organizations.

Chapter 2

Literature

The present work is related to several branches of literature about information disclosure and organizations. Within the organizational literature, Alonso, Dessein, and Matouschek (2008) highlight the importance of coordination in organizations and relate the existing to theory of firms which dates back to Marschak and Radner (1972) to most recent works about cheap-talk and information transmission in organizations.

Alonso et al. (2008) want to analyze the most efficient structure in an organization that is divided into several divisions. Such divisions care about adaptation and coordination. The authors compare two kind of structures. The first one is the centralized structure, in which a general manager takes the decisions of the overall organization but has to acquire information from the biased division managers. The second structure is called decentralized, and here the decision rights are left to each privately informed division manager. The authors find some situations in which centralization is preferred to decentralization taking into account the degree of importance of adaptation and coordination. Their main result is that, in some environments, decentralization is better than centralization even when coordination is very important. One important feature in Alonso et al. (2008)'s analysis is the lack of commitment at the ex-ante stage. The only commitment they consider is the allocation of decision rights (centralization or decentralization). That is because they consider the information transmission in the frame of a classic cheap-talk model.

In a similar setting, Rantakari (2008) analyzes other different structures of allocation of decision rights allowing more than the centralized and decentralized structures. For example, he allows a division taking the decisions for all the divisions. Also, Rantakari (2008) allows a division to be controlled by the headquarters while the other division is permitted to take its own decisions. Rantakari (2008) shows how the conflict of interests related to coordinated adaptation and what he calls soft information (information that is not verifiable) tend to modify the information transmission. The author recognizes the fact that different organizational structures plays a fundamental role solving the conflicts of interest. An important characteristic of the model presented by Rantakari (2008) is that he permits asymmetries in size and in the importance of coordination and adaptation between divisions.

The two papers mentioned above focus on determining the structures of communication that allows the best flow of information among agents (divisions). Such flow of information is conditioned on the importance of coordination and adaptation. In contrast, the model presented in this work takes the governance structure as given. The structure consists of a CEO who decides if managers communicate with each other or not. Later managers take their optimal decisions. The organizational structure presented here is different to those analyzed by Rantakari (2008) and Alonso et al. (2008).

Another approach is presented by Dessein, Galeotti, and Santos (2016). They analyze an organizational environment in which the communication is constrained, or attention is scarce. Dessein et al. (2016) propose a model in which there are complementary tasks that must be implemented in a context of privately informed agents. Agents must coordinate facing the constraint of limited time of attention paid to each specific task. This setting introduces communication frictions where the allocation of time or attention determines the way in which the information is distributed. The main result is that the firms set priorities when attention is scarce. In contrast, the present work does not introduce temporal constraints to each task. However, there is a constraint in communication between managers imposed by the CEO. The communication is complete or there is no communication. This constraint has not the same nature of that presented in Dessein et al. (2016)'s work, but it is important to highlight this feature.

The present work is also related to the classical Marschak and Radner (1972)'s theory of teams. The theory of teams consists of the analysis of how the information transmission among the members of an organization influence the beliefs and the actions inside the team. This information transmission must take into account the possible discrepancies on the information that agents possess. Marschak and Radner (1972) have the objective of studying the allocation of information among the decision makers in efficient ways. The present work, in contrast, does not take into account the fact that agents may have incentives to influence strategically the beliefs of other agents in the organization.

In summary, the literature on information transmission in organizations has focused on analyzing the optimal structures for decision making in order to achieve the greatest welfare possible. Also has focused on those contexts where managers face constraints in communication. The classic framework utilizes a cheap-talk setting that fits in some economic context of firms. But, there are other environments in which divisions must cooperate when there is a need for acquiring information related to local conditions. For instance, when marketing division pays for market studies that will reveal the market conditions in a determined context, or when a production division must pay for services of consultancy to know the commodity market conditions. In those kind of situations the model presented here fits better due to the need for information acquisition.

Within the literature of Information Transmission, Bergemann and Morris (2013), Bergemann and Morris (2016) and Bergemann and Morris (2019) offer an interesting compilation of several information design settings. In those settings, a designer commits to choose the optimal information structure. Doing so, the designer tries to influence the behavior of the other agents. The authors analyze communication in games, Bayesian persuasion and predictions in games with incomplete information.

In a parallel approach, Kamenica and Gentzkow (2011) analyze how a person (sender) can influence the actions of other person (receiver). The influence power emerges when the sender sends messages to the receiver in order to control receiver's informational environment. A key feature is that sender cannot change or distort the information once he has sent the signal. The purpose of distorting the informational environment is to modify the actions taken by the receiver. The actions taken by the receiver affect the payments of both agents. One important insight of bayesian persuasion is that commitment to information structures improves the information transmission between agents, in contrast to the cheap-talk framework.

Gentzkow and Kamenica (2014) point out that sometimes the designer, who controls the information that will be generated or transmitted among the agents, must choose a costly information structure, which requires a slightly different treatment than the usual Bayesian persuasion setting. Taking the idea of paying a cost for information structures, the present work deals with costly information. However, the present work does not deal with strategic communication.

In contrast to the models on information transmission, the strategic information disclosure is not considered in this work to simplify the analysis of costly information acquisition.

This work builds also upon another branch, which consists of papers dealing with higher order beliefs and with the analysis of actions taken in equilibrium for different contexts. For instance, Morris and Shin (2002) and Hellwig and Veldkamp (2009) provide an approach in a context where agents want to take actions similar to the true state of the world and similar to the action taken in average. Other context provided by Calvó-Armengol and de Martí-Beltran (2009) analyzes information transmission but in a context where the actions are complements an agents are worried about information gathering and links. These papers show that equilibrium actions can be expressed as linear functions that depend on the information that each agent possesses, if the utility function we work with is quadratic. The present work uses helpful insights from these papers to study how actions in equilibrium must behave.

Chapter 3

The model

The present work describes a model of team production where a number of tasks, such as engineering, manufacturing, marketing, etcetera, must be implemented by managers in a cooperative way in the organization. The managers have prior beliefs about their local conditions and can acquire further information to improve their knowledge about such conditions.

3.1 Players and preferences

The present work considers an organization that consists of two divisions and one headquarters. The model considers 3 players, a CEO who runs the headquarters, and two managers who respectively run each of the divisions. The role of the CEO is to choose, ex-ante, an Information Sharing Regime. In this model, there are two Information Sharing Regimes. On the one hand, the Full-Information Sharing Regime, where the CEO decides that both managers must acquire and completely transmit costly information. On the other hand, the No-Information Sharing Regime, where the CEO decides that managers do not communicate with each other, but each manager is free to take the decision of acquiring costly information. It is important to mention that the CEO is worried about doing the best for the entire enterprise, but she knows that each manager prioritizes matching his actions to his local conditions.

Each manager, which is denoted by $i \in \{1, 2\}$, is in charge of a task in his division and must take an action a_i. Before taking the action, manager i decides whether to acquire costly information to improve his knowledge about the local condition of his division. An important feature to highlight about managers is that they are biased towards the problem of adaptation. The bias refers to the fact that manager i increases his happiness or satisfaction when he achieves his local objectives; in this sense, each manager prioritizes matching his action to his local condition.

There is a bidimensional state of the world $\theta = (\theta_1, \theta_2)$ which is selected according to a commonly known prior distribution $P(\theta)$. The coordinates θ_1 and θ_2 are assumed to be independent. For simplicity, there are only two realizations of each coordinate θ_i: a low state, θ_i^L, that occurs with probability $P(\theta_i^L) = q_i \in (0,1)$, and a high state, θ_i^H, that occurs with probability $P(\theta_i^H) = (1 - q_i)$.

The utility of each manager depends on how he implements his task and on how he cooperates with the other manager. The notion of cooperation depends on the need of the organization and on the nature of actions. Here, it is considered that actions can be strategic complements or strategic substitutes. Complementarity means that the organization needs the managers to take similar actions, for example, marketing division and production division must take coordinated actions when promoting a new product. Substitutability refers to the fact that the organization needs the managers to take opposite actions, for example, if a division invests a lot of money in some projects, maybe the way in which the other division cooperates is investing less money in other projects.

The utility function of manager i takes the following form:

$$u_i(a,\theta) = -\phi \underbrace{(a_i - \theta_i)^2}_{\text{adaptation}} - \delta \underbrace{(a_i - a_j)^2}_{\text{cooperation}} - \mathbb{1}c \quad ,$$

where $\delta \in (-1, 1)$ is a parameter that represents the importance that managers give to cooperate. The negative values, $\delta < 0$, represent strategic substitutabilities, and positive values, $\delta > 0$, represent strategic complementarities. The parameter $\phi > 1$ captures the importance that manager i

gives to implementing his own task, as mentioned before, it can be interpreted as the satisfaction each manager receives when he achieves his local objectives. The adaptation term in the utility function means that each manager wants to match his actions to his local condition; while the cooperation term represents the need of both managers to take similar or opposite actions. The vector of actions taken by managers is denoted by $a = (a_1, a_2)$. The term $c > 0$ is the cost payed by manager i when he acquires information about the local conditions of his division. If manager does not want to acquire information then $c = 0$. Thus, $\mathbb{1}c = c$ if manager i decides to acquire information, and $\mathbb{1}c = 0$ otherwise.

The CEO is worried about maximizing the benefits of the organization as a whole, and she also cares about both adaptation and coordination. But importantly, she does not internalize the bias that the managers have in the accomplishment of their local objectives. It means that the CEO does not give extra importance to a single manager matching his actions to his local conditions. In other words, she does not prioritize the adaptation problem as managers do.

The preferences of the CEO are modeled in the following form

$$v(a, \theta) = -(a_1 - \theta_1)^2 - (a_2 - \theta_2)^2 - 2\delta(a_1 - a_2)^2 - \mathbb{1}c_1 - \mathbb{1}c_2 \quad .$$

Despite the CEO does not internalize the individual motive of the managers, she anticipates that the actions in equilibrium are taken in a context with managers biased towards their own divisions.

3.2 Timing of events

At the beginning of the game, nature selects the state of the world $\theta = (\theta_1, \theta_2)$ according to a prior distribution, $P(\theta)$, which is known by all agents. Taking into account the two possible realizations of each θ_i, the bidimensional state of the world can take one of the following four cases

$$\theta \in \left\{(\theta_1^L, \theta_2^L), (\theta_1^L, \theta_2^H), (\theta_1^H, \theta_2^L), (\theta_1^H, \theta_2^H)\right\} \quad .$$

After this, the CEO chooses one of the two Information Sharing Regimes.

Once the CEO has taken her decision, the game takes two different scenarios. In the first one, under the Full Information Sharing Regime, each manager must acquire costly information structure and disclose it to the other manager in a meeting. In the second one, under the No-Information Sharing Regime, manager i privately decides to acquire a costly information structure about θ_i or not, but in this case there is not information transmission.

Finally, managers choose the actions simultaneously.

- Nature chooses the state of the world
- The CEO chooses the information sharing regime
- The managers choose costly information structures about local conditions
- Information structures reveal private signals to managers
- The managers communicate according to the regime designed by the CEO
- The managers choose their actions

(Source: own elaboration)

Table 3.1: Time Line.

3.3 Equilibrium

The analysis is developed following two stages. In the first one, the CEO must choose the Information Sharing Regime subject to the actions in equilibrium that managers take. In the second stage both managers must choose the optimal actions and the information structure.

Using backwards induction, in the second stage, each manager chooses his action taking into account if he acquired previously the costly information about his division, and also taking as given the regime chosen by the CEO. In addition, every manager must decide whether to acquire costly information or not, taking as given the actions induced by information structures and the regime. In the case of Full Information Sharing Regime, both managers must acquire the costly information. Finally, the CEO will choose the optimal Information Sharing Regime subject to the actions taken in equilibrium by the managers.

3.3.1 Strategies of the Managers

Actions in equilibrium

Independently of the information sharing regime, in the second stage of the game, each manager chooses an action to maximize his expected utility function conditioned on the information about his division and on his beliefs about the decisions of other division. Thus, each division manager solves the following problem:

$$\max_{a_i} \; \mathbb{E}[u_i(a,\theta)|s_i,\beta_j] = \mathbb{E}[-\phi(a_i-\theta_i)^2 - \delta(a_i-a_j)^2 - \mathbb{1}c|s_i,\beta_j] \quad , \tag{3.1}$$

where $s_i \in \{\theta_i^L, \theta_i^H\}$ denotes the signal that manager i receives when he acquires the costly information. If manager i does not acquire information, he learns nothing and maintains his prior beliefs $P(\theta)$. Let $\beta_j \in [0,1]$ be the belief formed by manager i about the strategy that manager j takes, with $i \neq j$. Such an strategy consists of acquiring costly information or not. For simplicity, only pure strategies will be analyzed, i.e., $\beta_j = 0$ and $\beta_j = 1$. When $\beta_j = 1$, manager i believes that manager j has decided to acquire costly information. If $\beta_j = 0$, manager i believes that manager j has decided to not acquire costly information.

The optimal actions take the following form

$$a_i^* = \gamma\mathbb{E}[\theta_i|s_i,\beta_j] + (1-\gamma)\mathbb{E}[a_j|s_i,\beta_j] \quad \text{for each } i \in \{1,2\}, \tag{3.2}$$

where $\gamma = \frac{\phi}{\phi+\delta}$. Hence, the optimal action of manager i is a linear function depending on the expected value of his coordinate, θ_i, and the expected action of the other manager. If the need of coordination δ becomes smaller, that is, if $\delta \to 0$, then the optimal action of manager i only consists of the expected value of θ_i.

As mentioned before, the actions in equilibrium are conditioned on the information that each manager acquires and on the regime that the CEO chooses. For this reason, it is required to analyze the actions in both regimes.

Actions in the Full Information Sharing Regime

In this regime, manager i acquires costly information about his own local condition and makes it public to the other manager. In this case, the uncertainty about the strategy of the other manager vanishes and equation 3.2 becomes

$$a_i^* = \gamma\theta_i + (1-\gamma)a_j \quad \text{for each } i \in \{1,2\}. \tag{3.3}$$

Upon solving this linear system of equations, the actions taken in equilibrium take the following form

$$a_i^* = \alpha\theta_i + (1-\alpha)\theta_j \quad \text{for each } i \in \{1,2\}, \tag{3.4}$$

where $\alpha = \frac{\phi+\delta}{\phi+2\delta}$ for $i, j \in \{1,2\}$, with $\phi \neq 2\delta$. Under the Full Information Sharing Regime, the optimal actions are linear functions of the expected value of the own local state and the expected value of the local state of the other division. As mentioned earlier, if parameter $\delta \to 0$, then the optimal action of manager i equals the expected value of his own local state, that is, $\alpha = 1$.

Actions in the No-Information Sharing Regime

Hellwig and Veldkamp (2009), Calvó-Armengol and de Martí-Beltran (2009), Alonso et al. (2008), show different ways in which actions in equilibrium can be expressed as functions that depend on the information that each manager possesses. The main difference between this work and Hellwig and Veldkamp (2009), Calvó-Armengol and de Martí-Beltran (2009), and Alonso et al. (2008) is the information that manager acquires from the other manager. In those papers agent i has information or can get information from others to make his decisions.

In contrast, this work presents a model where the manager i is not given any information about the decision of the manager j. The manager i must form beliefs about the strategies of the other manager, therefore the expected actions depend on these beliefs and not on information transmission. Under the No-Information Sharing Regime, the optimal action of manager i is conditioned to whether the manager i has acquired costly information and on the beliefs of manager i about whether manager j has acquired costly information.

There are four cases to analyze. The first case is when both managers acquire information, and each manager believes that the other manager actually acquires costly information. The second case is when both managers do not acquire costly information, and each manager believes that the other manager actually does not acquire costly information. The third case is when manager i acquires costly information, while manager j does not acquire costly information, and each manager believes that the other manager actually does so. The fourth case is simply the symmetric counterpart of the third case.

The actions in each case take the following forms, see appendix A,

1. Both managers acquire costly information

$$a_i = \alpha\theta_i + (1-\alpha)\theta_j \quad \text{for each } i \in \{1,2\}.$$

2. No manager acquires costly information

$$a_i = \alpha\bar{\theta}_i + (1-\alpha)\bar{\theta}_j \quad \text{for each } i \in \{1,2\}.$$

3. Manager i acquires costly information, and manager j does not

$$a_i = \alpha\theta_i + (1-\alpha)\bar{\theta}_j, \quad \text{and} \quad a_j = \alpha\bar{\theta}_j + (1-\alpha)\theta_i, \quad \text{with } i \neq j$$

where $\bar{\theta}_i = \mathbb{E}_P[\theta_i] = q_i\theta_i^L + (1-q_i)\theta_i^H$ for each i, and $\mathbb{E}_P$ denotes the expectation of the argument induced by the prior distribution.

Information acquisition stage

Information acquisition modifies the beliefs of manager i about the local condition of his own division. When manager i decides to acquire costly information, he learns the true value of the local condition of his division and $\mathbb{E}_P[\theta_i]$ becomes θ_i. Whereas, if he chooses not to acquire information, he maintains his prior beliefs $P(\theta)$ and $\mathbb{E}_P[\theta_i]$ remains as $\bar{\theta}_i$. Similar to the last section, in each Information Sharing Regime there are some features that have to be analyzed.

Information acquisition in the Full Information Sharing Regime

Under this regime both managers must acquire the costly information in order to disclose it to each other. In this regime, the information becomes publicly verifiable. For example, suppose that the two divisions consist of the marketing division which pays for marketing research and the production division which pays for implementing a new process. In this regime, the two divisions meet each other in a meeting where they share the reports about the market research and about the feasibility of implementing the new process. Thus, there is no strategic decision to be taken in this regime. Both managers must acquire costly information.

Information acquisition in the No-Information Sharing Regime

In this regime, the managers are free to decide whether or not to acquire costly information. However, in this case managers do not communicate with each other. This implies that there is not information transmission. Therefore, the analysis resorts to compute the required Nash Equilibrium. For simplicity, only pure strategies will be analyzed. See the appendix B for a more general case in which the mixed strategies can be analyzed.

The expected utility that manager i will receive in the four cases of the last section is as described below.

1. Both managers acquire the costly information

$$U_i^1 = \mathbb{E}_P[u_i(\cdot)] = -\left[\phi(1-\alpha)^2 + \delta(1-2\alpha)^2\right]\left[\sigma_{\theta_i}^2 + \sigma_{\theta_j}^2 + (\bar{\theta}_i - \bar{\theta}_j)^2\right] - c.$$

2. No manager acquires costly information

$$U_i^2 = \mathbb{E}_P[u_i(\cdot)] = -\phi\sigma_{\theta_i}^2 - \left[\phi(1-\alpha)^2 + \delta(1-2\alpha)^2\right](\bar{\theta}_i - \bar{\theta}_j)^2.$$

3. Manager i acquires costly information, and manager j does not

$$U_i^3 = \mathbb{E}_P[u_i(\cdot)] = -\left[\phi(1-\alpha)^2 + \delta(1-2\alpha)^2\right]\left[\sigma_{\theta_i}^2 + (\bar{\theta}_i - \bar{\theta}_j)^2\right] - c.$$

4. Manager i does not acquire costly information, and manager j does

$$U_i^4 = \mathbb{E}_P[u_i(\cdot)] = -\phi\sigma_{\theta_i}^2 - \left[\phi(1-\alpha)^2 + \delta(1-2\alpha)^2\right]\left[\sigma_{\theta_j}^2 + (\bar{\theta}_i - \bar{\theta}_j)^2\right],$$

   where in each case $\sigma_{\theta_i}^2 = \mathbb{E}_P\left[\theta_i - \bar{\theta}_i\right]^2$ for each i represents the variance of the random variable θ_i.

It is helpful to consider the game in normal form as follows

	j acquires information	j does not acquire information
i acquires information	U_i^1, U_j^1	U_i^3, U_j^4
i does not acquire information	U_i^4, U_j^3	U_i^2, U_j^2

(Source: own elaboration)

Table 3.2: Normal form of the game in the information acquisition stage.

To find the Nash Equilibrium in pure strategies, manager i will choose the experiment that is the best response to every strategy chosen by manager j; and, conversely, manager j will choose the experiment that is the best response to every experiment chosen by manager i. Thus, if manager j chooses the fully informative experiment, the best response of manager i will be choosing the fully informative experiment if

$$
\begin{aligned}
U_i^1 &> U_i^4 \\
\Rightarrow \phi \left[\frac{\phi^2 + 3\delta(\phi + \delta)}{(\phi + 2\delta)^2} \right] \sigma_{\theta_i}^2 &> c.
\end{aligned} \tag{3.5}
$$

If manager j chooses the non informative experiment, the best response of manager i will be choosing the fully informative experiment if

$$
\begin{aligned}
U_i^3 &> U_i^2 \\
\Rightarrow \phi \left[\frac{\phi^2 + 3\delta(\phi + \delta)}{(\phi + 2\delta)^2} \right] \sigma_{\theta_i}^2 &> c.
\end{aligned} \tag{3.6}
$$

Notice that 3.5 and 3.6 are the same conditions, thus if condition denoted by 3.6 holds for manager i, this manager always chooses to acquire information. In contrast, the best response of manager i is always choosing not to acquire information if

$$
\phi \left[\frac{\phi^2 + 3\delta(\phi + \delta)}{(\phi + 2\delta)^2} \right] \sigma_{\theta_i}^2 < c. \tag{3.7}
$$

The set of Nash Equilibria depends on the condition 3.6 and 3.7, but we focus on the symmetric equilibria only, that is when condition 3.6 holds for each manager or when condition 3.7 holds for each manager. The variance of the coordinate θ_i plays an important role in those conditions. If the variance is high, the left hand side of the inequality may be greater than the right hand side; conversely, if variance is low, the left hand side of the inequality may be smaller than the cost of acquiring information. The term next to the variance, $\phi \left[\frac{\phi^2+3\delta(\phi+\delta)}{(\phi+2\delta)^2} \right]$, is an implicit function in δ and ϕ. For this reason, simulations must be done to see the behavior of that term for different values of the need for adaptation and for different values of the bias of the managers towards their own division.

The behavior of the term analyzed changes for several values of δ and ϕ. The objective of this section is to point the existence of values of the need for cooperation and the bias of the managers towards their own division that make more plausible an equilibrium than another. For instance, for small values of ϕ, the function presents a concave form in δ, with a discontinuity when $\delta < 0$ and $\phi = -2\delta$. The function takes high values when $2\delta \approx \phi$. This behavior changes for values of ϕ much bigger than 1. Now, for a value of δ near to 1, the function is increasing in ϕ. Dropping out the case of discontinuity, the term $\frac{\phi^2+3\delta(\phi+\delta)}{(\phi+2\delta)^2}$ is always positive.

Therefore, high levels of bias of managers towards his own division increases the left hand side of condition 3.6 making more attractive acquiring costly information. On the other hand, when the value of the need for cooperation δ is close -1, managers see less attractive to acquire costly information.

3.3.2 Decision of the CEO

At the ex-ante stage, the CEO decides the Information Sharing Regime under which managers take their actions. The analysis is assuming that the CEO wants to maximize the profits of the organization without internalizing the individual motive, ϕ, of each manager in the organization.

The CEO will choose the Full Information Sharing Regime only if

$$\mathbb{E}_P[v(a^*)] - 2c > \mathbb{E}_P[v(\tilde{a}^*)] - 2 \cdot \mathbb{1}c, \tag{3.8}$$

remember that such expectation depends only on the prior distribution of the states of nature at the ex-ante stage. The vector $a^* = (a_1^*, a_2^*)$, with $a_i^* = \alpha\theta_i + (1-\alpha)\theta_j$, refers to the actions taken in equilibrium by the managers when they must acquire costly information in order to disclose it in a meeting with the CEO. And $\tilde{a}^* = (\tilde{a}_1^*, \tilde{a}_2^*)$ are the actions taken in equilibrium when managers must decide privately to acquire information or not.

The expected utility that CEO will obtain when she chooses the Full Information Sharing Regime is given by

$$-\left\{2\left[(1-\alpha)^2 + \delta(1-2\alpha)^2\right]\left[\sigma_{\theta_i}^2 + \sigma_{\theta_j}^2 + (\bar{\theta}_i - \bar{\theta}_j)^2\right] + 2c\right\} \tag{3.9}$$

When the CEO chooses the No Information Sharing Regime, the expected utility she receives depends on the decision of acquiring information and on the optimal actions of the managers. Therefore, the analysis must take into account a number of cases equal to the number of equilibria in the information acquisition stage. For simplicity, only symmetric equilibria in the information acquisition stage are considered. The next step is comparing the expected utility that CEO will obtain in the Full Information Sharing Regime and the expected utility that CEO will obtain in the No-Information Sharing Regime in each equilibrium.

Both managers choose the fully informative experiment

In this case, the vector of actions taken in equilibrium in the No-Information Sharing Regime equals the vector of actions taken by managers in the Full Information Sharing Regime. If condition 3.6 holds for both managers, the CEO is sure that each manager will find it optimal to acquire the costly information. Hence, the CEO receives the same expected utility in both regimes and is indifferent between them.

Both managers will choose the fully non-informative experiment

Now, the comparison is between the expected utility that CEO will obtain in the Full Information Sharing Regime and the expected utility that CEO will obtain in the No-Information Sharing Regime given that managers does not acquire the costly information. The steps are shown in the appendix C.

In this case, the CEO will choose to do the meeting if the following condition holds

$$\left[\frac{\phi^2 + 4\delta\phi + 3\delta^2 - \delta\phi^2}{2(\phi + 2\delta)^2}\right][\sigma^2_{\theta_i} + \sigma^2_{\theta_j}] > c, \tag{3.10}$$

and also if conditions represented by 3.7 hold

$$\phi\left[\frac{\phi^2 + 3\delta(\phi + \delta)}{(\phi + 2\delta)^2}\right]\sigma^2_{\theta_i} < c \quad \text{for each } i,$$

thus, the best response of CEO is the following

$$BR_{CEO}(\cdot) = \begin{cases} \text{*Full Information Sharing Regime if} \\ \left[\dfrac{\phi^2 + 4\delta\phi + 3\delta^2 - \delta\phi^2}{2(\phi+2\delta)^2}\right]\left[\sigma^2_{\theta_i} + \sigma^2_{\theta_j}\right] > c, \quad \text{and} \\ \phi\left[\dfrac{\phi^2 + 3\delta(\phi+\delta)}{(\phi+2\delta)^2}\right]\sigma^2_{\theta_i} < c, \quad \text{for each } i \\ \\ \text{*No-Information Sharing Regime if} \\ \left[\dfrac{\phi^2 + 4\delta\phi + 3\delta^2 - \delta\phi^2}{2(\phi+2\delta)^2}\right]\left[\sigma^2_{\theta_i} + \sigma^2_{\theta_j}\right] < c, \quad \text{and} \\ \phi\left[\dfrac{\phi^2 + 3\delta(\phi+\delta)}{(\phi+2\delta)^2}\right]\sigma^2_{\theta_i} < c, \quad \text{for each } i \end{cases}$$

when the managers do not acquire information, the best response of the CEO is very sensitive to different levels of need of cooperation and levels of bias of managers towards their own division. Here, three conditions are required to hold. First of all, condition 3.7 for each manager is required to guarantee that managers do not acquire information. As discussed in the last section, condition 3.7 is feasible to hold when the local condition does not vary too much, when the managers are not too biased towards their own division and when the need for cooperation is relatively near to -1. Second of all, condition 3.10 must hold. Such condition depend on the term $\frac{\phi^2+4\delta\phi+3\delta^2-\delta\phi^2}{2(\phi+2\delta)^2}$, which is an implicit function of δ and ϕ. Once again, the use of simulations helps to see the behavior of such expression. As before, given a specific value of ϕ the function is concave in δ, reaching the highest values when $2\delta \approx \phi$. Now, for some specific values of δ, the function behaves as a strictly decreasing function in ϕ, reaching its highest value when $\phi \to 1$.

Hence, the best response of the CEO is choosing the Full Information Sharing Regime when the managers are not too biased towards their own divisions, when the need for cooperation is relatively high and when the variances of the local conditions are high enough to be compared with the cost of acquiring information. In addition, high cost makes difficult to maintain a Full Information Sharing Regime.

Chapter 4

Conclusion

The model presented here highlights the roles of (i) the need for cooperation between managers and (ii) the individual motives of the managers in deciding whether or not to acquire information relevant for the organization.

If there is no need for cooperation, the managers set little weight to the actions of other managers. In this case, the action of each manager only considers the adaptation problem, in which managers want to match their actions to the local conditions of the divisions. The decision of acquiring information only takes into account how biased are the managers towards their own divisions, the level of variance of the local conditions of divisions and the cost of information.

When the need of cooperation is positive, actions are strategic complements. It means that managers want to take similar actions to improve their level of utility. Thus, each manager will set a greater weight to the action taken by the other manager. In relation to information acquisition, when actions are strategic complements, there are situations in which managers are more attracted to acquire information. Such situations are characterized by a very low need for coordination and the existence of managers not too biased. Conversely, managers are more likely to not acquire information if the need for coordination is relatively high.

If the actions are strategic substitutes, there are cases in which managers are attracted to acquire information. Those cases are very similar to those in the case of strategic complements.

Such cases are characterized by a very low need for coordination and the existence of managers not too biased. Conversely, managers are more likely not to acquire information if the need for coordination is relatively high.

Now, the increases in cost of acquiring information may induce managers to not acquire information. If the increase in cost is high enough, then managers do not receive any benefit from being informed. In this case, the managers are better off if they remains their priors.

In relation to the individual motive of each manager, there are cases in which it seems more likely that managers choose to acquire information. For instance, when the need for cooperation is close to 1 and if managers are too biased towards their own division, it seems more plausible that managers choose to acquire information.

Regarding to the decisions of the CEO, she must take into account more restrictions than managers. She faces an extra condition to prefer a regime than the other. This condition reduces the values of need for cooperation and the bias of each manager that can induce an equilibrium. However, equilibrium of this kind exists.

In summary, the cost of acquiring information makes more difficult that managers wish to acquire such information. Also, there are situations in which the best option of the CEO is to let both managers taking the decision of not acquiring information. It depends on how biased are the managers and how big is the need for cooperation.

Appendix A

Actions in equilibrium

For the no information sharing regime, both managers must decide which information structure commit to, and this commitment will induce actions in equilibrium. Each manager will choose the optimal action taking into account the information structure he has committed to and his beliefs about the information structure that the other manager has committed to. Because we have to analyze the actions induced by given information structures, in particular we analyze the actions induced by the equilibrium in the experimentation stage, that is when $r_i = \beta_i$ and $r_j = \beta_j$, when the beliefs of each manager about the actions of the other manager equals to the real actions such manager will take.

In this way, when both managers commit to the fully informative experiment and believe that the other manager will actually commit to this experiment, the actions in equilibrium will follow from 3.2

$$a_i = \gamma\theta_i + (1-\gamma)a_j$$
$$a_j = \gamma\theta_j + (1-\gamma)a_i,$$

solving this system of equations we get

$$\begin{aligned} a_i &= \gamma\theta_i + (1-\gamma)[\gamma\theta_j + (1-\gamma)a_i] \\ a_i &= \frac{1}{1-(1-\gamma)^2}[\gamma\theta_i + (1-\gamma)\gamma\theta_j] \\ \Rightarrow a_i &= \alpha\theta_i + (1-\alpha)\theta_j \quad \text{for each } i. \end{aligned}$$

Now, the case in which both managers commit to the non informative experiment. From 3.2 we get

$$\hat{a}_i = \gamma\bar{\theta}_i + (1-\gamma)\hat{a}_j$$

$$\hat{a}_j = \gamma\bar{\theta}_j + (1-\gamma)\hat{a}_i,$$

solving this system of equations we get

$$\begin{aligned} \hat{a}_i &= \gamma\bar{\theta}_i + (1-\gamma)[\gamma\bar{\theta}_j + (1-\gamma)\hat{a}_i] \\ \hat{a}_i &= \frac{1}{1-(1-\gamma)^2}[\gamma\bar{\theta}_i + (1-\gamma)\gamma\bar{\theta}_j] \\ \Rightarrow \hat{a}_i &= \alpha\bar{\theta}_i + (1-\alpha)\bar{\theta}_j \quad \text{for each } i. \end{aligned}$$

And finally, the case in which a manager, i, commits to the fully informative experiment and the other, j, commits to the non informative one. The fourth case is very similar to this. From 3.2 we get

$$\tilde{a}_i = \gamma\theta_i + (1-\gamma)\tilde{a}_j$$

$$\tilde{a}_j = \gamma\bar{\theta}_j + (1-\gamma)\tilde{a}_i,$$

solving this system of equations we get

$$\tilde{a}_i = \gamma\theta_i + (1-\gamma)[\gamma\bar{\theta}_j + (1-\gamma)\tilde{a}_i]$$
$$\tilde{a}_i = \frac{1}{1-(1-\gamma)^2}[\gamma\theta_i + (1-\gamma)\gamma\bar{\theta}_j]$$
$$\Rightarrow \tilde{a}_i = \alpha\theta_i + (1-\alpha)\bar{\theta}_j,$$

substituting $\tilde{a}_i$ into $\tilde{a}_j$ we get

$$a_j = \alpha\bar{\theta}_j + (1-\alpha)\theta_i$$

Appendix B

Information acquisition stage

First of all, manager i's conditional expected utility is given by the following expression

$$\mathbb{E}[u_i(a^*,\theta)|s_i,r_i,\beta_j] = \beta_j\left[r_i\mathbb{E}_P[u_i^1(\cdot)] + (1-r_i)\mathbb{E}_{\mathbb{P}}[u_i^2(\cdot)]\right] + \\ + (1-\beta_j)\left[r_i\mathbb{E}_P[u_i^3(\cdot)] + (1-r_i)\mathbb{E}_P[u_i^4(\cdot)]\right] - r_i c_i,$$

reordering

$$\mathbb{E}[u_i(a^*,\theta)|s_i,r_i,\beta_j] = \\ = r_i\big\{\beta_j\{\mathbb{E}_P[u_i^1(\cdot)] + \mathbb{E}_P[u_i^4(\cdot)] - \mathbb{E}_P[u_i^2(\cdot)] - \mathbb{E}_P[u_i^3(\cdot)]\} + \mathbb{E}_P[u_i^3(\cdot)] - \mathbb{E}_P[u_i^4(\cdot)] - c_i\big\} \\ + \mathbb{E}_P[u_i^4(\cdot)] + \beta[\mathbb{E}_P[u_i^2(\cdot)] - \mathbb{E}_P[u_i^4(\cdot)]],$$

where $r_i \in [0,1]$ is the probability with which manager i chooses the fully informative experiment and $(1-r_i)$ is the probability with which manager i chooses the fully non-informative experiment. $\mathbb{E}_P$ denotes the expectation induced by the prior distribution. $U_i^1(\cdot)$ is the utility received by manager i when both managers take the actions under the fully revealing experiment, $U_i^2(\cdot)$ is the utility received by manager i when manager i takes the action under the fully revealing experiment and the manager j takes the action under the non informative experiment, $U_i^3(\cdot)$ is the utility received by manager i when manager j takes the action under the fully revealing experiment and the manager i takes the action under the non informative experiment, and finally, $U_i^4(\cdot)$ is the utility received by manager i when both managers take the actions under the non informative experiment.

Thus, the best response of manager i is given by the following expression

$$BR_i(\beta_j; \phi_i, \phi_j, \delta) = \begin{cases} r_i = 1 & \text{if } G_i > 0 \\ r_i = 0 & \text{if } G_i \leq 0, \end{cases}$$

where $G_i = \beta_j\{\mathbb{E}_P[u_i^1(\cdot)] + \mathbb{E}_P[u_i^4(\cdot)] - \mathbb{E}_P[u_i^2(\cdot)] - \mathbb{E}_P[u_i^3(\cdot)]\} + \mathbb{E}_P[u_i^3(\cdot)] - \mathbb{E}_P[u_i^4(\cdot)] - c_i$.

The equilibrium in this stage is achieved when for each manager i the beliefs formed about the experiment commitment of the other manager equals the experiment chosen, i.e., $r_j = \beta_j$. Therefore, both managers will choose the fully informative experiment if, for each $i \in \{1, 2\}$

$$\big\{\mathbb{E}_P[u_i^1(\cdot)] + \mathbb{E}_P[u_i^4(\cdot)] - \mathbb{E}_P[u_i^2(\cdot)] - \mathbb{E}_P[u_i^3(\cdot)]\big\}\beta_j > c_i - \mathbb{E}_P[u_i^3(\cdot)] + \mathbb{E}_P[u_i^4(\cdot)]$$

Intuitively, manager i will set probability one to choose the fully informative experiment if there is a gain in expected utility conditioned on the response of the other manager, and if this gain is greater than the cost of incurring in such experiment.

Appendix C

Decision of the CEO

In the case where both managers decide to commit to the non informative experiment, that is, when condition 3.6 holds, the actions taken in equilibrium are

$$a_i = \alpha\bar{\theta}_i + (1-\alpha)\bar{\theta}_j \quad \text{for each } i \in \{1,2\},$$

substituting those actions in 3.8, we get

$$\begin{aligned}\mathbb{E}_P[v(\tilde{a}^*)] &= -\mathbb{E}_P\big\{2[(1-\alpha)^2 + \delta(1-2\alpha)^2](\bar{\theta}_i - \bar{\theta}_j)^2 + (\theta_i - \bar{\theta}_i)^2 + (\theta_j - \bar{\theta}_j)^2\big\} \\ &= -\big\{2[(1-\alpha)^2 + \delta(1-2\alpha)^2](\bar{\theta}_i - \bar{\theta}_j)^2 + \sigma^2_{\theta_i} + \sigma^2_{\theta_j}\big\},\end{aligned}$$

the last expression will be compared with 3.9 to obtain a condition depending on parameters only represented by 3.10.

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