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Optimal Dissent in Organizations

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We model an organization as a two-agent hierarchy: an informed Decision Maker in charge of selecting projects and a (possibly) uninformed Implementer in charge of their execution. Both have intrinsic preferences over projects. This paper models the costs and benefits of divergence between their preferences, that is, dissent within the organization. Dissent is useful to (1) foster the use of objective (and sometimes private) information in decision making and (2) give credibility to the Decision Maker's choices. However, dissent comes at the cost of hurting the Implementer's intrinsic motivation, thereby impairing organizational efficiency. We show that dissent can be optimal, in particular, when information is useful and uncertainty is high. Moreover, dissent remains an optimal organizational form even when Implementers can choose their employer or when Decision Makers have real authority over hiring decisions.

Workers do, and managers figure out what to do.

F. Knight (1921)

1. INTRODUCTION

A key role of managers in organizations is to make decisions. Yet, as pointed out by Knight (1921), a project is rarely implemented by the manager who has selected it. This "separation of implementation and control" is not innocuous for decision making. *Implementers* may dislike selected projects or simply not adhere to the manager's vision for the firm. Such reluctance to carry out selected projects may not manifest as an open conflict, but rather as underprovision of effort. This paper explores theoretically the existence of such "implementation constraints" and relates them to organizational efficiency.

The insight that Decision Makers need to internalize Implementers' preferences is well recognized in the practitioner management literature. Arguably, it is one of the key messages of Sloan's (1963) autobiography, *My Years with General Motors*. In chapter 5, Sloan relates the story of the copper-cooled engine, a project that raised the enthusiasm of GM's managers but failed to obtain the support of the line engineers in charge of implementing it. Their lack of motivation in implementing the innovation resulted in failure, at a very large cost for the company. Sloan quotes his own analysis of the situation in 1923, at the core of the crisis: "We feel that [...] forcing the divisions to take something they do not believe in [...] is not getting us anywhere. We have tried that and we have failed".

Surprisingly, this role of Implementers as a constraint to decision making has not been explored in the theory of organizations. The idea that managers and their subordinates may have conflicting preferences is certainly not new to the economic literature. Many models of organizations actually assume such a conflict and seek ways to reduce it, through compensation, monitoring, the allocation of authority, signalling, and other organizational features. Thus, this entire literature shares the view that preference heterogeneity within the principal–agent relationship is, almost by definition, harmful to organizational efficiency and that organizations are there to limit its negative side effects.

However, preference heterogeneity may prove useful once one starts to acknowledge the "division of labour" among (1) those who make decisions and (2) those who have to implement them. We thus consider an organization consisting of two employees with different functions: a Decision Maker (she) in charge of selecting a project, and an Implementer (he) in charge of its execution. Both individuals have intrinsic and possibly differing preferences over projects but share an interest in the project's success. Successful implementation requires that the Implementer exert costly unobservable effort. Finally, the organization is endowed with some "objective" information about the "right" strategic decision (*i.e.* the one that maximizes the Owner's profit). The key feature of this set-up is that the Decision Maker has to anticipate the effort the Implementer is willing to provide on each particular project. A dissenting Implementer (*i.e.* an Implementer with intrinsic preferences not aligned with those of the Decision Maker) is more likely to be reluctant to work on the Decision Maker's preferred project. Anticipating this, the Decision Maker is led to use more of the objective information in her decision process and to take less account of her own preferences, which raises the organization's profitability. Thus, from the organization Owner's point of view, lack of congruence may impose an efficient implementation constraint that disciplines the decision-making process. Decision making being less arbitrary, the Implementer puts in more effort, as he anticipates a higher probability of success.

This implementation constraint has, in turn, an important consequence on the Implementer's motivation. Because the project's success matters for the Implementer, he is willing to provide more effort when the Decision Maker is making an informed decision and not a self-serving one. A dissenting Implementer—by fostering the use of objective information in the decision making process—will thus hold stronger beliefs on the project's probability of success and, as a consequence, will spend more effort on the project implementation.

Divergent preferences in the chain of command come at a cost, however. Because dissent fosters the use of objective information in decision making, dissent also leads the Decision Maker to select projects that are *intrinsically* disliked by these dissenting Implementers. Therefore, an independent Implementer is more often confronted with projects he dislikes, harming his motivation. The trade-off we exhibit in this paper is therefore one between (1) more profitable, objective, projects selected and (2) less intrinsically motivated agents. As we show, when the Decision Maker's information is sufficiently precise, the optimal organization employs dissenting Implementers to provide her with incentives to use this information in her decision process.

In our hierarchical setting, heterogeneity in preferences may therefore be beneficial to the organization, but for different reasons than in "horizontal" structures such as committees or parliaments. In such structures, diversity might be desirable, as it allows individual biases to "cancel each other out". In the hierarchical organization we study, the Implementer's preferences do not need to be more objective for dissent to improve efficiency. Since the implementation constraint prevents the Decision Maker from following her own bias, it forces her to rely more on objective information. Thus, dissent may be useful even in a situation where both the Decision Maker and the Implementer have an intrinsic preference for "wrong" projects.[1] We believe this observation has important consequences for organization design, especially in situations where it is easier

1. We make this intuition clearer in an extension of our basic model with three projects, so that the "right" course of action might be a project intrinsically disliked by both the Decision Maker and the Implementer.

to observe disagreement than to appraise opinions. In the corporate governance context, for instance, it is optimal for the board of directors to appoint a value-maximizing CEO. However, in general, boards simply cannot distinguish between projects that create value and projects that do not. Our theory suggests that, in this case, the board just needs to make sure that the top executives and the CEO share different views on the optimal strategy, even if both the executives' and the CEO's preferred strategies are not optimal.

Our work is related to some recent literature on organizational design, our main innovation being the study of homogeneity of preferences in a division-of-labour framework. Zabojnik (2002) acknowledges the separation between decision making and implementation, but the organization he considers is composed of only extrinsically motivated agents and his focus is on the role of delegation of authority within the hierarchy. Dessein (2002) presents a model of communication between a principal and her agent in a situation where they have to collectively make a decision. When the principal's and the agent's preferences are not congruent, the communication he obtains is very inefficient, which stands in sharp contrast to our own results. Dewatripont and Tirole (2005) introduce a model of costly communication where homogeneity in preferences may be detrimental to organizational efficiency. While Dewatripont and Tirole (2005) focus, as we do, on the link between congruence and decision making, their theory relies on the potential free-riding issues that may appear between the sender and the receiver along the communication process.

One important extension of our model is the assumption that the objective information about the true state of nature is privately observed by the Decision Maker. This turns our simple decision-making model into a signalling game where the project selected at equilibrium might convey part of the information observed by the Decision Maker. In this context, lack of congruence becomes an efficient way to make project selection *more informative*: because lack of congruence implies a strong implementation constraint, the Implementer anticipates that the Decision Maker will use more objective information. Thus, in an organization with a dissenting Implementer, it will be easier for him to extract information about the state of nature from the project selected at equilibrium, which, in turn, will foster his motivation. Even the biased Decision Maker might then prefer heterogeneity in preferences along the chain of command as a commitment device to react to her private information. This stands in sharp contrast with the baseline model—where the objective information is public—as the Decision Maker then always favours an organization where intrinsic preferences are perfectly aligned.[2]

We end the paper with a discussion of the role of uncertainty in the model. This comparative static is motivated by the large management literature on the best way to organize firms in changing environments. We derive an extension of the model where one of the project (the "status quo") is *a priori* more likely to be profitable than the other (the "change" project). In a low-uncertainty environment, we find that firms' optimal organization should be "monolithic", that is, composed of both pro "status quo" Implementers and pro "status quo" Decision Makers. However, as firm-level uncertainty grows, the optimal organization should combine a pro status quo Implementer with a pro-change Decision Maker. In our model, change should therefore come from the top, as argued in some of the management literature's most influential contributions.

The remainder of the paper is organized as follows. Section 2 exposes the most simple set-up of the model, discusses its different assumptions and solves for the equilibrium, as well as for the optimal organizational design. Section 3 then extends the basic model by assuming that the Decision Maker has some private information about the "right" course of action. Section 4 asks if heterogeneous organizations survive when (1) the Decision Maker makes hiring decisions and

2. This aspect of our model is related to traditional signalling models (*e.g.* Hermalin (1997) in the organization literature; or Cukierman and Tomasi (1998) in the political economy literature), where an informed principal often manages to send credible messages using "money-burning" devices.

(2) the Implementer can choose the organization he wants to work for. Section 5 explores the impact of environmental uncertainty on the optimal organizational design. Section 6 concludes with leads for further research.

2. THE COSTS AND BENEFITS OF DISSENT: A FIRST PASS

We consider an organization that belongs to an Owner seeking to maximize expected profits. This organization has two employees: a Decision Maker (she) and an Implementer (he). The Decision Maker selects a project and the Implementer is in charge of implementing it.

2.1. *Project structure*

There are two projects, labelled 1 and 2. There are also two *equally likely* states of nature θ, also labelled 1 and 2. Projects either fail, in which case they deliver 0 to the firm's Owner, or succeed and deliver a profit R. We will say that project $i \in \{1, 2\}$ is "adapted" to the state of nature θ when $\theta = i$.

The Decision Maker selects among the two potential projects the one to be completed. Once selected, a project is executed by the Implementer. There is moral hazard at the implementation stage: the Implementer has to choose an implementation effort $e \in \{0, 1\}$, which is assumed to be unobservable. Exerting high effort (*i.e.* $e = 1$) entails a private, non-transferable cost $\tilde{c} \in \mathbb{R}^+$ to the Implementer. $\tilde{c}$ is random and is distributed according to a c.d.f. $F(\cdot)$. F is defined on $\mathbb{R}^+$ and is supposed to be *strictly increasing and weakly concave*.[3] Moreover, as F is a c.d.f. function, $F(0) = 0$ and $\lim_{c\to\infty} F(c) = 1$. $F(\cdot)$ is common knowledge within the organization.

We make the extreme assumption that project selection and implementation efforts are perfect complements: to be successful, the Implementer's effort must be high ($e = 1$) *and* the project must be adapted to the state of nature (*i.e.* project i must be selected in state of nature $\theta = i$). What is important here is that selection and implementation efforts are at least weak complements in the production function (see Dewatripont and Tirole, 2005 for a similar assumption).

Before selecting the project, the organization receives a binary signal $\sigma \in \{1, 2\}$ on the state of nature. This signal is informative in the sense that

$$\mathbb{P}(\sigma = i \mid \theta = i) = \alpha > \frac{1}{2}, \text{ for all } i = 1, 2.$$

We begin the analysis with the assumption that this signal is observed by *both* the Decision Maker and the Implementer. This assumption is then relaxed in Section 3, where the signal becomes private information to the Decision Maker.

2.2. *Utility functions and organizational design*

The Owner is risk neutral and maximizes the expected profit. To simplify exposition, we first assume that monetary incentives cannot be offered because, for instance, agents are infinitely risk averse on the monetary part of their utility (as in Aghion and Tirole, 1997). Thus, the Decision Maker and the Implementer derive utility only from private benefits attached to the successful completion of a project. Discussion on monetary incentives is deferred to Section 2.5.

More precisely, the Decision Maker obtains private benefit $\overline{B} > 0$ (resp. $\underline{B} > 0$) when her most (resp. least) preferred project is implemented and succeeds (with $\bar{B} > \underline{B} > 0$). When the

3. An alternative modelling choice would consist in assuming that the Implementer exerts a continuous level of effort $e \in [0, 1]$, which yields, when the appropriate project has been selected (*i.e.* project i in state i), a probability of success e at a cost $C(e)$, where $C(\cdot)$ is a convex, strictly increasing function defined over [0, 1]. Both modelling choices are equivalent. In particular, the assumption that F is concave is equivalent to the assumption that $C'''() \geqslant 0$.

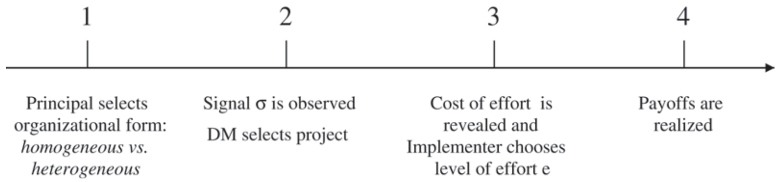

FIGURE 1

Timing of the model

project fails, *she receives no private benefit at all*. As a simple normalization, and without loss of generality, *we will assume throughout the paper that the preferred project of the Decision Maker is project 1*. We also assume that the Decision Maker's preferences are public information.

The Implementer obtains private benefit $\bar{b}$ (resp. $\underline{b} < \bar{b}$) when his most (resp. least) preferred project is selected and succeeds. In case of project failure, he has no private benefit.

Organizational design is simply the choice between (1) a *homogeneous* organization where both the Decision Maker and the Implementer prefer project 1 and (2) a *heterogeneous* organization where they have dissenting preferences, that is, the Decision Maker prefers project 1, whereas the Implementer prefers project 2.

To ease exposition, we assume that the Decision Maker is more intrinsically biased than the Implementer, in the sense that[4]

$$\frac{\bar{B}}{\underline{B}} \geq \frac{F(\bar{b}/2)}{F(\underline{b}/2)}. \tag{1}$$

2.3. *Sequence of events and information structure*

The model has four stages:

1. *Organizational design*: The Owner selects the organizational form, that is, either a homogeneous or a heterogeneous organization.
2. *Decision making*: The Decision Maker and the Implementer observe signal $\sigma \in \{1, 2\}$, with precision α, about the state of nature. The Decision Maker then selects one of the two projects.
3. *Implementation*: The implementation cost $\tilde{c} \in \mathbb{R}_+$ is revealed to the Implementer. He decides whether or not to exert effort on the project selected in stage 2.
4. *Outcome*: The project either succeeds (yielding profit R to the organization and private benefits to the agents) or fails (profit and private benefits are then equal to 0).

The corresponding timeline is drawn in Figure 1.

We solve the subgame perfect Nash equilibrium of this game. We first solve for the Implementer's provision of effort, conditional on the observed signal σ and on the project selected by the Decision Maker. We then find the Decision Maker's expected utility from selecting each project, conditional on the signal observed and her expectations on the Implementer's behaviour. We finally look for the organizational form (homogeneous vs. heterogeneous) that maximizes the Owner's expected utility in stage 1.

4. Anticipating our results, this assumption simply excludes equilibria where the Implementer is so biased that the Decision Maker is compelled to systematically select his preferred project. Such equilibria are interesting and perfectly consistent with the overall mechanisms that we describe hereafter, but they make the exposition cumbersome.

2.4. *Equilibrium characterization*

2.4.1. Main result. The first step in solving the model is to determine the Implementer's effort. Assume that project $\mathcal{P} \in \{1,2\}$ has been selected and that the public signal is $\sigma \in \{1,2\}$. $b(\mathcal{P})$ is the Implementer's private benefit when project $\mathcal{P}$ succeeds. Because of the model's symmetry, irrespective of whether $\sigma = 1$ or 2, the probability of success will be α when $\mathcal{P} = \sigma$ (the Decision Maker then "reacts to the signal") and $1-\alpha$ otherwise. Thus, the Implementer provides the high level of effort if and only if

$$\left(\alpha \mathbb{1}_{\mathcal{P}=\sigma} + (1-\alpha)\mathbb{1}_{\mathcal{P}\neq\sigma}\right) b(\mathcal{P}) - \tilde{c} \geq 0, \tag{2}$$

where $\tilde{c} \in \mathbb{R}_+$ is the Implementer's private cost of effort, revealed in stage 3.

At the decision-making stage (stage 2), the Decision Maker can thus expect the Implementer to exert the high level of effort with probability

$$\mathbb{P}[e=1 \mid \mathcal{P},\sigma] = F\left(\left(\alpha \mathbb{1}_{\mathcal{P}=\sigma} + (1-\alpha)\mathbb{1}_{\mathcal{P}\neq\sigma}\right) b(\mathcal{P})\right). \tag{3}$$

Equation (3) intuitively reveals that the Implementer is more likely to exert effort on a project that (1) he intrinsically likes and (2) has a higher probability of success.

We now turn to the decision-making process. First, we show that when the signal indicates project 1, the Decision Maker always selects project 1. Consider first the case of a homogeneous organization. If the signal indicates project 1, the Decision Maker selects project 1 if it provides him with a higher expected utility than project 2:

$$\begin{aligned} & \underbrace{\alpha}_{\text{Project 1 prob. of success}} \cdot \underbrace{F(\alpha\bar{b})}_{\text{I effort on 1}} \cdot \underbrace{\bar{B}}_{\text{DM private benefits on 1}} \\ \geq \; & \underbrace{(1-\alpha)}_{\text{Project 2 prob. of success}} \cdot \underbrace{F((1-\alpha)\underline{b})}_{\text{I effort provision on 2}} \cdot \underbrace{\underline{B}}_{\text{DM private benefits on 2}}, \end{aligned} \tag{4}$$

which always holds, since (1) project 1 is then the most likely to succeed and (2) in a homogeneous organization, both the Decision Maker and the Implementer have a strict preference for project 1.

Consider now the case of a heterogeneous organization. On the one hand, project 1 provides the Implementer with the lowest intrinsic motivation. On the other hand, because signal 1 is observed, project 1 is the project most likely to succeed. Additionally, project 1 provides the Decision Maker with the highest intrinsic motivation. Overall, Assumption (1) ensures that the former gains from selecting project 1 outweigh the latter loss, that is, that the following inequality is always verified:

$$\begin{aligned} & \underbrace{\alpha}_{\text{Project 1 prob. of success}} \cdot \underbrace{F(\alpha\underline{b})}_{\text{I effort provision on 1}} \cdot \underbrace{\bar{B}}_{\text{DM private benefits on 1}} \\ \geq \; & \underbrace{(1-\alpha)}_{\text{Project 2 prob. of success}} \cdot \underbrace{F((1-\alpha)\bar{b})}_{\text{I effort provision on 2}} \cdot \underbrace{\underline{B}}_{\text{DM private benefits on 2}} \end{aligned} \tag{5}$$

When the signal indicates project 2, the Decision Maker faces conflicting objectives: project 1 is her preferred project but leads to a lower objective probability of success. Consider first the case of a heterogeneous organization. The Decision Maker selects project 2 after observing signal 2 if and only if

$$\alpha F(\alpha \bar{b})\underline{B} \geq (1-\alpha) F((1-\alpha)\underline{b})\bar{B} \Leftrightarrow \alpha \geq \alpha^{\text{het}} \in]1/2, 1[, \tag{6}$$

while, in a homogeneous organization, a Decision Maker selects project 2 if and only if

$$\alpha F(\alpha \underline{b})\underline{B} \geq (1-\alpha) F((1-\alpha)\bar{b})\bar{B} \Leftrightarrow \alpha \geq \alpha^{\text{hom}} \in]1/2, 1[. \tag{7}$$

It is quite obvious from inequalities (6) and (7) that the Decision Maker's incentive for selecting project 2 is stronger in a heterogeneous organization, as the Implementer derives higher intrinsic utility from project 2 in this case. Formally $1/2 < \alpha^{\text{het}} < \alpha^{\text{hom}} < 1$.

These intuitive results are summarized in the following proposition:

Proposition 1. *There exist α^{het} and α^{hom} such that $1/2 < \alpha^{\text{het}} < \alpha^{\text{hom}} < 1$ and*

1. *For $\alpha \leq \alpha^{\text{het}}$, both organizations are "non-reactive"; that is, the Decision Maker always selects project* 1.
2. *For $\alpha^{\text{het}} \leq \alpha \leq \alpha^{\text{hom}}$, the homogeneous organization remains non-reactive, while the heterogeneous organization becomes "reactive"; that is, always selects the project indicated by the signal σ.*
3. *For $\alpha \geq \alpha^{\text{hom}}$, both organizations are "reactive".*

Proof. See Appendix A.

2.4.2. Reactivity in a three-project organization. Heterogeneous organizations are more reactive. In this model, this originates from the fact that a Decision Maker observing signal 2 faces two trade-offs. The first is between following her bias (thus selecting project 1) and following the Implementer's bias (thus selecting project 2). This effect is present in our simple set-up because there are only two projects: one that the Decision Maker intrinsically likes and another that the Implementer (possibly) prefers.

However, the higher reactivity of heterogeneous organizations does not depend on the assumption that there are only two projects. This is because the Decision Maker faces another trade-off, namely between following her own bias and selecting the right project. Having a dissenting Implementer reduces her incentive to follow her own bias and thus leads her to react to the signal more often. This second effect does not depend on the number of potential projects. It is conceptually important, as it suggests that the Implementer does not have to be more objective than the Decision Maker for dissent to elicit reactivity. This stands in sharp contrast with intuitions from horizontal organizations, where dissent would be beneficial only if it allowed biases to cancel each other out. It is the hierarchical nature of our model, as well as the implementation constraint, that makes dissent effective.

To get a better understanding of this result, it is useful to think of an extension of the above model with a third project. There are now three states of nature and, for all $i \in \{1, 2, 3\}$, project i can only succeed in state i. We assume that the signal indicates the true state of nature with probability α, but wrongfully indicates each one of the other two projects with probability $(1-\alpha)/2$. α, the signal precision, now goes from $1/3$ (uninformative signal) to 1 (fully informative signal).

The pay-offs to the Implementer and Decision Maker are set in the same spirit as in the two-project model. We assume, without loss of generality, that the Decision Maker is again intrinsically biased towards project 1: she enjoys private benefit $\overline{B}$ if project 1 is successfully implemented, while success of either project 2 or 3 only provides her with utility $\underline{B} < \overline{B}$. A homogeneous organization is now defined as an organization where the Implementer has intrinsic preferences similar to those of the Decision Maker: he gets $\overline{b}$ when project 1 succeeds but only $\underline{b} < \overline{b}$ when project 2 or 3 succeeds. In a heterogeneous organization, the Implementer enjoys the high private benefit $\overline{b}$ only when project 2 is successful, while the other two projects' success only provide him with utility $\underline{b}$.[5] Last, we make an assumption similar to Assumption (1):

$$\frac{\overline{B}}{\underline{B}} > \frac{F(\overline{b}/3)}{F(\underline{b}/3)}. \tag{8}$$

The following proposition describes the equilibria for both organizational forms:

Proposition 2. *There exist three thresholds α_1, α_2, and α_3, such that $1/3 < \alpha_1 < \alpha_2 < \alpha_3 < 1$ and*

1. *For $1/3 < \alpha < \alpha_1$, both organizations are "non-reactive", that is, the Decision Maker always selects project* 1.
2. *For $\alpha_1 < \alpha < \alpha_2$, the homogeneous organization is "non-reactive". The heterogeneous organization is "partly reactive" : it selects project* 1 *when $\sigma = 1$ or* 3*, and project* 2 *when $\sigma = 2$.*
3. *For $\alpha_2 < \alpha < \alpha_3$, the homogeneous organization is "non-reactive". The heterogeneous organization is "reactive" : the Decision Maker always reacts to the signal.*
4. *For $\alpha_3 < \alpha < 1$, both organizations are reactive.*

Proof. See Appendix B.

Proposition 2 proves that the introduction of a third project modifies the scope for reactivity. On the one hand, in both types of organizations, reactivity is enhanced by having an additional project, as, to the Decision Maker, the cost of not following the signal is larger: the probability of success when ignoring the signal goes from $(1-\alpha)$ in the two-project setting to $(1-\alpha)/2$. On the other hand, when the signal indicates project 3, both the Decision Maker and the Implementer have a low intrinsic preference for this project, and this even in a heterogeneous organization. This reduces the incentive for the Decision Maker to react to project 3, and thus impairs overall reactivity. Thus, a new equilibrium emerges where the Decision Maker reacts only to signals 1 and 2, but not to signal 3. In this equilibrium, reactivity to signal 2 is due to the fact that the Decision Maker avoids selecting a project the Implementer dislikes, while non-reactivity to signal 3 originates from the low incentives the Decision Maker has to select a project that both she and the Implementer dislike.

In spite of this new equilibrium, this extension suggests that, even when there are more than two projects, reactivity emerges more easily in a heterogeneous organization than in a homogeneous one; that is, $\alpha_3 > \alpha_2$.

2.5. *Organizational design*

2.5.1. Main result. We go back to the model with two projects and turn to organizational design, that is, the choice of the organizational form that optimizes firm value. When $\alpha > \alpha^{\text{hom}}$, both organizations are reactive, so that their expected values are the same:

$$V^{\text{het}} = V^{\text{hom}} = \frac{\alpha}{2}\left[F(\alpha\overline{b}) + F(\alpha\underline{b})\right]R. \tag{9}$$

5. The case where the Implementer has an intrinsic preference for project 3 is obviously identical.

This comes from the model's built-in symmetry: in reactive organizations, both projects can be *ex ante* selected with probability $\frac{1}{2}$. Conditional on the signal, both projects will succeed with probability α and this is always expected by the Implementer. Thus, the Implementer's preferred project does not affect the expected value.[6]

When $\alpha \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, the heterogeneous organization is reactive, while the homogeneous organization is non-reactive. We can then compute both organizations' expected profits:

$$\begin{cases} V^{\text{hom}} = \dfrac{1}{2}\left[\alpha F(\alpha\overline{b}) + (1-\alpha)\, F((1-\alpha)\overline{b})\right] R \\ V^{\text{het}} = \dfrac{\alpha}{2}\left[F(\alpha\overline{b}) + F(\alpha\underline{b})\right] R. \end{cases}$$

In the homogeneous non-reactive organization, project 1 is always selected and it is, *a priori*, successful, with probability $\frac{1}{2}$. However, in the state of nature where project 1 is the successful project, signal 1 will be observed with probability α, leading to an expected probability of high implementation effort $F\left(\alpha\overline{b}\right)$, while signal 2 will be observed with probability $1-\alpha$, leading to a lower expected implementation effort $F\left((1-\alpha).\overline{b}\right)$. The heterogeneous organization is reactive, and its value is therefore given by the same equation as (9).

For $\alpha \in [\alpha^{\text{het}}; \alpha^{\text{hom}}]$, the net benefit of heterogeneity vs. homogeneity can be decomposed into three terms:

$$V^{\text{het}} - V^{\text{hom}} = \underbrace{\left(\alpha - \frac{1}{2}\right) F(\alpha\overline{b})R}_{\text{reactivity gain}} + \underbrace{\frac{1}{2}(1-\alpha)\left[F(\alpha\overline{b}) - F\left((1-\alpha)\overline{b}\right)\right] R}_{\text{credibility gain}}$$
$$\underbrace{-\frac{\alpha}{2}\left(F(\alpha\overline{b}) - F(\alpha\underline{b})\right) R}_{\text{cost of mismatch}}. \tag{10}$$

The first expression is the "reactivity gain": since the signal is informative ($\alpha > \frac{1}{2}$), there are efficiency gains to using the signal in the decision-making process. This reactivity gain is an increasing function of α, the signal's precision. The second term is the "credibility gain": whenever the signal indicates project 2, selecting project 1 results in the Implementer's low expectation that project 1 can be successful at all. In other words, in a non-reactive organization, some decisions are perceived by the Implementer as less "legitimate", which reduces his motivation. Finally, the third expression relates to the "cost of mismatch". A non-reactive homogeneous organization always selects the project the Implementer prefers, thus maximizing the Implementer's *intrinsic* motivation. Conversely, a heterogeneous reactive organization selects project 1 with probability $\frac{1}{2}$,"compelling" the Implementer to implement with probability $\frac{1}{2}$ a project he intrinsically dislikes. We show in Proposition 3 that the overall net benefit of heterogeneity relative to homogeneity is a strictly increasing function of α, the signal precision, and that there exists an interior threshold α^* such that the heterogeneous reactive organization strictly dominates over $[\alpha^*; \alpha^{\text{hom}}]$, while the homogeneous organization is optimal over $[\alpha^{\text{het}}; \alpha^*]$. Finally, when $\alpha < \alpha^{\text{het}}$, both organizations are non-reactive, so that their value can be written as

$$\begin{cases} V^{\text{hom}} = \dfrac{1}{2}\left[\alpha F(\alpha\overline{b}) + (1-\alpha)\, F\left((1-\alpha)\overline{b}\right)\right] R \\ V^{\text{het}} = \dfrac{1}{2}\left[\alpha F(\alpha\underline{b}) + (1-\alpha)\, F\left((1-\alpha)\underline{b}\right)\right] R. \end{cases}$$

6. We break this symmetry in Section 5.

For these low values of α, both organizations always implement the same project (project 1). But, since the Implementer in the heterogeneous organization has low intrinsic motivation for project 1, the homogeneous organization systematically delivers higher expected profit. Proposition 3 summarizes the analysis of this simple model:

Proposition 3. *There exists $\alpha^* \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, such that*

1. *For $\alpha < \alpha^*$, the homogeneous non-reactive organization is optimal.*
2. *For $\alpha^{\text{hom}} > \alpha \geq \alpha^*$, the heterogeneous reactive organization is optimal.*
3. *For $\alpha \geq \alpha^{\text{hom}}$, both organizations yield the same expected profit.*

Proof. See Appendix C.

Three ingredients crucially hinge behind Proposition 3. First, in an organization, decisions are often not purely driven by profit consideration, but also by intrinsic preferences, come they from private benefits or differences in beliefs, as in Van den Steen (2005). Second, an organization is often endowed with at least some objective, valuable information on the relative merits of all potential strategies. Finally, decision making and implementation are often not executed by the same individuals. If one acknowledges these three features of most organizations, then organizational design, that is, the choice of alignment of intrinsic preferences within the organization, becomes crucial to organizational efficiency.

Interestingly, results of Proposition 3 can also be cast in terms of "optimal labour division", whereby the Owner can choose to delegate the implementation task to the Decision Maker herself or to a separate Implementer.[7] This is a particular case of the above model, where $\overline{b} = \overline{B}$ and $\underline{b} = \underline{B}$. More precisely, when Decision Makers are also in charge of implementation, the organization is homogeneous (and the Decision Maker anticipates her own future incentives for implementation). When decision making and implementation tasks are separated, Implementers may have opposite preferences, and the equivalent organization is more likely to be heterogeneous. In this context, Proposition 3 suggests that when reactivity is valuable enough, separating Decision Making from implementation is optimal, as it gives rise to the implementation constraint.

Perhaps surprisingly, the above analysis does not rest on the absence of monetary incentives. So far, we have not allowed the Owner of the firm to write state-contingent compensation contracts for the Implementer and the Decision Maker. When such contracts are introduced, we may expect the Owner to force the Decision Maker to react, and the Implementer to put in high effort more often. Then, one may wonder whether organizational design (*i.e.* the choice between the homogeneous and the heterogeneous organizational form) remains relevant.

We show that dissent may still, in general, be optimal, provided that the Implementer and the Decision Maker are both limitedly liable. To prove this point, we reason by contradiction. First, we assume that the Owner can design "very complete" monetary contracts: compensation is not only contingent on the success of the selected project, but also on the nature of the selected project *and* on the signal received by the Decision Maker. Solving for the optimal contract in general is beyond the scope of this paper, but we show in Appendix D that when F is the uniform distribution function, heterogeneity remains the optimal organizational form for a non-empty set of signal precision.

The robust intuition behind this result is that heterogeneity delivers reactivity at zero monetary cost. Assume that α is such that the Owner would be aiming for a reactive organization, absent monetary incentives. One possibility is to provide the Decision Maker with a reward when she reacts to the signal, and nothing if she does not. This is *ex ante* costly because negative

7. We wish to thank a referee for suggesting this alternative interpretation of the model.

payments are prevented by limited liability. Alternatively, the Owner can choose a heterogeneous organization. As we have seen above, for some values of α, such organizations are reactive, even when the Decision Maker receives zero monetary payment. Thus, for some values of $\alpha \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, we have that reactivity is profit maximizing and it is optimal to achieve it through dissent. In this case, the Decision Maker's optimal compensation is 0.

3. WHEN THE SIGNAL IS PRIVATE INFORMATION

The model of Section 2 assumes perfect information. Thus, the Implementer knows if the Decision Maker has reacted to the signal or not. However, in many situations, the Decision Maker might have access to private, soft, and unverifiable information (by going to meetings, reading confidential memos, and so on). When this is the case, reactivity may emerge less often, as the Decision Maker has strong incentives to mis-report her private signal and select her own preferred project. To investigate this possibility, this section assumes that the signal σ is private information to the Decision Maker.

3.1. *Equilibrium concept*

We assume here that the signal σ is not observable to the Implementer, but only to the Decision Maker. Therefore, our model becomes a standard signalling game, where the Implementer has to draw inferences about the signal σ from the informed Decision Maker's project choice.

An equilibrium is defined by two strategies: $(\mathcal{P}, \mu)$. $\mathcal{P}$ is the *Decision Maker's selection process* (the project that she selects), that is, a function that maps the Decision Maker's private signal $\sigma \in \{1, 2\}$ into the project space $\{1, 2\}$:

$$\mathcal{P} : \sigma \in \{1; 2\}. \mapsto \{1; 2\}.$$

$\mu(\cdot)$ is the *Implementer's posterior belief* (about the actual state of nature), that is, a function that maps the project selected by the Decision Maker onto a probability that 1 is the state of nature:

$$\mu : \mathcal{P} \in \{1; 2\} \mapsto \mathbb{P}(\theta = 1 \mid \mathcal{P}) \in [0, 1].$$

A perfect Bayesian equilibrium of the game is a couple $(\mathcal{P}, \mu)$ that verifies

1. *Individual rationality:* Given the Implementer's posterior belief $\mu(\cdot)$, $\mathcal{P}(\sigma)$ maximizes the Decision Maker's expected utility for each $\sigma \in \{1, 2\}$.
2. *Bayesian updating:* The posterior $\mathbb{P}(\theta = \mathcal{P} \mid \mathcal{P})$ is obtained using the selection process $\mathcal{P}(\cdot)$, the Implementer's prior about state θ and Bayes' law.

As already stressed, our model is similar to a standard signalling game (see, for example, Spence, 1973), with an informed principal (the Decision Maker, who knows the true value of the signal) and an uninformed agent (the Implementer, who does not observe this signal). As with most signalling games, there are many equilibria in our model if we do not impose any restrictions on the Implementer's out-of-equilibrium beliefs. The standard refinement of beliefs in the signalling literature is the notion of strategic stability, introduced by Kohlberg and Mertens (1986). We will use in this paper a weaker refinement, known as D1 (Cho and Sobel, 1990), which is sufficient for a unique equilibrium to emerge in our basic model. Intuitively, the D1 refinement makes the following restriction: when the Implementer observes an out-of-equilibrium "order", he believes it comes from the Decision Maker, whose signal makes her "most eager" to deviate from equilibrium. This means that, in a non-reactive organization, if the Decision Maker selects project 2 (this never happens in equilibrium), the Implementer would infer that she has observed

$\sigma = 2$, not $\sigma = 1$. Obviously, $\sigma = 2$ makes the Decision Maker "more eager" to select project 2 than $\sigma = 1$.

3.2. *Equilibrium characterization*

To solve the model, we proceed as in Section 2. The following proposition summarizes and describes the equilibria for both types of organizations:

Proposition 4. *Let $j \in \{het,hom\}$. For both types of organizations, there exist two thresholds $\frac{1}{2} < \alpha^j_{\mathrm{NR}} < \alpha^j_R < 1$ such that*

1. *For $\alpha < \alpha^j_{\mathrm{NR}}$, organization j is non-reactive.*
2. *For $\alpha^j_{\mathrm{NR}} \leq \alpha \leq \alpha^j_R$, organization j is "semi-reactive" : after observing signal 2, the Decision Maker selects project 1 with probability $\rho^j(\alpha)$.*
   $\rho^j(\alpha)$ is a decreasing and continuous function of α. $\rho^j(\alpha^j_{\mathrm{NR}}) = 1$ and $\rho^j(\alpha^j_R) = 0$.
3. *For $\alpha > \alpha^j_R$, the organization is fully reactive.*

Proof. See Appendix E.

In contrast to the basic model of Section 2.4, the analysis does not end with the characterization of pure reactive and non-reactive equilibria. This comes from the fact that the signal is now private information to the Decision Maker. When α is large enough, or low enough, there is no ambiguity from the Implementer's viewpoint, and the intuitions of the basic model carry through in the presence of asymmetric information. But for intermediate values of α, semi-reactive equilibria emerge where the Decision Maker, after observing signal 2, is indifferent between selecting project 1 and selecting project 2 and therefore randomizes between the two projects.

For $j \in \{\text{het,hom}\}$, we let ρ^j be the probability that the Decision Maker selects project 1 after observing signal 2. ρ_j thus measures the "inertia" of organization j. The following lemma shows how reactivity evolves (1) with the signal precision α and (2) with the organizational form:

Lemma 1. *For $j \in \{het,hom\}$, let $\rho^j(\alpha)$ be the probability that the Decision Maker j selects project 1 when the signal $\sigma = 2$. Then:*

1. *$\rho^j(\alpha)$ is a decreasing function of α.*
2. *$\rho^{\text{het}}(\alpha) < \rho^{\text{hom}}(\alpha)$ for all $\alpha \in [1/2; 1]$.*

Proof.

1. From Proposition 4, with $\rho^j(\alpha) = 1$ if $\alpha < \alpha^j_{\mathrm{NR}}$, and $\rho^j(\alpha) = 0$ if $\alpha > \alpha^j_R$.
2. See Appendix F.

The above results are depicted in Figure 2 in the particular case where $\alpha^{\text{hom}}_{\mathrm{NR}} < \alpha^{\text{het}}_R$. The inertia in homogeneous organizations (blue) is always larger than in heterogeneous ones (red). This is intuitive: in homogeneous organizations, the Decision Maker has more incentive to follow her own bias than to use objective information. The next lemma shows that information asymmetries impair reactivity in both types of organizations:

Lemma 2.

$$\textit{For } j \in \{\text{het, hom}\}\textit{:}\ \alpha^j < \alpha^j_{\mathrm{NR}} < \alpha^j_R\ .$$

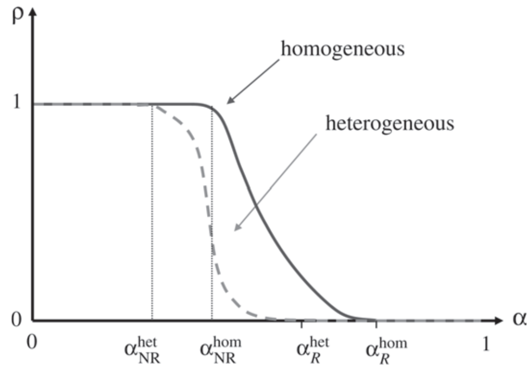

FIGURE 2
"non-reactivity" in both organizations

Proof. See Appendix G.

This lemma proves that, for $\alpha \in [\alpha^j, \alpha^j_{\text{NR}}]$, asymmetric information makes organization j non-reactive, while it was reactive in the perfect-information setting of Section 2.4. Indeed, when the signal was observed by the Implementer, the costs for the Decision Maker of not reacting to signal 2 were high because the Implementer had low expectations about project 1 (expected probability of success was $1-\alpha$). Once the signal becomes private information to the Decision Maker, the cost of not reacting to signal 2 decreases: the Implementer's belief on the success of project 1 is now at least $\frac{1}{2}$. Thus, introducing private information reduces the scope for reactivity.

3.3. *Organizational design*

The search for the optimal organizational form is similar to the one we performed in Section 2.5, except there are now three different types of equilibrium:

Proposition 5. *There exists a unique* $\alpha^{**} \in [\alpha^{\text{het}}_{\text{NR}}, \alpha^{\text{hom}}_{\text{NR}}]$ *such that*

1. *For* $\alpha < \alpha^{**}$*, the homogeneous non-reactive organization has the highest expected profit.*
2. *For* $\alpha^{**} < \alpha < \alpha^{\text{hom}}_R$*, the heterogeneous semireactive or reactive organization maximizes expected profit.*
3. *For* $\alpha > \alpha^{\text{hom}}_R$*, both organizations generate the same expected profit.*

Proof. See Appendix H.

As in the preliminary model of Section 2.4, the net gain of heterogeneity can be broken down into three different expressions: a reactivity gain, a credibility gain, and a cost of mismatch. However, the credibility gain takes a new meaning in this context of private information. In Section 2.4, the credibility gain originated from the observability of the signal σ: selecting the project indicated by the signal clearly strengthened the Implementer's belief about the probability of success of the project he had to implement. This helped to motivate him. When σ is private information to the Decision Maker, the heterogeneous organizational form makes the choice made by the Decision Maker more *informative* about the true state of nature. This additional information increases the Implementer's motivation, and thus makes heterogeneous organizations even more attractive to the Owner. In other words, dissent becomes even more beneficial to organizational efficiency than in Section 2.4, as it "reduces the noise" in the Implementer's inference about the true state of nature.

We end this section with a brief discussion on "transparency" in organizations. Assume the Owner can make the signal public information *at no cost*. Would he choose to do so? Perhaps surprisingly, the answer to this question is not always yes.

This is easily seen by considering cases where $\alpha < \alpha^j$, $j \in \{\text{hom}, \text{het}\}$, that is, when the signal precision is low. In that case, both the "transparent" and the "opaque" organizations are non-reactive. By turning the signal σ into public information, the Owner makes the Implementer's belief on the probability of success of the selected project more extreme, from $\left(\frac{1}{2}, \frac{1}{2}\right)$ in an opaque organization to $(\alpha, 1-\alpha)$ in a transparent one. Because F is concave, this decreases profit as effort becomes concentrated in one particular state of nature instead of being evenly spread out across states of nature. However, there is a countervailing effect: in a transparent, non-reactive, organization, the Implementer's effort is concentrated on projects that are more likely to succeed, that is, projects indicated by the signal. Which of these two effects dominates depend on the concavity of F. For instance, we show in Appendix I that if $F(x) + xf(x)$ is an increasing function of x over $[(1-\alpha)\underline{b}, \alpha\bar{b}]$, that is, if F is not "too" concave, then the latter effect dominates the former and the Owner always prefers making the signal public information. Symmetrically, when $F(x) + xf(x)$ is a decreasing function of x over $[(1-\alpha)\underline{b}, \alpha\bar{b}]$, that is, when F is "very" concave, opacity is optimal for the Owner at these low levels of α. In this case, keeping the Implementer "in the dark" about the nature of the signal received by the Decision Maker increases organizational efficiency.

As the previous analysis implicitly suggests, the optimal choice of transparency cannot be generally characterized, as it depends on the concavity of F. Yet, we can remark that when the signal becomes more precise, $\alpha > \alpha^j_{\text{NR}}$, $j \in \{\text{hom}, \text{het}\}$), the Owner always prefers to make it public information. With such a signal, we know that transparency weakly increases reactivity in the organization (see Lemma 2 —for $\alpha > \alpha^j_{\text{NR}} > \alpha^j$, the transparent organization is fully reactive, while the opaque organization is either fully or semi-reactive). Moreover, for each value of α, the fully reactive organization delivers a higher value to the Owner than the semi-reactive organization (see Appendix I). Hence, for $\alpha \geq \alpha^j_{\text{NR}}$, the organization is better off when the Implementer can observe the signal received by the Decision Maker.

4. ORGANIZATIONAL DYNAMICS

So far, we have assumed that organizational design was performed by the Owner. We thus implicitly omitted the Implementer's and Decision Maker's roles in shaping the organization. Yet, when the Decision Maker has real authority over hiring decisions, she may prefer to hire like-minded Implementers. Also, Implementers may prefer to work with like-minded Decision Makers and quit heterogeneous organizations. In this section, we ask whether optimal heterogeneous organizations survive in these cases.

4.1. *When the decision maker hires implementers*

In this section, we assume that the Decision Maker has the real authority over the hiring decision: the Decision Maker thus selects between the heterogeneous and the homogeneous organization. How does this affect the equilibrium organizational structure?

Consider first the simple set-up of Section 2.4, where the signal received by the Decision Maker is public information, and compare the Decision Maker's and Owner's objectives. When selecting the optimal organizational form, the Decision Maker is partly interested in the objective probability of success and thus values both reactivity and the Implementer's provision of effort. In addition, the Decision Maker is intrinsically biased towards project 1 and thus values implementation effort more when it is directed towards project 1. In comparison, the Owner is only interested in expected profits, and is therefore *ex ante* indifferent between projects 1 and 2. As a result, the Decision Maker is more likely to choose a homogeneous organization than the Owner, for a given α. We show below that, in this model without information asymmetries, the Decision Maker always selects the homogeneous organization (part 1 of Proposition 6), even when it is non-reactive.

The Decision Maker becomes more interested in reactivity (and therefore heterogeneity) when the signal σ is her private information. This is because, in reactive organizations, the order project selected conveys information about the signal. This increases the Implementer's motivation to implement project 1 when it is ordered. This additional benefit of heterogeneity tilts the Decision Maker's choice towards dissent, in particular, when the signal is very informative. We thus find a non-empty set of α where the Decision Maker chooses a reactive heterogeneous organization, just as the Owner would do.

We summarize the entire analysis of this issue in the following proposition:

Proposition 6. *Assume the Decision Maker has the real authority over organizational design. Then*

1. *If the signal σ is commonly observed, she will always select a homogeneous organization.*
2. *If the signal σ is private information, there exists two levels of signal precision $(\breve{\alpha}_1, \breve{\alpha}_2) \in [\alpha^{**}, \alpha_R^{\text{hom}}]$ such that the Decision Maker hires a dissenting Implementer (i.e. opts for a homogeneous organization) only when $\alpha \in [\breve{\alpha}_1, \breve{\alpha}_2]$.*

Proof. See Appendix J.

The Decision Maker and the Owner are never fully aligned (unless $\underline{B} = \bar{B}$, which is ruled out by Assumption 1) in their organizational choice: when $\alpha \in [\alpha^{**}, \breve{\alpha}_1]$, the "credibility" gain brought by dissent is too low to overcome the Decision Maker's own bias towards project 1 and therefore towards the homogeneous organization; when $\alpha \in [\breve{\alpha}_2, \alpha_R^{\text{hom}}]$, the homogeneous organization becomes sufficiently reactive (it is semi-reactive in this case) to make the reactivity gain from the heterogeneous organization relatively too small to overcome the Decision Maker bias. Nevertheless, for intermediate values of α (*i.e.* $\alpha \in [\breve{\alpha}_1, \breve{\alpha}_2]$), heterogeneity remains the equilibrium organizational form even when the biased Decision Maker has real authority over organizational design.

4.2. *Dissent in a labour market equilibrium*

In a reactive organization, the Implementer does not necessarily work on his preferred project and might thus prefer, all things equal, to work for a homogeneous organization. However, when the heterogeneous organization brings the highest expected profit, it might be possible to retain the Implementer in the organization by granting him a stronger share of this higher surplus. We show in this section that the latter effect can dominate the former and, therefore, that heterogeneous organizations can survive when taking into consideration the equilibrium on the labour market.

To clarify this discussion, we assume that Decision Makers are exogenously and randomly assigned to firms (we will briefly come back to this issue below). We assume that there is a continuum of organizations with mass 1, indexed by i. For firms $i \in [0, 0{\cdot}5]$, the Decision Maker is intrinsically biased towards project 1. For firms $i \in [0{\cdot}5, 1]$, the Decision Maker has an intrinsic preference for project 2. Symmetrically, there is a continuum of potential Implementers of mass 1, half of them ($j \in [0, 0{\cdot}5]$) with an intrinsic preference for project 1 and the remaining half ($j \in [0{\cdot}5; 1]$) intrinsically motivated by project 2.

We go back to the case where Owners are the ones making hiring decisions. The labour market equilibrium is thus an assignment of Implementers to firms (Owners). It can be represented as a one-to-one mapping $m(.)$, that assigns a firm i to any Implementer j. This is, thus, a problem of bilateral (frictionless) matching. To characterize it, we now make the simplifying assumption that the Implementers' utilities and the firms' expected profits are transferable. This amounts to assuming that Owners can pay different wages to Implementers depending on the design of their organization:

Definition 1. A matching function $m(\cdot)$ is an equilibrium if it maximizes the sum of organizations' expected profits and Implementers' expected utilities. Hence

$$m(\cdot) \in \arg\max \left\{ \int_0^1 \left(\pi_{m(j)} + U_j^I \right) dj \right\},$$

where U_j^I is the expected utility of the Implementer j, while $\pi_{m(j)}$ is the expected profit of the organization that employs j in equilibrium.

We introduce this labour market equilibrium consideration within the simple model of Section 2.4, where the signal σ is publicly observed and where Assumption 1 holds; that is, Decision Makers are more intrinsically biased than Implementers.

Proposition 7. *There exists $\widehat{R} > 0$ such that, for all $R > \widehat{R}$, there is a $\hat{\alpha} \in [\alpha^*, \alpha^{\text{hom}}]$:*

1. *For $\alpha \in [\alpha^{\text{het}}; \hat{\alpha}]$, there are only homogeneous organizations in equilibrium, that is, $m(i) = i$ is an equilibrium, but $m(i) = 1 - i$ is not.*
2. *For $\alpha \in [\hat{\alpha}; \alpha^{\text{hom}}]$, there are only heterogeneous organizations in equilibrium, that is, $m(i) = 1 - i$ is an equilibrium, but $m(i) = i$ is not.*

Proof. See Appendix K.

In words, for $\alpha \in [\hat{\alpha}; \alpha^{\text{hom}}]$, heterogeneous organizations deliver the highest expected profit and are the only ones that exist in equilibrium. This subset of α is non-empty ($\hat{\alpha} < \alpha^{\text{hom}}$) when profits are large enough compared to the magnitude of private benefits. Then, heterogeneous organizations generate enough financial profits to compensate dissenting Implementers for not working for Decision Makers with similar intrinsic preferences. When $\alpha \in [\alpha^*, \widehat{\alpha}]$, the signal is not informative enough: profits of reactivity are too small to allow Owners to compensate Implementers for working with antagonistic Decision Makers. Notice, however, that the matching equilibrium, as defined in Definition 1, is always—by construction—Pareto optimal (if we exclude Decision Makers from this criterion). Thus, when $\alpha \in [\alpha^*, \widehat{\alpha}]$, even if reactivity was desirable from the Owner's perspective, it is not from the social viewpoint.

The above bilateral matching problem excludes the Decision Maker from the process. We can also look at the equilibrium matching of Owners to Decision Makers, assuming that Implementers are already assigned to firms. In this case, the equilibrium matching process is the one that maximizes the sum of Decision Makers' and Owners' utilities, in a way analogous to Definition 1. In this context, we can derive a proposition similar to Proposition 7: when monetary profits are large enough, the Owners can come up with enough surplus to compensate Decision

Makers for working with dissenting Implementers. This result contrasts with the case of Proposition 6, part 1. There we saw that, in the symmetric information model, the Decision Maker would always prefer homogeneous organizations. What happens now is that the Owner can subsidize heterogeneous organizations using profits of reactivity, while he was not allowed to do so in Section 4.1.

5. AN APPLICATION: ORGANIZING FOR CHANGE

Both the recent practitioner-based literature (*e.g.* Intel's ex-CEO, Grove, 1999) and the academic management literature (*e.g.* Utterback, 1994; Christensen, 1997) insist on the vital need for companies to organize for innovation and fight inertia. In the face of increased competition and increased volatility (see, for example, Comin and Philippon, 2005), the ability to perform radical innovations and "reinvent" the company is put forth as a crucial purpose of organizational design. Scholars such as March (1991) and Argyris (1990) warn against a natural tendency of organizations to produce resistance to change. In the trade-off between exploration and exploitation staged in March (1991), such resistance to change can be optimally mitigated by the regular hiring of new members coming from outside the organization. This comes at the cost of lower short-term productivity, as the new hires lack experience. Should this "injection of fresh blood" occur at the top or at the bottom of the organization?

Our model sheds some new light on this issue. In particular, we show that in order to implement reactivity within an organization, it is optimal to hire a pro-change Decision Maker *and* have her collaborate with pro-status quo Implementers. A first motivation for such a result is that change is, almost by definition, the exception and not the rule: it is therefore valuable for the company to have Implementers who "enjoy" the status quo project, as it is the project most likely to be selected (even in a "reactive" organization). Moreover, a pro-status quo Implementer disciplines the bias of the Decision Maker towards change. If she was not constrained by the Implementer's intrinsic utility, a pro-change Decision Maker might be tempted to implement change "too often", that is, even when it is not efficient from a profit perspective. This "change for the sake of change" trap is avoided by the bottom-up pressure imposed by status quo-biased Implementers.

Our model leads to a pair of important empirical predictions: (1) reactivity becomes optimal as firm-level uncertainty[8] increases and (2) reactivity should be implemented through a "fresh blood at the top" policy rather than a "fresh blood at the bottom" policy. This double result fits quite well with the large increase in the hiring of outside CEOs documented by Murphy and Zabojnik (2007). They find that the fraction of CEOs hired from outside has almost doubled between the 1970's and the 1990's. This trend is parallel to the rise in volatility faced by firms. For example, Comin and Philippon (2005) establish that idiosyncratic volatility (measured as sales volatility or market leader turnover) has also doubled during that period. The management literature explicitly links the hire of outside CEOs to the need to implement change. Khurana (2002) shows (with a critical message) that the mission assigned to externally hired CEOs is often to be "corporate saviours", reinventing the company by adapting its strategy to a new market context. Schein (1992) also emphasizes the role of leaders in implementing radical changes against the prevailing corporate culture. In his view, organizational change comes from the top against the will of the bottom layers of the hierarchy, as our model predicts.

To formalize these intuitions, we build on the simple model of Section 2.4, where the signal σ is publicly observed, but we now assume that one state of nature is more likely than the other: state 1 occurs with probability $\theta > 1/2$. This state of nature corresponds to "business as

8. Firm-level uncertainty is defined as the *ex ante* probability that "change" is the successful project.

usual", that is, when change does not have to be implemented and the status quo is the best option. This new assumption breaks the model's symmetry and, as a result, makes the model's resolution more complicated. There are now four organizational forms to consider: status quo-biased and change-biased heterogeneous organization and status quo-biased and change-biased homogeneous organizations.

To simplify our analysis, we make the following assumption:

$$\forall x \in \mathbb{R}_+, xf(x) \text{ is increasing in } x. \tag{11}$$

Assumption (11) guarantees that F is not "too" concave. In particular, it ensures that a reactive organization is more profitable when the most-likely project (*i.e.* the status quo project) is the Implementer's preferred project, an intuitive property that can be violated if F is indeed too "concave".[9] This assumption allows us to characterize the optimal organizational form in a very simple way:

Proposition 8. *For each* $\theta \in [1/2, 1]$. *There exists* $1/2 < \alpha^{\text{het}}(\theta) < \alpha^{\text{hom}}(\theta) < 1$ *such that* $\alpha^{\text{het}}(\theta)$ *and* $\alpha^{\text{hom}}(\theta)$ *are increasing in* θ *and*

1. *If* $1/2 < \alpha < \alpha^{\text{het}}(\theta)$*, the optimal organization is homogeneous and has a status quo-biased Decision Maker and a status quo-biased Implementer.*
2. *If* $\alpha^{\text{het}}(\theta) < \alpha < \alpha^{\text{hom}}(\theta)$*, the optimal organization is heterogeneous: it has a status quo-biased Implementer but a change-biased Decision Maker.*
3. *If* $\alpha > \alpha^{\text{hom}}(\theta)$*, both above organizations deliver the optimum expected profit.*

Proof. See Appendix L.

The first result from Proposition 8 shows that, among the four possible types of organizations, only those with a status quo-biased Implementer can be optimal. This is simply because status quo is *ex ante* more likely to be the successful course of action ($\theta > 1/2$). It is thus optimal to hire an Implementer that has a strong intrinsic motivation for not changing. The second result of Proposition 8 states that a lower precision α makes non-reactive homogeneous organizations more attractive. This is the same result as in the baseline model, where $\theta = 1/2$. Finally, Proposition 8 shows that the thresholds in α increase with θ. A rise in uncertainty can be seen as a decrease in the *ex ante* probability that the status quo decision is the successful project (*i.e.* as a decrease in θ). Such an increase in firm-level uncertainty makes the reactive heterogeneous organization with a change-biased Decision Maker more profitable. Therefore, in an environment where strategic decisions becomes less persistent, the Owner might find it optimal to replace a status quo-biased Decision Maker with a change-biased Decision Maker, that is, to hire a "corporate saviour".

6. CONCLUSION

This paper has shown that dissent may enhance corporate decision-making quality. Because Decision Makers must internalize the motivation of intrinsically motivated Implementers, heterogeneity of preferences may act as a moderating device in the decision-making process. This moderating mechanism is different from whistle blowing or explicit opposition, and relies explicitly on the "separation of implementation and control" that is casually observed in organizations:

9. If F is highly concave, it is better to "evenly" distribute the probability of success across the two projects and thus to have the Implementer intrinsically like the project less likely to succeed.

the mere presence of a potentially independent Implementer along the chain of command compels the Decision Maker to use more private, objective information in her selection process. This mechanism is robust: even when monetary contracts are allowed or when Decision Maker or Implementer can change the organization, preference heterogeneity can always be both an efficient and equilibrium outcome.

We think the normative implications of our theory open new avenues for empirical research on organizations. For instance, in the area of corporate governance, our analysis suggests that boards of directors, instead of focusing on just replacing the CEO, should optimally configure the preferences of the executive suite. Optimal dissent should also serve as a useful framework to understand the long-standing debate on the division of power between elected politicians and professional bureaucrats.

APPENDIX A. PROOF OF PROPOSITION 1

Consider first a homogeneous organization. When $\sigma = 1$, the Decision Maker will always select $\mathcal{P} = 1$ as

$$\alpha F(\alpha\bar{b})\bar{B} > (1-\alpha)F\left((1-\alpha)\underline{b}\right)\underline{B}.$$

When $\sigma = 2$, the Decision Maker selects project 2 if and only if:

$$\alpha F(\alpha\underline{b})\underline{B} > (1-\alpha)F\left((1-\alpha)\bar{b}\right)\bar{B}.$$

Call $\psi(\alpha) = \alpha F(\alpha\underline{b})\underline{B} - (1-\alpha)F\left((1-\alpha)\bar{b}\right)\bar{B}$. ψ is a strictly increasing function of α and $\psi(1/2) < 0$ while $\psi(1) > 0$. Therefore, there is a unique $\alpha^{\text{hom}} \in]1/2, 1[$ so that the Decision Maker selects project 2 when the signal is 2 if and only if $\alpha \geq \alpha^{\text{hom}}$.

Using the same approach, we show that a heterogeneous organization is reactive (*i.e.* selects project 2 when $\sigma = 2$) if and only if $\alpha > \alpha^{\text{het}}$ where

$$\alpha^{\text{het}} F\left(\alpha^{\text{het}}\overline{b}\right)\underline{B} = \left(1-\alpha^{\text{het}}\right)F\left((1-\alpha^{\text{het}})\underline{b}\right)\overline{B}.$$

There is more scope for reactivity in a heterogeneous organization. Indeed, let $\alpha \geq \alpha^{\text{hom}}$, then $\alpha F(\alpha\underline{b})\underline{B} \geq (1-\alpha) F\left((1-\alpha)\bar{b}\right)\bar{B}$. Because $\overline{b} > \underline{b}$, this trivially implies that $\alpha F(\alpha\bar{b})\underline{B} > (1-\alpha)F\left((1-\alpha)\underline{b}\right)\bar{B}$, that is, that $\alpha > \alpha^{\text{het}}$, so that $\alpha^{\text{hom}} > \alpha^{\text{het}}$. This completes the proof of Proposition 1. ||

APPENDIX B. PROOF OF PROPOSITION 2

1. We start with the case of a homogeneous organization. It is easy to see that this organization is fully reactive if and only if

$$\alpha F\left(\alpha\underline{b}\right)\underline{B} > \frac{1-\alpha}{2}F\left(\frac{1-\alpha}{2}\overline{b}\right)\overline{B} \Longleftrightarrow \alpha > \alpha_3. \tag{12}$$

This condition simply states that the Decision Maker prefers to select project 3 after observing signal 3 (or project 2 after observing signal 3) over selecting project 1. If this condition is verified, the Decision Maker will select project 3 after observing signal 3, as project 2 would deliver a lower utility than project 1, and also always select project 2 after observing signal 2, as, again, project 3 would then deliver a lower utility than project 1. Finally, when the signal indicates project 1, the Decision Maker will always select 1, as it is the project most likely to succeed, and both she and the Implementer have an intrinsic preference for project 1.

When equation (12) is violated, the Decision Maker always prefers to select project 1. The organization is then non-reactive. It is clear from inequality (12) that $\alpha_3 \in]1/3; 1[$.

2. The case of the heterogeneous organization is slightly more involved. When the signal is 1, the Implementer will select project 1 if and only if

$$\alpha F\left(\alpha\underline{b}\right)\overline{B} > \frac{1-\alpha}{2}F\left(\frac{1-\alpha}{2}\overline{b}\right)\underline{B},$$

which, given Assumption (8), always holds as long as $\alpha > 1/3$.

When the signal is 2, the Decision Maker always prefers selecting project 1 over project 3: both projects have the same (low) probability of success, but the Decision Maker receives higher utility from project 1 while the

Implementer is indifferent between the two projects in term of intrinsic utility. Thus, the Decision Maker's choice boils down to project 1 or project 2. She will select project 2, as indicated by the signal, if and only if:

$$\alpha F\left(\alpha \bar{b}\right) \underline{B} > \frac{1-\alpha}{2} F\left(\frac{1-\alpha}{2}\underline{b}\right) \overline{B} \Longleftrightarrow \alpha > \alpha_1. \tag{13}$$

From Assumption (8), it is easy to show that $\alpha_1 > 1/3$. $\alpha_1 < 1$ is also straightforward.

When the signal is 3, project 3 is selected whenever it provides the Decision Maker with a higher utility than selecting project 1 (inequality (14) or selecting project 3 (inequality (15)):

$$\alpha F\left(\alpha \underline{b}\right) \underline{B} > \frac{1-\alpha}{2} F\left(\frac{1-\alpha}{2}\underline{b}\right) \overline{B} \Longleftrightarrow \alpha > \alpha_2^{*} \tag{14}$$

$$\alpha F\left(\alpha \underline{b}\right) \underline{B} > \frac{1-\alpha}{2} F\left(\frac{1-\alpha}{2}\bar{b}\right) \underline{B} \Longleftrightarrow \alpha > \alpha_2^{**}. \tag{15}$$

Let $\alpha_2 = \max[\alpha_2^*; \alpha_2^{**}]$: after observing signal 2, the Decision Maker selects project 2 if and only if $\alpha > \alpha_2$. Else, she selects either project 1 or 2. $\alpha_2 \in]1/3; 1[$ is straightforward.

3. Last, we prove that $1/3 < \alpha_1 < \alpha_2 < \alpha_3 < 1$. It is straightforward to show that, if α satisfies inequality (14), it also satisfies (13). Also, if α satisfies (12), it also satisfies both (14) and (15). This completes the proof of Proposition 2. ‖

APPENDIX C. PROOF OF PROPOSITION 3

We now move on to Proposition 3 and investigate organization value.[10] The value of a homogeneous reactive organization (*i.e.* for $\alpha \geq \alpha^{\text{hom}}$) is given by

$$V^{\text{hom}}(\alpha \geq \alpha^{\text{hom}}) = \frac{\alpha}{2}\left(F(\alpha\bar{b}) + F(\alpha\underline{b})\right).$$

Let us briefly explain this last expression. With probability $\frac{1}{2}$, the state of nature is 1. Because the organization is reactive, the Decision Maker will select the successful project, that is, project 1, with probability α, that is, as soon as she receives signal 1. The Implementer will then make expected effort $F(\alpha\bar{b})$, as project 1 is his preferred project. With probability $\frac{1}{2}$, the true state of nature is 2. With probability α, the Decision Maker will select the successful project, that is, project 2 (*i.e.* as soon as it is indicated by the signal), leading the Implementer to an expected probability of high effort $F(\alpha\underline{b})$.

The value of a non-reactive homogeneous organization (*i.e.* for $\alpha < \alpha^{\text{hom}}$) is given by

$$V^{\text{hom}}(\alpha) = \frac{1}{2}\left(\alpha F(\alpha\bar{b}) + (1-\alpha)F(1-\alpha)\bar{b}\right) \text{ if } \alpha < \alpha^{\text{hom}}.$$

Such an organization always implements project 1. Project 1 happens to be the successful project only with probability $\frac{1}{2}$. However, with probability α (resp. $1-\alpha$), the public signal will indicate project 1 (resp. project 2), leading to an expected implementation effort of $F(\alpha\bar{b})$ $\left(\text{resp.} F\left((1-\alpha)\bar{b}\right)\right)$.

The value of a heterogeneous organization is computed in a similar fashion:

$$\begin{cases} V^{\text{het}}(\alpha \geq \alpha^{\text{het}}) = \dfrac{\alpha}{2}\left(F(\alpha\bar{b}) + F(\alpha\underline{b})\right) \\[2ex] V^{\text{het}}(\alpha < \alpha^{\text{het}}) = \dfrac{1}{2}\left(\alpha F(\alpha\underline{b}) + (1-\alpha)F\left((1-\alpha)\underline{b}\right)\right). \end{cases}$$

Note that the value of the homogeneous reactive organization is similar to that of the heterogeneous reactive organization.

We can now easily turn to the comparison of firm value. For $\alpha \geq \alpha^{\text{hom}}$, both organizations are reactive and thus lead to the same profit.

For $\alpha < \alpha^{\text{het}}$, the difference between the two non-reactive organizations is simply given by

$$\delta(\alpha) = V^{\text{het}}(\alpha) - V^{\text{hom}}(\alpha) = \frac{1}{2}\left(\alpha\left(F(\alpha\underline{b}) - F(\alpha\bar{b})\right) + (1-\alpha)\left(F\left((1-\alpha)\underline{b}\right) - F\left((1-\alpha)\bar{b}\right)\right)\right) < 0,$$

10. We wish to thank Fumi Kiyotaki for pointing out a mistake in a previous proof of this proposition.

so that the homogeneous organization is strictly more profitable that the heterogeneous one. While both organizations are non-reactive over this range of signal precision, the homogeneous organization has a more intrinsically motivated Implementer.

Finally, for $\alpha \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, the homogeneous organization is non-reactive, while the heterogeneous one is reactive. The difference in value between the heterogeneous and the homogeneous organization is given by

$$\Delta(\alpha) = V^{\text{het}}(\alpha) - V^{\text{hom}}(\alpha) = \frac{1}{2}\left(\alpha F(\alpha \underline{b}) - (1-\alpha) F\left((1-\alpha)\bar{b}\right)\right) R.$$

Note that Δ is a strictly increasing function of α. By definition of α^{hom}, we know that

$$\begin{aligned}\alpha^{\text{hom}} F(\alpha^{\text{hom}} \underline{b}) &= (1-\alpha^{\text{hom}}) F\left((1-\alpha^{\text{hom}})\bar{b}\right) \frac{\bar{B}}{\underline{B}} \\ &> (1-\alpha^{\text{hom}}) F\left((1-\alpha^{\text{hom}})\bar{b}\right).\end{aligned}$$

So that $\Delta(\alpha^{\text{hom}}) > 0$. The sign of $\Delta(\alpha^{\text{het}}) > 0$ is ambiguous. For instance, when F is uniform, $\Delta(\alpha^{\text{het}}) < 0$ is equivalent to $\frac{\bar{B}}{\underline{B}} < \left(\frac{\bar{b}}{\underline{b}}\right)^2$. Therefore, two cases arise:

1. $\Delta(\alpha^{\text{het}}) < 0$. Because Δ is strictly increasing and continuous, using the intermediate value theorem, this implies that there is a unique $\alpha^* \in]\alpha^{\text{het}}, \alpha^{\text{hom}}[$ such that for $\alpha \in [\alpha^{\text{het}}, \alpha^*]$, the homogeneous non-reactive organization has the highest value, while, for $\alpha \in [\alpha^*, \alpha^{\text{hom}}]$, the heterogeneous reactive organization delivers the highest value.
2. $\Delta(\alpha^{\text{het}}) \geq 0$. In that case, the heterogeneous organizations delivers a higher value for all $\alpha \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, so that $\alpha^* = \alpha^{\text{het}}$.

This proves that there is $\alpha^* \in [\alpha^{\text{het}}, \alpha^{\text{hom}}[$ such that (1) the homogeneous organization is optimal for $\alpha < \alpha^*$ (2) the heterogeneous organization is optimal for $\alpha \in [\alpha^*, \alpha^{\text{hom}}[$ and (3) both organizations deliver the same value for $\alpha \geq \alpha^{\text{hom}}$. ‖

APPENDIX D. EXAMPLE WITH CONTINGENT WAGES

Here we show that financial contracting is not a perfect substitute for organizational design.

Proposition D.1. *Start from the simple model of dissent considered in Section* 2.4*, where the signal received by the Decision Maker is public information. Consider the special case where F is uniform over some range* [0, 1]*. Assume that the Owner can provide both the Implementer and the Decision Maker with compensation contingent* (1) *on the signal* (2) *on their preferred project and* (3) *on success of the project. Then there is a non-empty interval* $[\hat{\alpha}^*; \hat{\alpha}^{\text{hom}}]$ *such that for each* $\alpha \in [\hat{\alpha}^*; \hat{\alpha}^{\text{hom}}]$*, the heterogeneous organization strictly dominates the homogeneous one.*

Proof. $F(x) = x$. We first look for optimal compensation schemes that give *no compensation* to the Decision Maker and then show that they are optimal over some range in α. In this case, call

$$\begin{cases} z_1 = \underset{z}{\operatorname{argmax}}\, F\left(\alpha(\bar{b}+z)\right)(R-z) = \underset{z}{\operatorname{argmax}}\, F\left((1-\alpha)(\bar{b}+z)\right)(R-z) = \dfrac{R-\bar{b}}{2} \\ z_2 = \underset{z}{\operatorname{argmax}}\, F\left(\alpha(\underline{b}+z)\right)(R-z) = \underset{z}{\operatorname{argmax}}\, F\left((1-\alpha)(\underline{b}+z)\right)(R-z) = \dfrac{R-\underline{b}}{2}. \end{cases}$$

z_1 (resp. z_2) is the optimal wage the Owner will provide the Implementer with after the success of his most (resp. least) preferred project. It does not depend on the signal received by the Decision Maker.

The value of a reactive organization is then given by

$$V^R = \frac{\alpha^2}{2}\left(\left(\frac{\bar{b}+R}{2}\right) + \left(\frac{\underline{b}+R}{2}\right)\right),$$

while the value of the homogeneous non-reactive organization is

$$V^{\text{NR}} = \frac{\alpha^2 + (1-\alpha)^2}{2}\left(\frac{\bar{b}+R}{2}\right).$$

The reactive organization dominates the non-reactive organization if and only if

$$V^R > V^{\text{NR}} \Leftrightarrow \alpha^2 \left(\frac{\underline{b}+R}{2}\right)^2 \geq (1-\alpha)^2 \left(\frac{\bar{b}+R}{2}\right)^2 \Leftrightarrow \alpha > \hat{\alpha}^*.$$

Thus, when $\alpha > \hat{\alpha}^*$, a reactive organization that pays out no compensation to the Decision Maker is more profitable than any type of non-reactive organization.

Heterogeneous organizations are reactive, without paying any compensation to the Decision Maker, as long as

$$\alpha F\left(\alpha\left(\bar{b}+z_1\right)\right)\underline{B} \geq (1-\alpha)\, F\left((1-\alpha)\left(\underline{b}+z_2\right)\right)\bar{B} \Leftrightarrow \alpha \geq \hat{\alpha}^{\text{het}}.$$

Similarly, a homogeneous organization (that does not compensate the Decision Maker) is reactive if and only if

$$\alpha F\left(\alpha\left(\underline{b}+z_2\right)\right)\underline{B} \geq (1-\alpha)\, F\left((1-\alpha)\left(\bar{b}+z_1\right)\right)\bar{B} \Leftrightarrow \alpha \geq \hat{\alpha}^{\text{hom}}.$$

Obviously, $\hat{\alpha}^{\text{hom}} \geq \hat{\alpha}^{\text{het}}$ as even with an optimal compensation to the Implementer, the heterogeneous organization remains "more reactive" than the homogeneous one. The only way the Decision Maker affects profits is by being reactive or not. Thus, over $[\hat{\alpha}^{\text{het}}; \hat{\alpha}^{\text{hom}}]$, it is optimal to give zero compensation to the Decision Maker since (1) if reactivity is optimal, it can be achieved "for free" with a heterogeneous organization, and (2) if non-reactivity is optimal, homogeneous organizations allow the Owner to obtain it. Thus, optimal firm value is given by V^{NR} and V^R.

Call $\psi(\alpha) = \alpha^2 \left(\frac{\underline{b}+R}{2}\right)^2 - (1-\alpha)^2 \left(\frac{\bar{b}+R}{2}\right)^2$. We know $\psi(\hat{\alpha}^*) = 0$ and ψ is increasing with α.

$$\psi(\hat{\alpha}^{\text{hom}}) = (1-\hat{\alpha}^{\text{hom}})^2 \left(\frac{R+\underline{b}}{2}\right)^2 \left(\frac{R+\underline{b}}{R+\bar{b}}\frac{\bar{B}}{\underline{B}} - 1\right).$$

Thanks to Assumption 1 adapted to the uniform case, we know that $\frac{\bar{B}}{\underline{B}} \geq \frac{\bar{b}}{\underline{b}}$. But $\frac{R+\underline{b}}{R+\bar{b}} > \frac{\underline{b}}{\bar{b}}$, so that $\frac{R+\underline{b}}{R+\bar{b}}\frac{\bar{B}}{\underline{B}} > \frac{\underline{b}}{\bar{b}}\frac{\bar{B}}{\underline{B}} \geq 1$. This proves that: $\psi(\hat{\alpha}^{\text{hom}}) > 0$ so that $\hat{\alpha}^{\text{hom}} < \hat{\alpha}^*$.

Over $[\hat{\alpha}^{\text{hom}}; \hat{\alpha}^*]$, the heterogeneous organization is reactive and strictly dominates the homogeneous organization, which is non-reactive. Over that interval, compensating the Decision Maker in the heterogeneous organization is useless, as she already has the "intrinsic" incentives to react, and not reacting would lead to a strictly lower profit. Similarly, compensating the Decision Maker in the homogeneous organization to induce her to react to the signal would destroy profit, as it would lead to the same probability of success as in the heterogeneous organization, but would cost strictly more in terms of incentives for the Decision Maker. Moreover, there is no point in compensating the Decision Maker if the organization remains non-reactive. Overall, this proves that over $[\hat{\alpha}^{\text{hom}} > \hat{\alpha}^*]$ the best organizational form is heterogeneous, even though the Owner has access to complete contracting. ‖

APPENDIX E. PROOF OF PROPOSITION 4

We start with the case of a homogeneous organization. Define the reactive equilibrium by $\mathcal{P}(\sigma) = \sigma$ and $\mu(1) = \alpha$, $\mu(2) = 1-\alpha$. For this to be an equilibrium, the Decision Maker must prefer selecting project 1 after observing signal 1. This condition is formally

$$\alpha F(\alpha\bar{b})\bar{B} \geq (1-\alpha)F(\alpha\underline{b})\underline{B}.$$

Because $\bar{B} > \underline{B}$ and $\bar{b} > \underline{b}$ this last condition is always verified. The other equilibrium condition requires that the Decision Maker prefers selecting project 2 after observing signal 2:

$$\alpha F(\alpha\underline{b})\underline{B} \geq (1-\alpha)F(\alpha\bar{b})\bar{B}.$$

For $\alpha \in [\frac{1}{2}, 1]$, call $\psi(\alpha) = \alpha F(\alpha\underline{b})\underline{B} - (1-\alpha)F(\alpha\bar{b})\bar{B}$. We compute the first derivative of ψ with respect to α:

$$\forall \alpha \in [\frac{1}{2}, 1],\quad \psi'(\alpha) = \underbrace{\underline{B}\left(F\left(\alpha\underline{b}\right) + \alpha\underline{b}f\left(\alpha\underline{b}\right)\right)}_{>0} + \bar{B}\left(F\left(\alpha\bar{b}\right) - (1-\alpha)\bar{b}f\left(\alpha\bar{b}\right)\right).$$

Because F is concave and $F(0) = 0$, we know that for all $x \geq 0$, $F(x) \geq xf(x)$. Therefore

$$F\left(\alpha\bar{b}\right) \geq \alpha\bar{b}f\left(\alpha\bar{b}\right) > (1-\alpha)\bar{b}f\left(\alpha\bar{b}\right).$$

For all $\alpha \in \left[\frac{1}{2}, 1\right]$, $\psi'(\alpha)$ is thus strictly positive so that ψ is strictly increasing with αintermediate value theorem thus implies that there is a unique $\alpha_R^{\text{hom}} \in]\frac{1}{2}, 1[$ such that the homogeneous organization is reactive if and only if $\alpha \geq \alpha_R^{\text{hom}}$.

The characterization of the reactive equilibrium in heterogeneous organizations goes along the exact same lines. There exists a unique $\alpha_R^{\text{het}} \in]\frac{1}{2}, 1[$ such that the heterogeneous organization is reactive if and only if $\alpha \geq \alpha_R^{\text{het}}$.

We now prove that reactivity is more prevalent in heterogeneous organizations, that is, that $\alpha_R^{\text{hom}} > \alpha_R^{\text{het}}$Let $\alpha > \alpha_R^{\text{hom}}$. By definition of α_R^{hom}

$$\alpha F(\alpha \underline{b})\underline{B} \geq (1-\alpha)\, F(\alpha \bar{b}).$$

Because $\bar{b} > \underline{b}$, this last inequality implies:

$$\alpha F(\alpha \bar{b})\underline{B} > (1-\alpha)\, F(\alpha \underline{b}).$$

So that $\alpha > \alpha_R^{\text{het}}$, which proves that $\alpha_R^{\text{hom}} > \alpha_R^{\text{het}}$.

We now turn to the non-reactive equilibrium. Consider first the case of a homogeneous organization. A non-reactive equilibrium is defined as $\mathcal{P}(\sigma) = 1$; that is, the Decision Maker always selects project 1, irrespective of her private signal σ. Baye's rule and the selection process $\mathcal{P}$ both imply that the Implementer can't draw any inference from project 1 being selected, that is, $\mu(1) = \frac{1}{2}$. However, the equilibrium imposes *a priori* no restriction on the out-of-equilibrium belief $\mu(2)$, that is, any $\mu(2) \in [1-\alpha, \alpha]$ is admissible. In order to refine this equilibrium, we impose the D1 criterion.

Let us briefly introduce some notations. Call U_1^* (resp. U_2^*) the equilibrium utility of a Decision Maker receiving signal 1 (resp. signal 2). Call $U_1^D(\mu(2))$ (resp. $U_2^D(\mu(2))$) the out-of-equilibrium utility of a Decision Maker receiving signal 1 (resp. signal 2) when out-of-equilibrium beliefs are given by $\mu(2)$, that is, the utility a Decision Maker gets by deviating from the non-reactive equilibrium and selecting project 2.

Call $D_i = \left\{\mu(2) \in [1-\alpha, \alpha] \;\mid\; U_i^* < U_i^D\big(\mu(2)\big)\right\}$ and $D_i^0 = \left\{\mu(2) \in [1-\alpha, \alpha] \;\mid\; U_i^* = U_i^D\big(\mu(2)\big)\right\}$. The D1 refinement is defined as follows:

Definition (**D1 Refinement**). If $D_1 \bigcup D_1^0 \subseteq D_2$, then $\mu(2) = 1-\alpha$. In words, if each out-of-equilibrium belief $\mu(2)$ that leads to a profitable deviation for a Decision Maker with signal 1 also leads to a strictly profitable deviation for a Decision Maker with signal 2, then the Implementer must believe that only Decision Makers with signal 2 deviate from the equilibrium, that is, that $\mu(2) = 1-\alpha$.

Therefore, let $\mu(2) \in [1-\alpha, \alpha]$ such that $U_1^* \leq U_1^D(\mu(2))$ (*i.e.* $\mu(2) \in D_1 \bigcup D_1^0$). This implies that

$$(1-\alpha)\underline{B}F\left((1-\mu(2))\underline{b}\right) \geq \alpha \bar{B} F\left(\frac{\underline{b}}{2}\right).$$

But then, because $\alpha > 1-\alpha$, it must be that

$$U_2^D(\mu(2)) = \alpha \underline{B} F\left((1-\mu(2))\underline{b}\right) > (1-\alpha)\bar{B}F\left(\frac{\underline{b}}{2}\right) = U_2^*.$$

So that $\mu(2) \in D_2$, which implies $D_1 \bigcup D_1^0 \subseteq D_2$. Therefore, using our equilibrium concept (*i.e.* perfect Bayesian equilibrium with D1 refinement), the non-reactive equilibrium (which is nothing else than a pooling equilibrium where both types of Decision Maker selects the same project at equilibrium) must necessarily verify $\mu(2) = 1-\alpha$.

Now that $\mu(2)$ is specified, we can write the two incentive constraints that guarantee the existence of a non-reactive equilibrium in the homogeneous organization. The first of these constraints ensures that after observing signal 2, the Decision Maker nevertheless selects project 1:

$$(1-\alpha)F\left(\frac{\bar{b}}{2}\right)\bar{B} \geq \alpha F(\alpha \underline{b})\underline{B}. \tag{16}$$

The second constraint guarantees that after observing signal 1, the Decision Maker selects project 1:

$$\alpha F\left(\frac{\bar{b}}{2}\right)\bar{B} \geq (1-\alpha)\, F(\alpha \underline{b})\underline{B}. \tag{17}$$

It is straightforward that if inequality (16) is verified, inequality (17) is also satisfied, so that there is only one relevant incentive constraint: inequality (16). Moreover, inequality (16) is clearly strictly decreasing in α, strictly verified for $\alpha = \frac{1}{2}$ and strictly violated for $\alpha = 1$. Thus, there exists a unique $\alpha_{\text{NR}}^{\text{hom}} \in]\frac{1}{2}; 1[$ such that condition (16) is verified only if the signal's precision α belongs to $\left[\frac{1}{2}; \alpha_{\text{NR}}^{\text{hom}}\right]$. Therefore, the non-reactive equilibrium is sustainable in a homogeneous organization only for $\alpha \in \left[\frac{1}{2}; \alpha_{\text{NR}}^{\text{hom}}\right]$.

Let's move now to the case of a heterogeneous organization. We leave it to the reader to prove that the only admissible out-of-equilibrium belief satisfying the D1 refinement in a non-reactive equilibrium is $\mu(2) = 1-\alpha$. It is also left to the reader to show that there exists a unique $\alpha_{\text{NR}}^{\text{het}} \in \left[\frac{1}{2};1\right]$ such that the condition defining the non-reactive equilibrium in the heterogeneous organization is verified only if signal's precision α belongs to $\left[\frac{1}{2};\alpha_{\text{NR}}^{\text{het}}\right]$.

We now turn to the characterization of semi-reactive equilibria. We first prove that there can't exist a semi-reactivity equilibrium where the Decision Maker would randomize over the two projects after having observed signal 1 and always select project 2 after observing signal 2. In this equilibrium, the Implementer's belief that state of nature is 1 after project 1 has been selected would be $\mu(1)=\alpha$. However, if such an equilibrium were to exist, the Decision Maker would have to be indifferent between selecting project 2 or project 1 after observing signal 1. Consider first the case of a homogeneous organization. Such indifference can never occur, as *whatever the ex post belief* $\mu(2)\in[1-\alpha,\alpha]$, *we always have*

$$\alpha F(\alpha\bar{b})\bar{B} > (1-\alpha)\,F\left((1-\mu(2))\underline{b}\right)\underline{B}.$$

Consider now the case of a heterogeneous organization. The indifference condition between the two projects after signal 1 has been observed would imply that there exists a $\mu(2)\in[1-\alpha,\alpha]$ such that

$$\alpha F(\alpha\underline{b})\bar{B} = (1-\alpha)\,F(\mu\bar{b})\underline{B}. \tag{18}$$

This would imply that $\alpha F(\alpha\underline{b})\bar{B} \le (1-\alpha)\,F\left(\mu(2)\bar{b}\right)\underline{B}$.

However, we know that $\forall\alpha\in\left[\frac{1}{2},1\right]$, $\alpha F(\alpha\underline{b})\bar{B} > (1-\alpha)\,F(\alpha\bar{b})\underline{B}$. Indeed, call $\psi(\alpha)=\alpha F(\alpha\underline{b})\bar{B}-(1-\alpha)$ $F(\alpha\bar{b})\underline{B}$. Using F's concavity, one can prove that ψ is strictly increasing. Using Assumption 1, we have directly that $\psi\left(\frac{1}{2}\right)>0$ so that ψ is indeed strictly positive over $\left[\frac{1}{2},1\right]$. Thus, we can conclude

$$\forall\alpha\in\left[\frac{1}{2},1\right],\ \ \forall\mu(2)\in[1-\alpha,\alpha]\ \ \alpha F(\alpha\underline{b})\bar{B} > (1-\alpha)\,F\left(\mu(2)\bar{b}\right)\underline{B}.$$

Therefore, the equilibrium where the Decision Maker would be indifferent between the two projects after observing signal 1 cannot occur in a heterogeneous organization.

The only semi-reactive equilibrium involves the Decision Maker randomizing over the two projects after receiving signal 2. Formally this equilibrium is defined

$$\mathcal{P}(1)=1\ \text{ and }\ \mathcal{P}(2)=\begin{cases}1 & \text{with probability } \rho\\ 2 & \text{with probability } 1-\rho,\end{cases}$$

where ρ is endogenous to the equilibrium and will be determined subsequently. Project 2 is selected only when signal 2 has been received. Therefore, the Implementer's belief conditional on project 2 being selected is naturally $\mu(2)=1-\alpha$. On the other hand, when project 1 is selected, the Implementer ignores whether the Decision Maker indeed received signal 1 or whether she randomized over the two projects after having received signal 2. Using Bayes' rule, the Implementer's posterior belief must satisfy

$$\mu(1)=\frac{\alpha+\rho(1-\alpha)}{1+\rho}.$$

Consider first the case of a homogeneous organization. For the semi-reactive equilibrium to be sustainable, it must be that the Decision Maker is indifferent between selecting project 1 or 2 after observing signal 2, lest she would not randomize between the two projects. This indifference condition can be written as

$$\alpha F(\alpha\underline{b})\underline{B} = (1-\alpha)\,F\left(\mu(1)\bar{b}\right)\bar{B},$$

which can be rewritten as

$$F\left(\mu(1)\bar{b}\right)=\frac{\alpha}{1-\alpha}\frac{\underline{B}}{\bar{B}}F(\alpha\underline{b}). \tag{19}$$

This indifference condition implicitly defines, for each $\alpha\in\left[\alpha_{\text{NR}}^{\text{hom}},\alpha_R^{\text{hom}}\right]$ a unique $\rho^{\text{hom}}\in[0,1]$. Indeed, the R.H.S. of equation (19) is strictly increasing in α and goes from $F\left(\frac{\bar{b}}{2}\right)$ for $\alpha=\alpha_{\text{NR}}^{\text{hom}}$ to $F\left(\alpha_R^{\text{hom}}\bar{b}\right)$ for $\alpha=\alpha_R^{\text{hom}}$. The L.H.S. expression is strictly increasing with $\mu(1)$. Thus, for each $\alpha\in\left[\alpha_{\text{NR}}^{\text{hom}},\alpha_R^{\text{hom}}\right]$, there is a unique $\mu^{\text{hom}}(1)(\alpha)\in\left[1/2,\alpha_R^{\text{hom}}\right]$ that satisfies condition (19). In particular, $\mu^{\text{hom}}(1)=\frac{1}{2}$ for $\alpha=\alpha_{\text{NR}}^{\text{hom}}$ and $\mu^{\text{hom}}(1)=\alpha_R^{\text{hom}}$ for $\alpha=\alpha_R^{\text{hom}}$. Finally, because F is strictly increasing and the R.H.S. of equation (19) is a strictly increasing function of α, $\mu^{\text{hom}}(1)$ is also a strictly increasing function of α.

The definition of $\mu^{\text{hom}}(1)$ as a function of ρ^{hom} is

$$\mu^{\text{hom}}(1)=\frac{\alpha+\rho^{\text{hom}}(1-\alpha)}{1+\rho^{\text{hom}}}.$$

This is a strictly decreasing function of ρ^{hom} so that there is a unique $\rho^{\text{hom}} \in [0,1]$ associated with each $\mu^{\text{hom}}(1) \in [1/2, \alpha_R^{\text{hom}}]$. In particular, $\rho^{\text{hom}}\left(\alpha_{\text{NR}}^{\text{hom}}\right) = 1$, while $\rho^{\text{hom}}\left(\alpha_R^{\text{hom}}\right) = 0$. Note that μ^{hom} is a strictly decreasing function of ρ^{hom}:

$$\frac{\partial \mu^{\text{hom}}(1)}{\partial \rho^{\text{hom}}} = \frac{1-2\alpha}{\left(1+\rho^{\text{hom}}\right)^2} < 0.$$

Because $\mu^{\text{hom}}(1)$ is a strictly increasing function of α and ρ^{hom} is a strictly decreasing function of $\mu^{\text{hom}}(1)$, ρ^{hom} must be a strictly decreasing function of α.

Consider now the case of a heterogeneous organization. Similarly, the indifference condition becomes:

$$F\left(\mu(1)\underline{b}\right) = \frac{\alpha}{1-\alpha}\frac{\underline{B}}{\bar{B}}F(\alpha\bar{b}). \tag{20}$$

This indifference condition implicitly defines, for each $\alpha \in \left[\alpha_{\text{NR}}^{\text{het}}, \alpha_R^{\text{het}}\right]$ a unique $\rho^{\text{het}} \in [0,1]$. Indeed, the R.H.S. of equation (20) is strictly increasing in α and goes from $F\left(\frac{b}{2}\right)$ for $\alpha = \alpha_{\text{NR}}^{\text{het}}$ to $F\left(\alpha_R^{\text{het}}\underline{b}\right)$ for $\alpha = \alpha_R^{\text{het}}$. The L.H.S. expression is strictly increasing with $\mu(1)$. Thus, for each $\alpha \in \left[\alpha_{\text{NR}}^{\text{het}}, \alpha_R^{\text{het}}\right]$, there is a unique $\mu^{\text{het}}(1)(\alpha) \in \left[1/2, \alpha_R^{\text{het}}\right]$ that satisfies condition equation (19). In particular, $\mu^{\text{het}}(1) = \frac{1}{2}$ for $\alpha = \alpha_{\text{NR}}^{\text{het}}$ and $\mu^{\text{het}}(1) = \alpha_R^{\text{het}}$ for $\alpha = \alpha_R^{\text{het}}$. Finally, because F is strictly increasing and the R.H.S. of equation (20) is a strictly increasing function of α, $\mu^{\text{het}}(1)$ is also a strictly increasing function of α.

As we proved earlier, ρ is a strictly decreasing function of μ. Thus, for each $\alpha \in \left[\alpha_{\text{NR}}^{\text{het}}, \alpha_R^{\text{het}}\right]$, there is a unique $\rho^{\text{het}} \in [0,1]$ that satisfies equation (20). In particular, $\rho^{\text{het}}\left(\alpha_{\text{NR}}^{\text{het}}\right) = 1$, while $\rho^{\text{het}}\left(\alpha_R^{\text{het}}\right) = 0$. Finally, note that because $\mu^{\text{het}}(1)$ is strictly increasing with α, ρ^{het} is a strictly decreasing function of α.

From equation (19) and (20), using the implicit function theorem,[11] we also conclude that μ^{hom} and μ^{het} are continuous functions of α over $\left[\alpha_{\text{NR}}^{\text{hom}}, \alpha_R^{\text{hom}}\right]$ and $\left[\alpha_{\text{NR}}^{\text{het}}, \alpha_R^{\text{het}}\right]$, respectively. ‖

APPENDIX F. PROOF OF LEMMA 1

We first prove that $\alpha_{\text{NR}}^{\text{hom}} > \alpha_{\text{NR}}^{\text{het}}$. Consider $\alpha \geq \alpha_{\text{NR}}^{\text{hom}}$. By definition of $\alpha_{\text{NR}}^{\text{hom}}$

$$\alpha F(\alpha\underline{b})\underline{B} \geq (1-\alpha)F\left(\frac{\bar{b}}{2}\right)\bar{B}.$$

But because $\bar{b} > \underline{b}$, this in turn implies that:

$$\alpha F(\alpha\bar{b})\underline{B} > (1-\alpha)F\left(\frac{\underline{b}}{2}\right)\bar{B}.$$

So that $\alpha > \alpha_{\text{NR}}^{\text{het}}$. This proves that $\alpha_{\text{NR}}^{\text{hom}} > \alpha_{\text{NR}}^{\text{het}}$. We then define ρ as the probability that the Decision Maker selects project 1 when the signal is 2.

Secondly, we show that $\rho^{\text{hom}} > \rho^{\text{het}}$ when both organizations are semi-reactive. For $\alpha \in \left[\frac{1}{2}, \alpha_{\text{NR}}^{\text{het}}\right] \cup \left[\alpha_R^{\text{hom}}, 1\right]$, both organizational forms share the same selection process, so that they share the same reactivity. For $\alpha \in]\alpha_{\text{NR}}^{\text{het}}, \alpha_{\text{NR}}^{\text{hom}}]$, the heterogeneous organization is semi-reactive, with non-reactivity[12] $\rho^{\text{het}} > 0$, while the homogeneous organization is non-reactive, that is, $\rho^{\text{hom}} = 1 > \rho^{\text{het}}$. For $\alpha \in]\alpha_R^{\text{het}}, \alpha_R^{\text{hom}}[$, the heterogeneous organization is fully reactive, with non-reactivity $\rho^{\text{het}} = 0$, while the homogeneous organization is semireactive with $\rho^{\text{hom}} > 0 = \rho^{\text{het}}$.

Finally, there is the possibility that both organizations are in a semireactive equilibrium, which happens when $\alpha_{\text{NR}}^{\text{hom}} \leq \alpha_R^{\text{het}}$ and for $\alpha \in \left[\alpha_{\text{NR}}^{\text{hom}}, \alpha_R^{\text{het}}\right]$). In that case, we can write the two indifference conditions (20) and (19) as

$$\begin{aligned} F\left(\mu^{\text{het}}\underline{b}\right) &= \frac{\alpha\underline{B}}{(1-\alpha)\bar{B}}F(\alpha\bar{b}) \\ &> \frac{\alpha\underline{B}}{(1-\alpha)\bar{B}}F(\alpha\underline{b}) \\ &= F\left(\mu^{\text{hom}}\bar{b}\right). \end{aligned}$$

11. f is strictly positive over $\mathbb{R}_+$.

12. Remember that ρ is the probability that the Decision Maker selects project 1 after observing signal 2, so it measures non-reactivity ($\rho = 1$ means non-reactivity, while $\rho = 0$ means perfect reactivity).

As F is strictly increasing, this proves that $\mu^{\text{het}} > \mu^{\text{hom}}$, which in turn implies that $\rho^{\text{hom}} > \rho^{\text{het}}$. Thus, there is more reactivity in the heterogeneous organization compared to the homogeneous organization, even in the case where both organizations are semi-reactive. This achieves the proof of Proposition 4. ‖

APPENDIX G. PROOF OF LEMMA 2

The proof that $\alpha_{\text{NR}}^{j} < \alpha_{R}^{j}$ for $j \in \{\text{het}, \text{hom}\}$ is direct. When $j = hom$ for instance, if $\alpha < \alpha_{\text{NR}}^{\text{hom}}$, then: $\alpha F(\alpha \underline{b})\underline{B} < (1-\alpha)F\left(\frac{\bar{b}}{2}\right)\bar{B} < (1-\alpha)F(\alpha\bar{b})\bar{B}$ so that $\alpha < \alpha_{R}^{\text{hom}}$.

Similarly, if $j = \text{hom}$ and $\alpha < \alpha^{\text{hom}}$, then $\alpha F(\alpha\underline{b})\underline{B} < (1-\alpha)F\left((1-\alpha)\bar{b}\right)\bar{B} < (1-\alpha)F\left(\frac{\bar{b}}{2}\right)\bar{B}$ so that $\alpha < \alpha_{\text{NR}}^{\text{hom}}$. The proofs are similar when $j = \text{het}$. ‖

APPENDIX H. PROOF OF PROPOSITION 5

We first extend the definition of ρ^{hom}:

$$\rho^{\text{hom}} = \begin{cases} 0 \quad \text{if } \alpha \geq \alpha_{R}^{\text{hom}} \\ \rho^{\text{hom}} \quad \text{as defined by equation 19 for } \alpha \in \left[\alpha_{\text{NR}}^{\text{hom}}, \alpha_{R}^{\text{hom}}\right] \\ 1 \quad \text{if } \alpha \leq \alpha_{\text{NR}}^{\text{hom}} \end{cases}.$$

One can also extend the definition of ρ^{het} in a similar fashion:

$$\rho^{\text{het}} = \begin{cases} 0 \quad \text{if } \alpha \geq \alpha_{R}^{\text{het}} \\ \rho^{\text{het}} \quad \text{as defined by equation 20 for } \alpha \in \left[\alpha_{\text{NR}}^{\text{het}}, \alpha_{R}^{\text{het}}\right] \\ 1 \quad \text{if } \alpha \leq \alpha_{\text{NR}}^{\text{het}} \end{cases}.$$

We note $\mu^{\text{het}} = \frac{\alpha+\rho^{\text{het}}(1-\alpha)}{1+\rho^{\text{het}}}$ and $\mu^{\text{hom}} = \frac{\alpha+\rho^{\text{hom}}(1-\alpha)}{1+\rho^{\text{hom}}}$ the posterior beliefs associated with the extended ρs. We can now write for each α, the Owner's expected profit from the two organizational forms:

$$\begin{cases} V^{\text{hom}} = \frac{R}{2}.\left(\alpha + (1-\alpha)\rho^{\text{hom}}\right) F\left(\mu^{\text{hom}}\bar{b}\right) + \frac{R}{2}\alpha(1-\rho^{\text{hom}}).F(\alpha\underline{b})R \\ V^{\text{het}} = \frac{R}{2}.\left(\alpha + (1-\alpha)\rho^{\text{het}}\right) F\left(\mu^{\text{het}}\underline{b}\right) + \frac{R}{2}\alpha(1-\rho^{\text{het}}).F(\alpha\bar{b})R. \end{cases}$$

We begin this proof by showing that the expected profits from both organizational forms are weakly increasing with α. We have shown in Appendix E that both ρ^{hom} and ρ^{het} are strictly decreasing functions of α over $\left[\alpha_{\text{NR}}^{\text{hom}}, \alpha_{R}^{\text{hom}}\right]$ and $\left[\alpha_{\text{NR}}^{\text{het}}, \alpha_{R}^{\text{het}}\right]$ respectively. However, using the definition of ρ^{hom} and ρ^{het} over $\left[\alpha_{\text{NR}}^{\text{hom}}, \alpha_{R}^{\text{hom}}\right]$ and $\left[\alpha_{\text{NR}}^{\text{het}}, \alpha_{R}^{\text{het}}\right]$ respectively, one can show that V^{hom} and V^{het} are strictly increasing functions of α over this interval. The Owner's expected profit from the two organizational forms can be rewritten as

$$\begin{cases} V^{\text{hom}} = \frac{1}{2}\left(\frac{\alpha\underline{B}}{(1-\alpha)\bar{B}}\left(\alpha + \rho^{\text{hom}}(1-\alpha)\right) + \alpha(1-\rho^{\text{hom}})\right) F(\alpha\underline{b})R \\ V^{\text{het}} = \frac{1}{2}.\left(\frac{\alpha\underline{B}}{(1-\alpha)\bar{B}}\left(\alpha + \rho^{\text{het}}(1-\alpha)\right) + \alpha(1-\rho^{\text{het}})\right) F(\alpha\bar{b})R. \end{cases}$$

These two expressions are clearly increasing in α, as their partial derivative in α is positive, while their partial derivative in ρ is negative and ρ is a strictly decreasing function of α.

Over $\left[1/2, \alpha_{\text{NR}}^{\text{hom}}\right]$ (resp. $\left[1/2, \alpha_{\text{NR}}^{\text{het}}\right]$) the homogeneous (resp. heterogeneous) organization's expected profit is independent of α. Over $\left[\alpha_{R}^{\text{hom}}, 1\right]$ (resp. $\left[\alpha_{R}^{\text{het}}, 1\right]$) the homogeneous (resp. heterogeneous) organization's expected profit is strictly increasing in α, as it is given by: $\frac{\alpha}{2}\left(F(\alpha\bar{b}) + F(\alpha\underline{b})\right)$.

Overall, the expected profit from the two organizational forms is weakly increasing with α.

We now compare the Owner's expected profit from the two organizational forms. To do so, we need to condition the analysis on the existence of a region where both organizations are semi-reactive, which happens when $\alpha_{\text{NR}}^{\text{hom}} \leq \alpha_{R}^{\text{het}}$.

Assume this is a case: $\alpha_{\mathrm{NR}}^{\mathrm{hom}} \leq \alpha_R^{\mathrm{het}}$. First, over $\left[\alpha_{\mathrm{NR}}^{\mathrm{het}}, \alpha_{\mathrm{NR}}^{\mathrm{hom}}\right]$, the homogeneous organization is non-reactive, while the heterogeneous organization is semi-reactive. The difference in profits is then strictly increasing with α, as the non-reactive organization's profit is constant with respect to α and the semi-reactive organization's profit is increasing with α (see above). For $\alpha = \alpha_{\mathrm{NR}}^{\mathrm{het}}$, the heterogeneous organization is non-reactive, so that its expected profit is $\frac{R}{2} F\left(\frac{\bar{b}}{2}\right)$ and is strictly inferior to the expected profit from the homogeneous non-reactive organization. For $\alpha = \alpha_{\mathrm{NR}}^{\mathrm{hom}}$, a little computation (using the definition of $\alpha_{\mathrm{NR}}^{\mathrm{hom}}$ and the indifference condition in the semi-reactive heterogeneous organization) allows us to write the difference in expected profits as

$$V^{\mathrm{het}}(\alpha_{\mathrm{NR}}^{\mathrm{hom}}) - V^{\mathrm{hom}}(\alpha_{\mathrm{NR}}^{\mathrm{hom}}) = \left(1-\rho^{\mathrm{hom}}\right) F(\alpha_{\mathrm{NR}}^{\mathrm{hom}}\underline{b})\left(\alpha_{\mathrm{NR}}^{\mathrm{hom}} - \frac{\alpha_{\mathrm{NR}}^{\mathrm{hom}}\underline{B}}{(1-\alpha_{\mathrm{NR}}^{\mathrm{hom}})\bar{B}}\left(1-\alpha_{\mathrm{NR}}^{\mathrm{hom}}\right)\right).$$

But remember we have assumed that $\alpha_{\mathrm{NR}}^{\mathrm{hom}} \leq \alpha_R^{\mathrm{het}}$. Using the definition of these two thresholds, this implies that for $\alpha \in \left[\alpha_{\mathrm{NR}}^{\mathrm{hom}}, \alpha_R^{\mathrm{het}}\right]$, $F(\alpha\underline{b}) \geq F(\frac{\bar{b}}{2})$. For $\alpha = \alpha_{\mathrm{NR}}^{\mathrm{hom}}$, we thus have $\frac{\alpha_{\mathrm{NR}}^{\mathrm{hom}}\underline{B}}{\left(1-\alpha_{\mathrm{NR}}^{\mathrm{hom}}\right)\bar{B}} = \frac{F\left(\frac{\bar{b}}{2}\right)}{F\left(\alpha_{\mathrm{NR}}^{\mathrm{hom}}\underline{b}\right)} \leq 1$.

Therefore: $V^{\mathrm{het}}(\alpha_{\mathrm{NR}}^{\mathrm{hom}}) - V^{\mathrm{hom}}(\alpha_{\mathrm{NR}}^{\mathrm{hom}}) \geq \left(1-\rho^{\mathrm{hom}}\right) F(\alpha_{\mathrm{NR}}^{\mathrm{hom}}\underline{b})\,(2\alpha-1) > 0$. Thus, the difference in profits is strictly positive in $\alpha_{\mathrm{NR}}^{\mathrm{hom}}$ and strictly negative in $\alpha_{\mathrm{NR}}^{\mathrm{het}}$. By the intermediate value theorem, there must be $\alpha^{**} \in]\alpha_{\mathrm{NR}}^{\mathrm{het}}, \alpha_{\mathrm{NR}}^{\mathrm{hom}}[$ such that the heterogeneous organization delivers a higher expected profit than the homogeneous organization on $]\alpha^{**}, \alpha_{\mathrm{NR}}^{\mathrm{hom}}]$, while the converse is true over $[\alpha_{\mathrm{NR}}^{\mathrm{het}}, \alpha^{**}[$. Let $\alpha \in]\alpha_{\mathrm{NR}}^{\mathrm{hom}}, \alpha_R^{\mathrm{het}}[$Then the two organizations are semi-reactive. Using the indifference conditions 19 and 20 defining the semi-reactive equilibrium, we can write the two expected profits as:

$$\begin{cases} V^{\mathrm{hom}} = \frac{1}{2}.\left(\frac{\alpha\underline{B}}{(1-\alpha)\bar{B}}\left(\alpha+\rho^{\mathrm{hom}}(1-\alpha)\right)+\alpha(1-\rho^{\mathrm{hom}})\right)F(\alpha\underline{b})R \\ V^{\mathrm{het}} = \frac{1}{2}\left(\frac{\alpha\underline{B}}{(1-\alpha)\bar{B}}\left(\alpha+\rho^{\mathrm{het}}(1-\alpha)\right)+\alpha(1-\rho^{\mathrm{het}})\right)F(\alpha\bar{b})R. \end{cases}$$

$\underline{b} < \bar{b}$ and $\rho^{\mathrm{hom}} > \rho^{\mathrm{het}}$ over $]\alpha_{\mathrm{NR}}^{\mathrm{hom}}, \alpha_R^{\mathrm{het}}[$. Therefore, it is obvious that over this interval: $V^{\mathrm{het}} > V^{\mathrm{hom}}$.

Let $\alpha \in]\alpha_R^{\mathrm{het}}, \alpha_R^{\mathrm{hom}}[$. Over this interval, the heterogeneous organization is reactive, while the homogeneous organization is semi-reactive. The expected profit from the two organizational forms are given by

$$\begin{cases} V^{\mathrm{hom}} = \frac{1}{2}.\left(\left(\alpha+\rho^{\mathrm{hom}}(1-\alpha)\right)F\left(\mu^{\mathrm{hom}}\bar{b}\right)+\alpha(1-\rho^{\mathrm{hom}})F(\alpha\underline{b})\right)R \\ V^{\mathrm{het}} = \frac{\alpha}{2}.\left(F(\alpha\bar{b})+F(\alpha\underline{b})\right)R. \end{cases}$$

The difference in expected profits can be written as

$$\begin{aligned} 2V^{\mathrm{het}}-2V^{\mathrm{hom}} &= \alpha\left(F(\alpha\bar{b})-F\left(\mu^{\mathrm{hom}}\bar{b}\right)\right)+\rho^{\mathrm{hom}}\left(\alpha F(\alpha\underline{b})-(1-\alpha)F\left(\mu^{\mathrm{hom}}\bar{b}\right)\right) \\ &\geq \alpha\left(F(\alpha\bar{b})-F(\mu^{\mathrm{hom}}\bar{b})\right)+\rho^{\mathrm{hom}}\alpha F(\alpha\underline{b})\left(1-\frac{\underline{B}}{\bar{B}}\right) \\ &> 0. \end{aligned}$$

Thus, over $]\alpha_R^{\mathrm{het}}, \alpha_R^{\mathrm{hom}}[$, the heterogeneous organization delivers a higher expected profit to the Owner than the homogeneous organization.

Finally, over $[\alpha_R^{\mathrm{hom}}, 1]$, both organizations are reactive, so that they share the same expected profit.

Now, assume that $\alpha_{\mathrm{NR}}^{\mathrm{hom}} > \alpha_R^{\mathrm{het}}$.

For $\alpha \leq \alpha_{\mathrm{NR}}^{\mathrm{het}}$, both organizations are non-reactive, so the homogeneous organization has a higher value. For $\alpha_{\mathrm{NR}}^{\mathrm{het}} < \alpha < \alpha_{\mathrm{NR}}^{\mathrm{hom}}$, the heterogeneous organization is semi-reactive or reactive, while the homogeneous organization is non-reactive. As we showed above, the difference in expected profits between the heterogeneous and the homogeneous organization is then increasing with α. For $\alpha = \alpha_{\mathrm{NR}}^{\mathrm{het}}$ still non-reactive. For $\alpha = \alpha_{\mathrm{NR}}^{\mathrm{hom}}$, the difference in expected profits can be written as:

$$\begin{aligned} 2V^{\mathrm{het}}-2V^{\mathrm{hom}} &= \alpha\left(F\left(\alpha\bar{b}\right)-F\left(\frac{\bar{b}}{2}\right)\right)+\left(\alpha F(\alpha\underline{b})-(1-\alpha)F\left(\frac{\bar{b}}{2}\right)\right) \\ &\geq \alpha\left(F\left(\alpha\bar{b}\right)-F(\frac{\bar{b}}{2})\right)+\alpha F(\alpha\underline{b})\left(1-\frac{\underline{B}}{\bar{B}}\right) \\ &> 0. \end{aligned}$$

Therefore, there must be $\alpha^{**} \in]\alpha_{\text{NR}}^{\text{het}}, \alpha_{\text{NR}}^{\text{hom}}[$ such that the heterogeneous organization has a strictly higher expected profit over $]\alpha^{**}, \alpha_{\text{NR}}^{\text{hom}}]$, while the homogeneous organization delivers a strictly higher expected profit over $[\alpha_{\text{NR}}^{\text{het}}, \alpha^{**}[$.

If $\alpha \in [\alpha_{\text{NR}}^{\text{hom}}, \alpha_{R}^{\text{hom}}$, the homogeneous organization is semi-reactive, while the heterogeneous organization is fully reactive. We proved above that in such a case, the heterogeneous organization has a higher expected profit.[13] Finally, if $\alpha > \alpha_{R}^{\text{hom}}$, both organizations are reactive and thus have the same expected profit. ||

APPENDIX I. TRANSPARENCY AND OPACITY

This Appendix exhibits a sufficient condition under which the organization's Owner prefers opacity, that is, leaving the signal private information to the Decision Maker, over transparency. Let $\alpha < \alpha^{j}$, where $j \in \{\text{hom}, \text{het}, \}$. Both the transparent and the opaque organizations are non-reactive. The net gain for the Owner of the signal being public information is given by the difference between the expected pay-off in the model of Section 3 and the basic model of Section 2:

$$\Delta(\alpha) = \frac{R}{2}\Big[\alpha F(\alpha b^{j}) + (1-\alpha)F((1-\alpha)b^{j})\Big] - \frac{1}{2}\Big[F(\frac{b^{j}}{2})\Big],$$

where $b^{j} = \bar{b}$ if $j = hom$ and $b^{j} = \underline{b}$ if $j = het$. $\Delta\left(\frac{1}{2}\right) = 0$. $\Delta'(\alpha) = F(\alpha b^{j}) + \alpha b^{j} \times f(\alpha b^{j}) - \big(F\big((1-\alpha)b^{j}\big) + (1-\alpha)b^{j} \times f\big((1-\alpha)b^{j}\big)\big)$. If $F(x) + xf(x)$ is increasing over $[(1-\alpha)\underline{b}, \alpha\bar{b}]$, then Δ is increasing over $[\frac{1}{2}, \alpha^{j}[$ and therefore positive over this interval. Conversely, if $F(x) + xf(x)$ is decreasing over $[(1-\alpha)\underline{b}, \alpha\bar{b}]$, then Δ is decreasing over $[\frac{1}{2}, \alpha^{j}[$ and therefore negative over this interval. In this last case, the organization's value is maximized by leaving the Implementer "in the dark" about the nature of the signal received by the Decision Maker.

We end this section by showing that for $\alpha > \alpha_{\text{NR}}^{j}$, the Owner always selects transparency. Consider first the case of a heterogeneous organization. For $\alpha_{\text{NR}}^{\text{het}} < \alpha < \alpha_{R}^{\text{het}}$, the gain for the Owner of the signal being public information is given by:

$$\begin{aligned}\Delta(\alpha) = {} & \frac{1}{2}.\big[\alpha F(\alpha\bar{b}) + \alpha F(\alpha\underline{b})\big] - \\ & \frac{1}{2}\Big(\alpha + \rho^{\text{het}}(1-\alpha)\Big).F\Big(\mu^{\text{het}}.\underline{b}\Big) - \frac{1}{2}\alpha(1-\rho^{\text{het}})F(\alpha\bar{b}).\end{aligned}$$

The above expression can be rewritten as

$$\Delta = \frac{\alpha\rho^{\text{het}}}{2}F(\alpha\bar{b}) + \frac{\alpha}{2}\Big[F(\alpha\underline{b}) - F(\mu^{\text{het}}\underline{b})\Big] - \frac{(1-\alpha)\rho^{\text{het}}}{2}F(\mu^{\text{het}}\underline{b}).$$

Using the indifference condition (18), we obtain

$$\begin{aligned}\Delta = {} & \left(1 - \frac{B}{\bar{\bar{B}}}\right)\frac{\alpha\rho^{\text{het}}}{2}F(\alpha\bar{b}) + \frac{\alpha}{2}\Big[F(\alpha\underline{b}) - F(\mu^{\text{het}}\underline{b})\Big] \\ & > 0.\end{aligned}$$

Thus, the Owner strictly prefers when the signal is publicly observed.

For $\alpha_{R}^{\text{het}} < \alpha$, both organizations are fully reactive and therefore generate the same expected profit. Thus, in a heterogeneous organization, for $\alpha > \alpha_{\text{NR}}^{\text{het}}$, the Owner prefers when the signal is publicly observed.

We now turn to the case of a homogeneous organization. If $\alpha_{\text{NR}}^{\text{hom}} < \alpha < \alpha_{R}^{\text{hom}}$, the gain for the Owner of the signal being public information is given by

$$\begin{aligned}\Delta = {} & \frac{1}{2}.\big[\alpha F(\alpha\bar{b}) + \alpha F(\alpha\underline{b})\big] - \\ & \frac{1}{2}\Big(\alpha + \rho^{\text{hom}}(1-\alpha)\Big).F\Big(\mu^{\text{hom}}\bar{b}\Big) - \frac{1}{2}\alpha(1-\rho^{\text{hom}})F(\alpha\underline{b}).\end{aligned}$$

The above expression can be rewritten as

$$\Delta = \frac{\alpha\rho^{\text{hom}}}{2}F(\alpha\underline{b}) + \frac{\alpha}{2}\Big[F(\alpha\bar{b}) - F(\mu^{\text{hom}}\bar{b})\Big] - \frac{(1-\alpha)\rho^{\text{hom}}}{2}F\Big(\mu^{\text{hom}}\bar{b}\Big).$$

13. The proof did not involve the assumption that $\alpha_{\text{NR}}^{\text{hom}} \leq \alpha_{R}^{\text{het}}$.

Using the indifference condition (19), we obtain

$$\Delta = \left(1 - \frac{\underline{B}}{\bar{\bar{B}}}\right) \frac{\alpha\rho^{\text{hom}}}{2} F(\alpha\underline{b}) + \frac{\alpha}{2}\left[F(\alpha\bar{b}) - F(\mu^{\text{hom}}\bar{b})\right]$$
$$> 0.$$

Thus, the Owner strictly prefers when the signal becomes public information. For $\alpha_R^{\text{hom}} < \alpha$, both organizations are fully reactive and therefore generate the same expected profit. Thus, in a homogeneous organization, for $\alpha > \alpha_{\text{NR}}^{\text{hom}}$, the Owner prefers when the signal is publicly observed. ‖

APPENDIX J. PROOF OF PROPOSITION 6

Consider first the model of Section 2.4. For $\alpha \le \alpha^{\text{het}}$, both organizational forms are non-reactive. The Decision Maker then clearly prefers the homogeneous organization, as it has the most intrinsically motivated Implementer. For $\alpha \ge \alpha^{\text{hom}}$, both organizations are reactive and thus deliver the following expected utility for the Decision Maker:

$$\begin{cases} W^{\text{het}} = \frac{\alpha}{2}\left(F(\alpha\bar{b})\underline{B} + F(\alpha\underline{b})\bar{B}\right) \\ W^{\text{hom}} = \frac{\alpha}{2}\left(F(\alpha\underline{b})\underline{B} + F(\alpha\bar{b})\bar{B}\right). \end{cases}$$

Therefore, $W^{\text{hom}} - W^{\text{het}} = \frac{\alpha}{2}\left(F(\alpha\bar{b}) - F(\alpha\underline{b})\right)\left(\bar{B} - \underline{B}\right) > 0$.

Finally, when $\alpha \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, the heterogeneous organization is reactive, while the homogeneous organization is non-reactive. The two organizational forms provide the Decision Maker with expected utility:

$$\begin{cases} W^{\text{het}} = \frac{\alpha}{2}\left(F(\alpha\bar{b})\underline{B} + F(\alpha\underline{b})\bar{B}\right) \\ W^{\text{hom}} = \frac{1}{2}\left((1-\alpha)F((1-\alpha)\bar{b})\bar{B} + \alpha F(\alpha\bar{b})\bar{B}\right). \end{cases}$$

We know, however, that the homogeneous organization is non-reactive, so that: $(1-\alpha)F((1-\alpha)\bar{b})\bar{B} \ge \alpha F(\alpha\underline{b})\underline{B}$. Thus:

$$W^{\text{hom}} - W^{\text{het}} \geq = \frac{\alpha}{2}\left(F(\alpha\bar{b}) - F(\alpha\underline{b})\right)\left(\bar{B} - \underline{B}\right) > 0.$$

Consider now the model of Section 3 and let us assume first that $\alpha_{\text{NR}}^{\text{hom}} < \alpha_R^{\text{het}}$. This corresponds to the case where the threshold α^{**} trades-off the non-reactive homogeneous organization with the semi-reactive heterogeneous organization.

1. For $\alpha \le \alpha_{\text{NR}}^{\text{het}}$, both organizations are non-reactive and provide the Decision Maker with the following utility:

$$\begin{cases} 2W^{\text{het}} = F(\frac{b}{2})\bar{B} \\ 2W^{\text{hom}} = F(\frac{\bar{b}}{2})\bar{B} \end{cases}$$

so that the Decision Maker clearly selects the homogeneous organization.

2. For $\alpha_{\text{NR}}^{\text{hom}} \ge \alpha \ge \alpha_{\text{NR}}^{\text{het}}$, the homogeneous organization is non-reactive, while the heterogeneous organization is semi-reactive. Using the Decision Maker indifference condition in the heterogeneous organization, we find that for such levels of signal precision:

$$\begin{cases} 2W^{\text{het}} = \frac{\alpha}{1-\alpha} F(\alpha\bar{b})\underline{B} \\ 2W^{\text{hom}} = F(\frac{\bar{b}}{2})\bar{B}. \end{cases}$$

$\Delta W(\alpha) = 2W^{\text{het}}(\alpha) - 2W^{\text{hom}}(\alpha)$ is thus an increasing function of α. We know from case 1 that $\Delta W(\alpha_{\text{NR}}^{\text{het}}) < 0$ and we have $\Delta W(\alpha_{\text{NR}}^{\text{hom}}) = \frac{\alpha}{1-\alpha} F(\alpha\bar{b})\underline{B} - \frac{\alpha}{1-\alpha} F(\alpha\underline{b})\underline{B} > 0$ using the definition of $\alpha_{\text{NR}}^{\text{hom}}$. Therefore, there is $\breve{\alpha}_1 \in [\alpha_{\text{NR}}^{\text{het}}, \alpha_{\text{NR}}^{\text{hom}}]$ such that $\Delta W > 0$ if and only if $\alpha > \breve{\alpha}_1$. Thus, when $\alpha_{\text{NR}}^{\text{hom}}\alpha \ge \alpha_{\text{NR}}^{\text{het}}$, the Decision Maker selects the heterogeneous organization if and only if $\alpha > \breve{\alpha}_1$. We note that $\Delta W(\alpha^{**} < 0$ so that $\breve{\alpha}_1 > \alpha^{**}$.

3. For $\alpha_R^{\text{het}} \ge \alpha \ge \alpha_{\text{NR}}^{\text{hom}}$, both organizations are semi-reactive, yielding the following utility to the Decision Maker:

$$\begin{cases} 2W^{\text{het}} = \frac{\alpha}{1-\alpha} F(\alpha\bar{b})\underline{B} \\ 2W^{\text{hom}} = \frac{\alpha}{1-\alpha} F(\alpha\underline{b})\underline{B}. \end{cases}$$

Clearly, the Decision Maker prefers the heterogeneous organization when $\alpha_R^{\text{het}}\alpha \ge \alpha_{\text{NR}}^{\text{hom}}$.

4. For $\alpha_R^{\text{hom}} \geq \alpha \geq \alpha_R^{\text{het}}$, the heterogeneous organization is reactive, while the homogeneous organization is semi-reactive. This leaves the Decision Maker with the following utility:

$$\begin{cases} 2W^{\text{het}} = \alpha F(\alpha \underline{b})\bar{B} + \alpha F(\alpha \bar{b})\underline{B} \\ 2W^{\text{hom}} = \dfrac{\alpha}{1-\alpha} F(\alpha \underline{b})\underline{B}. \end{cases}$$

As earlier, we note: $\Delta W(\alpha) = 2W^{\text{het}}(\alpha) - 2W^{\text{hom}}(\alpha)$. We know from the previous case that $\Delta W(\alpha_R^{\text{het}}) > 0$. When $\alpha = \alpha_R^{\text{hom}}$, we have $2W^{\text{hom}}(\alpha_R^{\text{hom}}) = \alpha F(\alpha \bar{b})\bar{B} + \alpha F(\alpha \underline{b})\underline{B} > 2W^{\text{het}}(\alpha_R^{\text{hom}})$. Therefore, $\Delta W(\alpha_R^{\text{hom}}) < 0$. Thus, there exists $\breve{alpha}_2 \in [\alpha_R^{\text{hom}}, \alpha_R^{\text{het}}]$ such that $\Delta W(\breve{\alpha}_2) = 0$
We have:

$$\Delta W'(\breve{\alpha}_2) = \underbrace{\left(F(\breve{\alpha}_2 \underline{b})\bar{B} + F(\breve{\alpha}_2 \bar{b})\underline{B}\right)}_{=\frac{F(\breve{\alpha}_2 \underline{b})}{1-\breve{\alpha}_2}\underline{B}} - \frac{1}{(1-\breve{\alpha}_2)^2} F(\breve{\alpha}_2 \underline{b})\underline{B}$$

$$+ \breve{\alpha}_2 \underline{b} f(\breve{\alpha}_2 \underline{b})\bar{B} + \breve{\alpha}_2 \bar{b} f(\breve{\alpha}_2 \bar{b})\underline{B} - \frac{\breve{\alpha}_2 \underline{b}}{1-\breve{\alpha}_2} f(\breve{\alpha}_2 \underline{b})\underline{B}$$

$$= \breve{\alpha}_2 \underline{b} f(\breve{\alpha}_2 \underline{b})\bar{B} + \breve{\alpha}_2 \bar{b} f(\breve{\alpha}_2 \bar{b})\underline{B} - \frac{\breve{\alpha}_2}{(1-\breve{\alpha}_2)^2} F(\breve{\alpha}_2 \underline{b})\underline{B} - \frac{\breve{\alpha}_2 \underline{b}}{1-\breve{\alpha}_2} f(\breve{\alpha}_2 \underline{b})\underline{B}$$

But we know, using the definition of $\breve{\alpha}_2$ that $\underline{B} > (1-\breve{\alpha}_2)\bar{B}$ and $F(\breve{\alpha}_2 \underline{b}) > (1-\breve{\alpha}_2)F(\breve{\alpha}_2 \bar{b})$so that:

$$\begin{aligned} \Delta W'(\breve{\alpha}_2) &< \breve{\alpha}_2 \underline{b} f(\breve{\alpha}_2 \underline{b})\bar{B} + \breve{\alpha}_2 \bar{b} f(\breve{\alpha}_2 \bar{b})\underline{B} - \frac{\breve{\alpha}_2}{1-\breve{\alpha}_2} F(\breve{\alpha}_2 \bar{b})\underline{B} - \breve{\alpha}_2 \underline{b} f(\breve{\alpha}_2 \underline{b})\bar{B} \\ &< \breve{\alpha}_2 \bar{b} f(\breve{\alpha}_2 \bar{b})\underline{B} - \frac{\breve{\alpha}_2}{1-\breve{\alpha}_2} F(\breve{\alpha}_2 \bar{b})\underline{B} \\ &< \breve{\alpha}_2 \bar{b} f(\breve{\alpha}_2 \bar{b})\underline{B} - F(\breve{\alpha}_2 \bar{b})\underline{B} \\ &< 0. \end{aligned}$$

Therefore, we conclude that ΔW crosses 0 once and only once over $[\alpha_R^{\text{hom}}, \alpha_R^{\text{het}}]$, and that this happens in $\breve{\alpha}_2$. Thus, when $\alpha_R^{\text{hom}}\alpha \geq \alpha_R^{\text{het}}$, the Decision Maker selects the heterogeneous organization if and only if $\alpha < \breve{\alpha}_2$.

5. Finally, when $\alpha > \alpha_R^{\text{hom}}$, both organizations are reactive. They deliver the following utility to the Decision Maker:

$$\begin{cases} 2W^{\text{het}} = \alpha F(\alpha \underline{b})\bar{B} + \alpha F(\alpha \bar{b})\underline{B} \\ 2W^{\text{hom}} = \alpha F(\alpha \underline{b})\underline{B} + \alpha F(\alpha \bar{b})\bar{B}. \end{cases}$$

And clearly, the Decision Maker then selects the homogeneous organization.

The proof of Proposition 6 when $\alpha_{\text{NR}}^{\text{hom}} < \alpha_R^{\text{het}}$ is left to the reader. ‖

APPENDIX K. PROOF OF PROPOSITION 7

1. Let us first show points 1 and 2. The expected profits of the reactive heterogeneous and the non-reactive homogeneous organizations are given by:

$$V_R^{\text{het}} = \frac{1}{2}\left[\alpha F(\alpha \bar{b}) + \alpha F(\alpha \underline{b})\right].R$$

$$V_{\text{NR}}^{\text{hom}} = \frac{1}{2}\left[\alpha F(\alpha \bar{b}) + (1-\alpha)F((1-\alpha)\bar{b})\right].R.$$

The Implementers' expected utility in each of these organizations is given by:

$$U_R^{\text{het}} = \frac{1}{2}\left[\alpha F(\alpha \bar{b}).\bar{b} - \int_0^{\alpha \bar{b}} c\,dF(c) + \alpha F(\alpha \underline{b}).\underline{b} - \int_0^{\alpha \underline{b}} c\,dF(c)\right]$$

$$U_{\text{NR}}^{\text{hom}} = \frac{1}{2}\left[\alpha F(\alpha \bar{b}).\bar{b} - \int_0^{\alpha \bar{b}} c\,dF(c) + (1-\alpha)F((1-\alpha)\bar{b}).\bar{b} - \int_0^{(1-\alpha)\bar{b}} c\,dF(c)\right].$$

We thus compute the joint surplus generated by both the homogeneous and the heterogeneous organization:

$$S_R^{\text{het}} = \frac{1}{2}\left[\alpha F(\alpha\overline{b}).\left(R+\overline{b}\right) - \int_0^{\alpha\overline{b}} c dF(c) + \alpha F(\alpha\underline{b}).\left(R+\underline{b}\right) - \int_0^{\alpha\underline{b}} c dF(c)\right]$$

$$S_{\text{NR}}^{\text{hom}} = \frac{1}{2}\left[\alpha F(\alpha\overline{b}).\left(R+\overline{b}\right) - \int_0^{\alpha\overline{b}} c dF(c) + (1-\alpha)F((1-\alpha)\overline{b}).\left(R+\overline{b}\right) - \int_0^{(1-\alpha)\overline{b}} c dF(c)\right].$$

Assume $\alpha \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$. If the joint surplus from the non-reactive homogeneous organization is higher that the joint surplus from the reactive heterogeneous organization, then Implementers naturally end up in a homogeneous organization, which, because $\alpha \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, is indeed non-reactive (see Proposition 3). Conversely, if $S_{\text{NR}}^{\text{hom}} < S_R^{\text{het}}$, then Implementers will end up in heterogeneous organizations, which happen to be reactive in this range of α. Thus, there will be only homogeneous organizations at equilibrium if and only if $S_{\text{NR}}^{\text{hom}} > S_R^{\text{het}}$:

$$\int_0^{\alpha\underline{b}} \left[\alpha\left(R+\underline{b}\right) - c\right].dF(c) < \int_0^{(1-\alpha)\overline{b}} \left[(1-\alpha).\left(R+\overline{b}\right) - c\right].dF(c) \tag{21}$$
$$\Longleftrightarrow \alpha < \widehat{\alpha}.$$

It appears from the above expression that $\widehat{\alpha} \in [1/2; 1]$. If $\widehat{\alpha} < \alpha^{\text{het}}$, then the homogeneous organization is never an equilibrium on $[\alpha^{\text{het}}; \alpha^{\text{hom}}]$. If, on the contrary, $\widehat{\alpha} > \alpha^{\text{hom}}$, it always is. Finally, if $\widehat{\alpha} \in [\alpha^{\text{het}}, \alpha^{\text{hom}}]$, then we have points 1 and 2 of Proposition 7.

2. We move to point 3. Let us assume that $\widehat{\alpha} \geqslant \alpha^{\text{hom}}$. This implies:

$$\frac{\widehat{\alpha}.F(\widehat{\alpha}\underline{b})}{(1-\alpha\widehat{\alpha}).F((1-\widehat{\alpha}).\underline{b})} \geqslant \frac{\overline{B}}{\underline{B}}$$

while, from condition (21) we can write the definition of $\widehat{\alpha}$ such that:

$$\frac{\widehat{\alpha}F(\widehat{\alpha}\underline{b})}{(1-\widehat{\alpha})F((1-\widehat{\alpha})\underline{b})} = \frac{(R+\overline{b}) - E(\widetilde{c}/(1-\widehat{\alpha}) \mid \widetilde{c} < (1-\widehat{\alpha}).\overline{b})}{(R+\underline{b}) - E(\widetilde{c}/\widehat{\alpha} \mid \widetilde{c} < \widehat{\alpha}\underline{b})}. \tag{22}$$

It is straightforward to see that $E(\widetilde{c}/(1-\widehat{\alpha}) \mid \widetilde{c} < (1-\widehat{\alpha})\overline{b}) < \overline{b}$ and $E(\widetilde{c}/\widehat{\alpha} \mid \widetilde{c} < \widehat{\alpha}\underline{b}) < \underline{b}$. As $R \longrightarrow \infty$, both conditional expectations are bounded above, which means that the R.H.S. of (22) tends towards 1. Thus, there exists $\widehat{R}$ large enough such that, for $R > \widehat{R}$, the R.H.S. of (22) is smaller than $\overline{B}/\underline{B}$. In this case, $\widehat{\alpha}$ has to be strictly smaller than α^{hom}. Hence, there exists a non-zero interval $[\widehat{\alpha}; \alpha^{\text{hom}}]$ for which heterogeneous organizations survive in equilibrium.

3. Last, we show that $\widehat{\alpha} > \alpha^*$. Integrating $cF(c)$ by part in expression (21) leads to

$$\alpha < \widehat{\alpha} \Longleftrightarrow$$
$$R.\left[\alpha F(\alpha\underline{b}) - (1-\alpha)F((1-\alpha)\overline{b})\right] < \int_{\alpha\underline{b}}^{(1-\alpha)\overline{b}} F(c)dc.$$

The L.H.S. of the above expression is equal to zero for $\alpha = \alpha^*$ by definition of α^*. Thus

$$\alpha^* < \widehat{\alpha}$$
$$\Longleftrightarrow 0 < \int_{\alpha^*\underline{b}}^{(1-\alpha^*)\overline{b}} F(c)dc$$
$$\Longleftrightarrow \alpha^* < \frac{\overline{b}}{\overline{b}+\underline{b}}.$$

By definition of α^*:

$$z > \alpha^*$$
$$\Longleftrightarrow z.F(z\underline{b}) > (1-z).F((1-z)\overline{b}).$$

Thus:

$$\frac{\bar{b}}{\bar{b}+\underline{b}} > \alpha^*$$
$$\Longleftrightarrow \bar{b} > \underline{b},$$

which always holds. ||

APPENDIX L. PROOF OF PROPOSITION 8

We first introduce two notations:

$$\mu = \frac{(1-\theta)\alpha}{(1-\theta)\alpha+(1-\alpha)\theta} = \mathbb{P}(s=2 \mid \sigma=2)$$
$$\eta = \frac{\theta\alpha}{\theta\alpha+(1-\alpha)(1-\theta)} = \mathbb{P}(s=1 \mid \sigma=1)$$

where it is easy to see that $\eta > \mu$ and $\eta > 1-\mu$.

Let us first consider the two homogeneous organizations. In a status quo-biased homogeneous organization, reactivity emerges if and only if:

$$\mu F(\mu\underline{b})\underline{B} > (1-\mu)F((1-\mu)\bar{b})\bar{B}$$
$$\Leftrightarrow \mu > \frac{\bar{b}}{\bar{b}+\underline{b}}. \tag{23}$$

Condition 23 alone defines reactivity as, in any case, project 1 is always selected by the Decision Maker after signal 1 has been observed. A homogeneous change-biased organization is reactive if the following two conditions are met:

$$\begin{cases} \mu F(\mu\bar{b})\bar{B} \geq (1-\mu).F\left((1-\mu)\underline{b}\right)\underline{B} \Leftrightarrow \alpha \geq \alpha_{T1} \\ \eta F(\eta\underline{b})\underline{B} \geq (1-\eta).F\left((1-\eta)\bar{b}\right)\bar{B} \Leftrightarrow \alpha \geq \alpha_{T2}. \end{cases}$$

We have used the fact that μ and η are both increasing functions of α. Assume that $\alpha = \alpha_{T1}$, then: $\mu F(\mu\bar{b})\bar{B} = (1-\mu).F\big((1-\mu)\underline{b}\big)\underline{B}$. But because $\eta > 1-\mu$ and $\mu > 1-\eta$, this implies: $\eta F(\eta\underline{b})\underline{B} > (1-\eta).F((1-\eta)\bar{b})\bar{B}$, that is, $\alpha > \alpha_{T2}$, thus $\alpha_{T1} > \alpha_{T2}$ and only the first equation defines the reactive equilibrium in this organization. Note that when the change-biased homogeneous organization is non-reactive, its Decision Maker always selects the change project, that is, project 2.

Obviously, if a status quo-biased homogeneous organization is reactive, then a change-biased homogeneous organization is also reactive.

We now show that the pro-change organization is always less profitable than the status quo-biased organization. Let us first consider the case where the status quo-biased organization is reactive. In this case, both organizations are reactive, so the profit functions are given by:

$$\begin{cases} V^{\text{hom}}_{\text{change}} = \theta\alpha F(\eta\underline{b}) + (1-\theta)\alpha F(\mu\bar{b}) \\ V^{\text{hom}}_{\text{statusquo}} = \theta\alpha F(\eta\bar{b}) + (1-\theta)\alpha F(\mu\underline{b}). \end{cases}$$

Thanks to Assumption 11 and using $\eta > \mu$, it is easy to prove that in that case, $V^{\text{hom}}_{\text{statusquo}} > V^{\text{hom}}_{\text{change}}$.

We now move to the case where the status quo biased and the changed-biased homogeneous organizations are non-reactive. The expected profit from a status quo-biased organization is given by:

$$V^{\text{hom}}_{\text{statusquo}} = \theta\left(\alpha F(\eta\bar{b}) + (1-\alpha)F\left((1-\mu)\underline{b}\right)\right).$$

The change-biased non-reactive organization either

1. always selects project 1, in which case its expected profit is

$$V^{\text{hom}}_{\text{change}} = \theta\left(\alpha F(\eta\underline{b}) + (1-\alpha)F\left((1-\mu)\bar{b}\right)\right),$$

and is always lower that the expected profit of the status quo-biased, non-reactive organization or

2. always selects project 2, in which case its expected profit is:

$$V_{\text{change}}^{\text{hom}} = (1-\theta)\left(\alpha F(\mu\bar{b}) + (1-\alpha)F\left((1-\eta)\underline{b}\right)\right).$$

In that case, $\theta > 1-\theta$ and condition 11 ensures that this profit is also lower that the expected profit of the status quo-biased, non-reactive organization.

Finally, we need to consider the case where the change-biased homogeneous organization is reactive while the status quo-biased homogeneous organization is non-reactive. Expected profits are then given by:

$$\begin{cases} V_{\text{change}}^{\text{hom}} = \theta\alpha F(\eta\underline{b}) + (1-\theta)\alpha F(\mu\bar{b}) \\ V_{\text{statusquo}}^{\text{hom}} = \theta\left(\alpha F(\eta\bar{b}) + (1-\alpha)F\left((1-\mu)\underline{b}\right)\right). \end{cases}$$

Here again, thanks to Assumption 11 and using $\eta > \mu$, it is easy to prove that in that case, $V_{statusquo}^{\text{hom}} > V_{change}^{\text{hom}}$.

We now consider the two different heterogeneous organizations. When the Implementer is status quo biased (and thus the Decision Maker is change biased), the two reactivity conditions are now

$$\begin{cases} \eta F(\eta\bar{b})\underline{B} > (1-\eta)F\left((1-\eta)\underline{b}\right)\bar{B} \\ \mu F(\mu\underline{b})\overline{B} > (1-\mu)F\left((1-\mu)\overline{b}\right)\underline{B}. \end{cases}$$

We leave it to the reader to show that the heterogeneous organization where the Decision Maker is change biased always delivers a (weakly) higher expected profit than the heterogeneous organization where the Decision Maker is status quo biased.

We have thus proved that the optimal organization is either (1) a homogeneous organization with a status quo-biased Decision Maker and Implementer or (2) a heterogeneous organization with a change-biased Decision Maker and a status quo-biased Implementer. Both organizations features a status quo-biased Implementer.

Define $\alpha_{\text{change}}^{\text{het}}$ as the threshold above which the heterogeneous organization with a change-biased Decision Maker becomes reactive. Similarly, define $\alpha_{\text{statusquo}}^{\text{hom}}$ as the threshold above which the homogeneous organization with a status quo-biased Decision Maker is reactive.

For $\alpha > \alpha_{\text{statusquo}}^{\text{hom}}$, both organizations have the same expected profit, as they are both reactive and have an Implementer with similar preferences. For $\alpha < \alpha_{\text{change}}^{\text{het}}$, both organizations are non-reactive and always implementing 1 and thus also deliver the same expected profit, as, again, they have an Implementer with similar preferences.

Finally, for $\alpha \in [\alpha_{\text{change}}^{\text{het}}, \alpha_{\text{statusquo}}^{\text{hom}}]$, the homogeneous organization is non-reactive (and always selects project 1), while the heterogeneous one is reactive. Their expected profits are given by

$$\begin{cases} V_{\text{statusquo}}^{\text{hom}} = \theta\left(\alpha F(\eta\bar{b}) + (1-\alpha)F\left((1-\mu)\bar{b}\right)\right) \\ V_{\text{change}}^{\text{het}} = \theta\alpha F(\eta\bar{b}) + (1-\theta)\alpha F(\mu\underline{b}). \end{cases}$$

The heterogeneous reactive organization has a higher expected profit if and only if:

$$(1-\theta)\alpha F(\mu\underline{b}) - \theta(1-\alpha)F\left((1-\mu)\bar{b}\right) \geq 0.$$

It is easy to see that this defines an increasing function of α, negative in $\alpha = \alpha_{\text{change}}^{\text{het}}$ and positive in $\alpha = \alpha_{\text{statusquo}}^{\text{hom}}$. Thus, there exists $\tilde{\alpha_1}$ such that, for $\alpha \in \left[\tilde{\alpha_1}; \alpha_{\text{statusquo}}^{\text{hom}}\right]$, the heterogeneous reactive organization has higher expected profit.

We refer the reader to our working paper (Landier, Sraer and Tesmar, 2007) for the proof that $\alpha_{\text{statusquo}}^{\text{hom}}$ and $\tilde{\alpha_1}$ are increasing functions of θ. ‖

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