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Ex Ante Incentives and Ex Post Flexibility

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Ex Ante Incentives
and Ex Post Flexibility*

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Résumé / Abstract

Nous développons dans cet article un modèle principal-agent permettant de mieux cerner l'arbitrage inéluctable entre incitations et flexibilité en situation d'information asymétrique. Nous caractérisons la meilleure réponse de l'organisation face à ce défi en termes d'un niveau optimal d'inertie. Une plus grande flexibilité d'adaptation aux changements dans l'environnement ou l'information, que ces changements soient observés par le principal ou l'agent, peut réduire les efforts non-observables consentis par l'agent pour assurer le succès de l'organisation.

Our objective in this paper is to illustrate and better understand the unavoidable arbitrage between incentives and flexibility in contexts of asymmetric information and to characterize the general features of an appropriate response to this challenge. We show that procedures and institutions in organizations which reduce the capacity to implement change may be necessary to generate the optimal level of inertia. We show that more flexibility in adapting to changing conditions or new information, typically known or observed by either the agent or the principal but not both, may come at the expense of efforts exerted up front by the agent to make the organization more successful. There is a trade-off in this context between ex ante *efforts and* ex post *flexibility of adaptation.*

Mots Clés : Incitations, Flexibilité, Adaptation, Information asymétrique
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1. INTRODUCTION

Building flexible companies or agile corporations has become a buzzword in the management literature.[1] Without exception, flexibility has a positive tune: more flexibility is better.[2] Yet, if flexibility is so precious, why so many organizations (including, not the least, public bureaucracies) fail to meet the challenge of change ? Most of us have experienced the frustrations of rigid and inflexible organizations and bureaucratic rules. Some large and powerful companies have reacted too slowly to the need of change and were brought to the brink of bankruptcy and obsolescence. The political cost of changing social and economic policies has been blamed for the growing burden of government deficits.

Rumelt (1994) claims that the most crucial problem facing the top level management of corporations or organizations, large and small, public and private, is not product-market strategy but indeed organizational change: "If managers are to commit energy, careers, time, and attention to a program of change, there must be trust that the direction

[1] A typical management literature definition of strategic flexibility is given by Harrigan (1985, page 1) as "... firms' abilities to reposition themselves in a market, change their game plans, or dismantle their current strategies when customers they serve are no longer as attractive as they once were." There are few general and formal definitions of flexibility proposed in the literature. George Stigler (1939) pioneered the analysis of cost flexibility by stating that firms in general have to make a choice among different equipment giving rise to different cost configurations, for example a cost function which has a relatively wide flat bottom and a cost function which can attain a lower minimum average cost at the expense of steeper rising average cost as production moves away from the most efficient scale of production. More formal definitions of flexibility were given by Marshak and Nelson (1962) and Jones and Ostroy (1984). Those decision theoretic definitions are reviewed in Boyer and Moreaux (1989).

[2] A research report from Business International (1991) stresses the need for companies to be flexible given the important changes in the way competition operates and is likely to operate in the next decade: we are told that competitors now form a forest rather than a few trees around the firm-fortress, and markets are becoming more and more ephemeral and liable to significant and sudden variations. On the basis of a large number of case studies, Business International claims that flexibility is indeed the all-inclusive concept integrating a whole set of recent management theories, and moreover that "... collaboration inside and outside the company is the way flexibility is achieved." The thesis of Business International is that the process of change towards flexibility and collaboration in a company is built around four paths: first from a reliance on rules to guidance according to goals, second from motivation by product possibilities to motivation by market possibilities, third from hierarchy to network in which the corporate system is constantly recreated, and fourth from compliance based on an internal carrot and stick incentive system to alliances, both internally and externally, based on passing the carrot and the stick to the participants themselves, whether they are customers, employees, suppliers or partners. The latter path implies an internal reorganization based on the empowerment of employees, information sharing between employees and management, more and smaller goal-oriented units, more pressure to act simultaneously and more customer pressure.

chosen will not be lightly altered. Here we touch the central paradox that change may require the promise of future inertia."[3] In other words, today's inertia may be the result of a past commitment necessary to implement change. One explanation for organizational sclerosis goes as follow. In order to prosper, an organization must provide incentives to its members and promise them future rents. As the organization grows older, these rents, which are disseminated across the organization, inhibits change. Members of the organization learn to use their power to protect their rents and the conflicts between interest groups will make it hard to reform the organization. A significant free-rider problem arises and sclerosis sets in until the very survival of the organization and of the rents associated with it are in danger. Even then, the organization may be unable to orchestrate change. Olson (1982) uses such a framework to explain the rise and decline of nations.

This paper attempts to answer some basic questions which the above story raises. The allocation of rents and power to bring or block change is in some way endogenously determined and results from the organizational design. But then, why would an organization give to interest groups within the organization the incentives and power to block changes that might be beneficial to the overall organization ? How will an organization choose to allocate rents and decision power ? Why and in what sense does such an allocation generate inertia ? The relatively simple model presented in this paper is meant to address those questions in a formal way. We model the *endogenous* determination of the level of flexibility or inertia as a rational choice made by the organization.[4]

We use the most stylized and abstract representation of an organization: it is composed of a principal (the owner/manager/supervisor) who is generally the residual

[3] Rumelt argues that one source of inertia is dulled motivation with other sources being distorted perception, failed creative response, political deadlocks, and action disconnects. The cost of change, the loyalty of consumers, and the cross-subsidy comforts, a kind of soft budget constraint on some activities or divisions of the firm, may lead the firm to resist change.

[4] In the language of Business International (1991), flexible companies ... must balance rigid structure and loose network, clear strategy and opportunistic market response; ... the capacity for fast response with firm decisions on when to use it, the ability to collaborate with the readiness to protect assets."

claimant and an agent (the executive/worker/supervised). Our objective is to provide a simple model in order to illustrate and better understand the unavoidable arbitrage between incentives and flexibility in contexts of asymmetric information and to characterize the general features of an appropriate response to this challenge.[5]

The basic structure of the model is as follows. An agent is asked to invest an unobservable "specific (sunk)" effort to increase the probability of success of some initial project. New information (a signal) is then generated about the profitability of an alternative project; the projects being assumed to be mutually exclusive, the organization must decide whether or not to abandon the initial project in favor of the alternative one. If the organization decides to switch to the alternative project, the agent is again asked to invest an unobservable, specific and sunk level of effort which increases the probability of success of the alternative project. Finally, outcome is observed and payments are made.

More flexibility to abandon the initial project to pursue the alternative project will in general be detrimental to the level of specific efforts that the agent will be willing to exert to increase the probability of success of the initial project (hence the fundamental trade-off between *ex ante* incentives and *ex post* flexibility). Moreover, allocation of rents will distort the choice between project 1 and project 2.

The principal's problem is analyzed in three different informational settings. In each setting, the agent's efforts both for the initial and the alternative projects are unobservable by the principal. The agent receives rents in the organization because of moral hazard and limited liability. In order to induce the agent to provide the proper level of effort, the principal must reward the agent if the project undertaken is successful while limited liability prevents the principal from financing this reward through a penalty in case of failure (for instance by a bond posted by the agent). In the following section,

[5] In a different context, Boyer and Moreaux (1995) characterize the trade-off between commitment and flexibility. They consider a duopoly model of flexible manufacturing technology adoption in which asymmetric equilibria emerges, a firm choosing a flexible technology while the other chooses an inflexible technology even if both firm are in perfectly similar situations.

we analyze, after presenting the formal model, the benchmark case where the signal on the profitability of the alternative project is common knowledge. In Section 3, the signal is observed only by the principal while in Section 4, it is private information of the agent. If only the agent observes the signal θ, he may have an incentive to misreport θ in order to favor the project in which his rent is larger. Similarly, if the principal is the only one observing the signal, she may want to misreport it in order to maximize her net benefits. The principal must *ex ante* select and commit to a payment profile and a switching decision rule providing the necessary incentives. The organizational response to these distorted incentives is to generate a bias in favor of the *status quo*.

Finally, in Section 5, we compare the results obtained from the analyses of the different settings. If the signal about the alternative project can or should, for some technical or economic reasons, be observed only by either the agent or the principal, to whom should be given the responsibility of observing the signal and recommending change ? The effective or real authority for recommending and/or implementing change need not always be retained by the principal. We provide further discussion and comments in the conclusion. The Appendix contains the detailed proofs of the propositions and the corollaries.

2. THE MODEL

The organization, represented by a principal and an agent, must invest in an initial project. Later on, the organization will observe a signal θ about the probability of success of an alternative project. Based on the observed value of θ, the organization may choose either to abandon the initial project 1 in favor of the alternative project 2 or pursue project 1 (the projects are mutually exclusive).

The timing of observations and decisions is as follows. First, the agent invests some unobservable level of effort $e \in \{\ell(\text{low}), h(\text{high})\}$ into the initial project 1, at cost of effort $V_1^\ell = 0$ and $V_1^h > 0$ respectively. This investment in effort determines the probability of success p_1^e of that project with $p_1^h > p_1^\ell$. Effort is specific to the project and considered as sunk. Second, the signal θ is observed: it takes value g (good) with probability ρ and value b (bad) with probability $(1-\rho)$; we assume that $\rho > \frac{1}{2}$. The organization must then decide whether to abandon the initial project in favor of the alternative one or to maintain the initial project (the *status quo*). If project 2 is selected, then the agent must again provide some unobservable level of effort e_2 which is either low (ℓ) or high (h), at a cost of $V_2^\ell = 0$ and $V_2^h > 0$ respectively. The level of effort e_2 together with the value of the signal θ determine the probability of success of project 2. Finally, the state of nature, that is the outcome of the project chosen, is revealed and payments are made.

The outcomes of the projects are random. The expected level of net profits depends on the project pursued, on the level of effort invested by the agent and on the value of θ. Let R_1^e be the expected return from project 1 when effort e has been invested and let $R_2^{e\theta}$ be the expected return of project 2 given e and θ. The probability of success of project 1 is given by p_1^h [p_1^ℓ] if the agent's effort in project 1 is high [low]. The probability of success of project 2 depends on effort and on the value of the signal θ. It is given by p_2^{hg}, $p_2^{\ell g}$, p_2^{hb} or $p_2^{\ell b}$ depending on whether the agent's effort and the signal are (h,g), (ℓ,g), (h,b) or (ℓ,b). We will make the following assumption on the impact of effort on the probability of success:

(A1) $$p_1^h > p_1^\ell > 0, \quad p_2^{\ell g} > 0, \quad p_2^{\ell b} = 0, \quad p_2^{hg} - p_2^{\ell g} > p_2^{hb} > 0,$$

that is, a signal g is relatively favorable to project 2; moreover effort is more productive in raising the probability of success of project 2 when the signal is indeed favorable to project 2 ($\theta = g$).

An incentive system takes the general form of a payment profile w specifying a payment contingent on the project pursued (1 or 2), on whether it is a success s or a failure f, and on whether the announced value of θ is g or b: $\{w_1^s, w_1^f, w_2^{sg}, w_2^{fg}, w_2^{sb}, w_2^{fb}\}$. Limited liability requires that $w \geq 0$. A switching rule, which specifies when project 1 will be abandoned in favor of project 2, is a pair (r_g, r_b), where r_g $[r_b]$ denotes the probability that project 2 is chosen when the value of θ observed or announced is g $[b]$.

The effort level exerted by the agent is always a private information of the agent and therefore, in order to induce the high level of effort, the principal must offer a payment profile such that it is privately beneficial for the agent to provide that level of effort. To achieve this, the principal must create a wedge between the payment made in case of success and the payment made in case of failure such that the expected net payment received by the agent is weakly larger when $e = h$. This, together with limited liability, generates rents for the agent. We assume that the agent's reservation utility level is 0. If project 2 is chosen when $\theta = g$, the wedge must satisfy

$$p_2^{hg} w_2^{sg} + (1 - p_2^{hg}) w_2^{fg} - V_2^h \geq p_2^{\ell g} w_2^{sg} + (1 - p_2^{\ell g}) w_2^{fg}$$

or

$$w_2^{sg} - w_2^{fg} \geq \frac{V_2^h}{p_2^{hg} - p_2^{\ell g}} \equiv \psi_2^g. \tag{2.1}$$

The limited liability assumption implies $w_2^{fg} \geq 0$, and therefore $w_2^{sg} \geq \psi_2^g$. Hence, we obtain that the net payment received by the agent is no less than $p_2^{hg} \psi_2^g + w_2^{fg} - V_2^h$, which is equal to $p_2^{\ell g}V_2^h/(p_2^{hg} - p_2^{\ell g}) + w_2^{fg} > 0$, and therefore exceeds the agent's reservation utility: the agent receives an effort-based informational rent.

Similarly, if project 2 is chosen when $\theta = b$, the wedge must satisfy

$$w_2^{sb} - w_2^{fb} \geq \frac{V_2^h}{p_2^{hb} - p_2^{\ell b}} = \frac{V_2^h}{p_2^{hb}} \equiv \psi_2^b. \tag{2.2}$$

Again, the limited liability assumption implies $w_2^{fb} \geq 0$, and therefore $w_2^{sb} \geq \psi_2^b$. However, using A1, we obtain that $p_2^{hb}\psi_2^b + w_2^{fb} - V_2^h = p_2^{\ell b}V_2^h/(p_2^{hb} - p_2^{\ell b}) + w_2^{fb} = w_2^{fb}$. Hence the agent receives no rent for providing effort when the signal is bad if $w_2^{fb} = 0$. Note that from A1 we have $\psi_2^g < \psi_2^b$: since effort is more efficient in increasing the probability of success when $\theta = g$, the effort inducing payment wedge for the alternative project is larger when the signal is bad.

For project 1, the wedge $(w_1^s - w_1^f)$ necessary to induce a high level of effort must take into account the fact that the project may be abandoned in favor of project 2 after the effort cost has been sunk. From the switching rule (r_g, r_b), this will occur with probability $\rho r_g + (1-\rho)r_b$. If there is such a switch, then the agent will obtain a rent of $p_2^{h\theta}\psi_2^\theta - V_2^h$ from the payment profile relevant for project 2. But given that ρ is independent of whether the effort put into project 1 is high or low, the value of the appropriate rent is added on both sides of the relevant incentive constraint for e_1; therefore, the effort inducing payment wedge for project 1 depends on the probability that a switch will occur but is independent of the rent itself accruing to the agent from the realization of project 2. Hence, this wedge must satisfy:

$$\begin{aligned}[\rho(1-r_g)+&(1-\rho)(1-r_b)][p_1^h(w_1^s - w_1^f) + w_1^f] - V_1^h \\ &\geq [\rho(1-r_g) + (1-\rho)(1-r_b)][p_1^\ell(w_1^s - w_1^f) + w_1^f]\end{aligned}$$

that is

$$(w_1^s - w_1^f) \geq \frac{\psi_1}{\rho(1-r_g) + (1-\rho)(1-r_b)} > \psi_1 \equiv \frac{V_1^h}{p_1^h - p_1^\ell}. \tag{2.3}$$

Ex ante, the agent receives from project 1 an expected payment

$$p_1^h[\rho(1-r_g)+(1-\rho)(1-r_b)]\frac{\psi_1}{[\rho(1-r_g)+(1-\rho)(1-r_b)]}-V_1^h+w_1^f$$

equal to $p_1^\ell V_1^h/[p_1^h-p_1^\ell]+w_1^f>0$ which is also the *ex post* rent from project 1 if the decision to pursue project 1 is taken.

We will consider three alternative information structures. In the first case (benchmark case), the signal θ is jointly observable by the principal and the agent; in the second case, it is observable only by the principal and in the third case, it is observable only by the agent.[6] When θ is observable and contractible, the optimal organizational design will maximize the principal's expected profits subject to the limited liability constraints and, if the principal wishes to elicit a high level of effort from the agent, the incentive constraints (2.1), (2.2) and (2.3).

We do not intend here to consider all the possible cases for this problem. We wish instead to limit our attention to cases where both the effort and the signal are meaningful. More precisely, we limit the set of exogenous parameters $[R_1^e,\ R_2^{e\theta},\ \rho,\ p_1^e,\ p_2^{e\theta},\ V_1^e,\ V_2^e]$ such that the principal always prefers to elicit a high level of effort for project 1 and project 2 and such that a switch to project 2 occurs if and only if the common knowledge signal is favorable, that is, if and only if $\theta=g$. This is the interesting case on which we want to concentrate. Therefore, we make the following assumptions:

(A2) $$R_1^h-p_1^h\frac{\psi_1}{(1-\rho)}>R_1^\ell,\quad R_2^{h\theta}-\psi_2^\theta>R_2^{\ell\theta}\ \text{ for } \theta\in\{g,b\}$$

(A3) $$R_1^h<R_2^{hg}-p_2^{hg}\psi_2^g$$

[6] We do not model the process by which a 'new' project is discovered. One possible way to model this process in the first context is to suppose that effort can be extended either to raise the probability of success ($p_c(e_c)$) of the current project 1 or to raise the probability ($p_n(e_n)$) of discovering a new and better project. Designing efficient schemes for total effort provision $e_c+e_n=e$ at cost $\psi(e)$ and for allocating that effort between the two objectives is clearly a major concern of organizational design. Moreover, the value of e could depend on market structure as one can infer from Tirole (1988, chap. 4).

$$\text{(A4)} \qquad R_1^h - p_1^h \frac{\psi_1}{(1-\rho)} > R_2^{hb} - p_2^{hb}\psi_2^b$$

Proposition 1: *Under A1 to A4, the principal prefers to induce a high level of effort both for project 1 and for project 2 and switching occurs if and only if* $\theta = g$.

Note that from a social welfare point of view, a switch to the alternative project should occur *ex post* when $\theta = g$ (should not occur when $\theta = b$) if and only if the expected net total benefits from project 2, assuming that the agent exert a high level of effort in all cases, are larger (smaller) than the expected total gross benefits from the original project, that is, iff

$$R_1^h \begin{cases} < R_2^{hg} - V_2^h & \text{if } \theta = g \\ > R_2^{hb} - V_2^h & \text{if } \theta = b \end{cases} \tag{2.4}$$

Under the assumptions of the model, the switching rule $r_b = 0$ and $r_g = 1$ is also the socially optimal rule. Indeed we have: $R_1^h < R_2^{hg} - p_2^{hg}\psi_2^g < R_2^{hg} - V_2^h$ and $R_1^h > R_1^h - \frac{\psi_1}{(1-\rho)} > R_2^{hb} - p_2^{hb}\psi_2^b = R_2^{hb} - V_h^2$.

The above analysis and result can be extended to the case where the signal is observed by both the principal and the agent but is not contractible. Giving the authority to the principal, as the residual claimant, still allows the implementation of the optimal allocation with $r_b = 0$ and $r_g = 1$. The key is to notice that the principal has no incentive to misreport θ. If $\theta = g$, we have $R_2^{hg} - p_1^{hg}\psi_2^g > R_1^h > R_1^h - p_1^h \frac{\psi_1}{1-\rho}$ and thus the principal will prefer to recommend change. If $\theta = b$, the principal knows that if she recommends change, the agent will choose a low level of effort unless $(w_2^s - w_2^f) \leq \psi_2^b$. Since by assumption $R_1^h > \max\{R_2^{\ell b} - V_2^\ell \ ,\ R_2^{hb} - p_2^{hb}\psi_2^b\}$, it is not in her interest to recommend change.

We use the above as a benchmark for the following sections. We shall consider how the fact that θ becomes private information affects the rents in the organization and the switching rule. We will show that when the signal is private information of either the principal or the agent, switching to project 2 may not always occur when $\theta = g$.

Moreover, we will show that, when the signal can be observed by the principal or the agent but not by both, the principal may sometimes be better off observing the signal herself and sometimes be better off by letting the signal be observed by the agent.

3. THE SIGNAL θ IS OBSERVABLE ONLY BY THE PRINCIPAL.

We consider now the case where the signal on the profitability of the alternative project is observed only by the principal. We assume that the principal cannot commit herself not to use opportunistically her private information on θ. The principal's problem is to select an incentive scheme and a credible switching rule so that the agent chooses the high level of effort expecting rationally that the principal will reveal truthfully the observed signal and apply the announced switching rule. The credibility of the switching rule will depend on the principal's relative interests in revealing the signal she observes and, given the signal revealed, in letting the announced switching rule apply. The principal's relative interests will themselves rest on the payment profile, that is, the structure of payments to be made to the agent in the different possible outcomes.

The following constraint states that it should not be in the principal's best interest to always pretend that project 2 is bad:

$$\begin{aligned}
&[(1-\rho)(1-r_b)+\rho(1-r_g)][R_1^h-\Big(p_1^h(w_1^s-w_1^f)+w_1^f\Big)]\\
&\quad+(1-\rho)r_b[R_2^{hb}-\Big(p_2^{hb}(w_2^{sb}-w_2^{fb})+w_2^{fb}\Big)]\;+\rho r_g[R_2^{hg}-\Big(p_2^{hg}(w_2^{sg}-w_2^{fg})+w_2^{fg}\Big)]\\
\geq&(1-r_g)[R_1^h-\Big(p_1^h(w_1^s-w_1^f)+w_1^f\Big)]\\
&\quad+(1-\rho)r_g[R_2^{hb}-\Big(p_2^{hb}(w_2^{sg}-w_2^{fg})+w_2^{fg}\Big)]+\rho r_g[R_2^{hg}-\Big(p_2^{eg}(w_2^{sg}-w_2^{fg})+w_2^{fg}\Big)].
\end{aligned}$$

One can note that the third terms on each side are the same. This constraint can be rewritten as

$$\begin{aligned}
&(r_g-r_b)[R_1^h-\Big(p_1^h(w_1^s-w_1^f)+w_1^f\Big)]\leq\\
&\quad r_g[R_2^{hg}-\Big(p_2^{hg}(w_2^{sg}-w_2^{fg})+w_2^{fg}\Big)]-r_b[R_2^{hg}-\Big(p_2^{hg}(w_2^{sb}-w_2^{fb})+w_2^{fb}\Big)]
\end{aligned}\tag{3.1}$$

Similarly, it should not be in the principal's best interest to always pretend that project

2 is good, a condition which can be written as

$$r_g[R_2^{hb} - \left(p_2^{hb}(w_2^{sg} - w_2^{fg}) + w_2^{fg}\right)] - r_b[R_2^{hb} - \left(p_2^{hb}(w_2^{sb} - w_2^{fb}) + w_2^{fb}\right)] \leq [(r_g - r_b)][R_1^h - \left(p_1^h(w_1^s - w_1^f) + w_1^f\right)] \tag{3.2}$$

The principal's problem becomes:

$$\left.\begin{aligned} \max_{r_b, r_g, w} \Big[&[(1-\rho)(1-r_b) + \rho(1-r_g)][R_1^h - \left(p_1^h(w_1^s - w_1^f) + w_1^f\right)] \\ &+ (1-\rho)r_b[R_2^{hb} - \left(p_2^{hb}(w_2^{sb} - w_2^{fb}) + w_2^{fb}\right)] \\ &+ \rho r_g[R_2^{hg} - \left(p_2^{hg}(w_2^{sg} - w_2^{fg}) + w_2^{fg}\right)]\Big] \\ &\text{subject to (2.1), (2.2), (2.3), (3.1), and (3.2)} \end{aligned}\right\} \tag{3.3}$$

We obtain

<u>Proposition 2</u>: *The solution to the principal's problem* (3.3) *entails: constraint* (3.1) *is not binding,* $w_1^f = 0$, $w_1^s = \frac{\psi_1}{(1-\rho r_g)}$, $(w_2^{sg} - w_2^{fg}) = \psi_2^g$, $w_2^{fg} = \max\{0, (R_2^{hb} - p_2^{hb}\psi_2^g) - (R_1^h - p_1^h \frac{\psi_1}{(1-\rho r_g)})\}$, $r_b = 0$ *and* r_g^P *solves:*

$$\max_{r_g \in [0,1]} \Big[(1-\rho r_g)(R_1^h - p_1^h \frac{\psi_1}{1-\rho r_g}) + \rho r_g \Big(R_2^{hg} - p_2^{hg}\psi_2^g - \max\{0\ ,\ (R_2^{hb} - p_2^{hb}\psi_2^g) - (R_1^h - p_1^h \frac{\psi_1}{1-\rho r_g})\}\Big)\Big]. \tag{3.4}$$

The optimal level of flexibility in the organization, r_g^P, is determined by the level of $R_2^{hb} - p_2^{hb}\psi_2^g$ relative to $R_1^h - p_1^h \frac{\psi_1}{(1-\rho)}$ and $R_2^{hg} - p_2^{hg}\psi_2^g$. The value of $R_2^{hb} - p_2^{hb}\psi_2^g$ measures the expected benefits of the principal when she pretends that project 2 is good when it is truly bad. If the agent is fooled, the principal will need to pay him only $p_2^{hb}\psi_2^g < p_2^{hb}\psi_2^b = V_2^h$ in order to induce a high level of effort from the agent. This could be advantageous for the principal since under assumption A1:

$$p_2^{hb}\psi_2^g = p_2^{hb}\frac{V_2^h}{p_2^{hg} - p_2^{\ell g}} < V_2^h < p_2^{hg}\frac{V_2^h}{p_2^{hg} - p_2^{\ell g}} = p_2^{hg}\psi_2^g.$$

Because θ is not observable by the agent and because the principal could exploit opportunistically her information, by pretending that project 2 is good when it is bad, extra agency costs must be incurred. In order to credibly convey that she will not engage in such behavior, the principal must compensate the agent when project 2 fails. The agency costs thus increase by

$$\rho r_g \max\{0\ ,\ (R_2^{hb} - p_2^{hb}\psi_2^g) - (R_1^h - \frac{p_1^h \psi^1}{(1-\rho r_g)})\}. \tag{3.5}$$

These agency costs are increasing and convex in r_g. This introduces a bias towards the *status quo*.

The principal's expected profit can be expressed as

$$\Pi(r_g, C) = (1-\rho r_g) R_1^h + \rho r_g R_2^{hg} - C \tag{3.6}$$

where C is the payment to the agent (labor cost); the isoprofit curves have slope

$$\left.\frac{dC}{dr_g}\right|_{\Pi(r_g,C)=\overline{\Pi}} = \rho(R_2^{hg} - R_1^h).$$

From Proposition 2, we can write the expected labor cost as a function of the flexibility level as follows:

$$C^P(r_g) = p_1^h\psi_1 + \rho r_g p_2^{hg}\psi_2^g + \rho r_g \max\left\{0, (R_2^{hb} - p_2^{hb}\psi_2^g) - (R_1^h - p_1^h \frac{\psi_1}{1-\rho r_g})\right\}. \tag{3.7}$$

Let us define $\tilde{r}_g^P$ as the value of r_g for which $(R_2^{hb} - p_2^{hb}\psi_2^g) = (R_1^h - p_1^h \frac{\psi_1}{1-\rho r_g})$ if a solution in $[0,1]$ exists,[7] that is,

$$\tilde{r}_g^P = \frac{1}{\rho}\left[1 - \frac{p_1^h\psi_1}{R_1^h - (R_2^{hb} - p_2^{hb}\psi_2^g)}\right].$$

The $C^P(r_g)$ function is illustrated on Figure 1 together with the isoprofit curves of $\Pi(r_g, C)$ for the case $0 < \tilde{r}_g^P < 1$.

[Insert Figure 1 here]

[7] We set $\tilde{r}_g^P = 0$ when $R_2^{hb} - p_2^{hb}\psi_2^g > R_1^h - p_1^h\psi_1$ and $\tilde{r}_g^P = 1$ when $R_2^{hb} - p_2^{hb}\psi_2^g < R_1^h - p_1^h\frac{\psi_1}{1-\rho}$.

The optimal level of flexibility is always in the interval $[\tilde{r}_g^P, 1]$ since by assumption A3, the slope of the isoprofit curves is larger than the slope of the expected labor cost function to the left of $\tilde{r}_g^P$.[8] The optimum r_g^P may be either at the kink $\tilde{r}_g^P$ of the expected labor cost curve or at the tangency point between the convex portion of the labor cost curve and an isoprofit curve.

Corollary 1: *The principal chooses the common knowledge flexibility level,* $r_g^P = 1$*, iff*

$$p_1^h \psi_1 \leq \max\left\{(1-\rho)[R_1^h - (R_2^{hb} - p_2^{hb}\psi_2^g)]\ ,\ (1-\rho)^2[(R_2^{hg} - p_2^{hg}\psi_2^g) - (R_2^{hb} - p_2^{hb}\psi_2^g)]\right\}. \quad (3.8)$$

The optimal flexibility level is equal to 1 if the principal finds no value in misreporting the value of the signal θ even if she could do it without cost. When she has to bear extra cost to make her announcement credible, she still chooses $r_g = 1$ if the slope of the isoprofit curves is always larger than the slope of the expected labor cost function.

Corollary 2: *The principal chooses complete inertia,* $r_g^P = 0$*, iff*

$$p_1^h \psi_1 \geq (R_2^{hg} - p_2^{hg}\psi_2^g) - (R_2^{hb} - p_2^{hb}\psi_2^g) \quad (3.9)$$

If (3.9) holds, the best the principal can do is to never abandon project 1. The incentives for the principal to always pretend that project 2 is good are so strong that it becomes too costly for the principal to credibly convey that project 2 is good. Complete inertia is implemented in the organization.

Corollary 3: *The principal chooses partial flexibility*

$$\frac{1}{\rho}\left[1 - \min\Big\{\Big(\frac{p_1^h\psi_1}{(R_2^{hg} - p_2^{hg}\psi_2^g) - (R_2^{hb} - p_2^{hb}\psi_2^g)}\Big)^{\frac{1}{2}}, \max\{0, \frac{p_1^h\psi_1}{R_1^h - (R_2^{hb} - p_2^{hb}\psi_2^g)}\}\Big\}\right]. \quad (3.10)$$

iff neither (3.8) *nor* (3.9) *hold.*

[8] As shown above, the slope of the isoprofit curves is $\rho(R_2^{hg} - R_1^h)$. The slope of the expected labor cost function to the left of $\tilde{r}_g^P$ is $\rho(p_2^{hg}\psi_2^g - p_1^h\psi_1)$.

The closer $p_1^h\psi_1$ is to the upper bound $(R_2^{hg} - p_2^{hg}\psi_2^g) - (R_2^{hb} - p_2^{hb}\psi_2^g)$, the more the principal is tempted to misrepresent the value of the alternative project when the signal is bad and therefore the larger the level of inertia chosen and implemented by the principal will be.[9] Thus:

<u>Corollary 4</u>: *The level of <u>inertia</u> in an organization (when the principal is the one getting the information θ on the value of the alternative project) is positively related to* $p_1^h\psi_1 \equiv p_1^h \frac{V_1^h}{p_1^h - p_1^\ell}$ *and to* $(p_2^{hg} - p_2^{hb})\psi_2^g \equiv \frac{p_2^{hg} - p_2^{hb}}{p_2^{hg} - p_2^{\ell g}} V_2^h$ *and negatively related to the difference* $(R_2^{hg} - R_2^{hb})$. *That is, positively related to* V_1^h, p_1^ℓ, $p_2^{\ell g}$ *and* V_2^h; *and negatively related to* p_1^h *and* p_2^{hb}; *it is positively related to* p_2^{hg} *if and only if* $p_2^{hb} > p_2^{\ell g}$.

[9] As long as assumptions A2, A3 and A4 remain satisfied.

4. THE SIGNAL θ IS OBSERVABLE ONLY BY THE AGENT.

When the signal θ is observable only by the agent, the principal must commit to a payment schedule and a switching rule such that the agent will not misreport θ. Given a switching rule (r_b, r_g), the agent will truthfully reveal θ if only if the following two conditions are satisfied (recall that V_1^e is incurred before the signal is observed but that V_2^e is incurred only once the signal is observed and project 2 is pursued).

$$\left.\begin{aligned}
&\max_{e\in\{\ell,h\}}\Big[[(1-\rho)(1-r_b)+\rho(1-r_g)][p_1^e(w_1^s-w_1^f)+w_1^f]-V_1^e\Big]\\
&\qquad+(1-\rho)r_b\max_{e\in\{\ell,h\}}[p_2^{eb}(w_2^{sb}-w_2^{fb})+w_2^{fb}-V_2^e]\\
&\qquad+\rho r_g\max_{e\in\{\ell,h\}}[p_2^{eg}(w_2^{sg}-w_2^{fg})+w_2^{fg}-V_2^e]\\
\geq&\max_{e\in\{\ell,h\}}\Big[[(1-r_g)][p_1^e(w_1^s-w_1^f)+w_1^f]-V_1^e\Big]\\
&\qquad+(1-\rho)r_g\max_{e\in\{\ell,h\}}[p_2^{eb}(w_2^{sg}-w_2^{fg})+w_2^{fg}-V_2^e]\\
&\qquad+\rho r_g\max_{e\in\{\ell,h\}}[p_2^{eg}(w_2^{sg}-w_2^{fg})+w_2^{fg}-V_2^e]
\end{aligned}\right\}\tag{4.1}$$

$$\left.\begin{aligned}
&\max_{e\in\{\ell,h\}}\Big[[(1-\rho)(1-r_b)+\rho(1-r_g)][p_1^e(w_1^s-w_1^f)+w_1^f]-V_1^e\Big]\\
&\qquad+(1-\rho)r_b\max_{e\in\{\ell,h\}}[p_2^{eb}(w_2^{sb}-w_2^{fb})+w_2^{fb}-V_2^e]\\
&\qquad+\rho r_g\max_{e\in\{\ell,h\}}[p_2^{eg}(w_2^{sg}-w_2^{fg})+w_2^{fg}-V_2^e]\\
\geq&\max_{e\in\{\ell,h\}}\Big[[(1-r_b)][p_1^e(w_1^s-w_1^f)+w_1^f]-V_1^e\Big]\\
&\qquad+(1-\rho)r_b\max_{e\in\{\ell,h\}}[p_2^{eb}(w_2^{sb}-w_2^{fb})+w_2^{fb}-V_2^e]\\
&\qquad+\rho r_b\max_{e\in\{\ell,h\}}[p_2^{eg}(w_2^{sb}-w_2^{fb})+w_2^{fb}-V_2^e]
\end{aligned}\right\}\tag{4.2}$$

Condition (4.1) is necessary to guarantee that the agent will not always claim that $\theta = g$, thereby generating too much flexibility at the expense of too little effort invested in project 1. Condition (4.2) is necessary to guarantee that the agent will not always claim that $\theta = b$, thereby generating too much inertia.

When the signal θ is observable only by the agent, the principal's problem becomes:

$$\left.\begin{array}{r}\max_{r_b, r_g, w}\Big[[(1-\rho)(1-r_b)+\rho(1-r_g)][R_1^h-\Big(p_1^h(w_1^s-w_1^f)+w_1^f\Big)] \\ +(1-\rho)r_b[R_2^{hb}-\Big(p_2^{hb}(w_2^{sb}-w_2^{fb})+w_2^{fb}\Big)] \\ +\rho r_g[R_2^{hg}-\Big(p_2^{hg}(w_2^{sg}-w_2^{fg})+w_2^{fg}\Big)]\Big] \\ \text{subject to (2.1), (2.2), (2.3), (4.1), and (4.2)}\end{array}\right\} \qquad (4.3)$$

Note that it is possible that constraints (4.1) and (4.2) be simultaneously binding: the rents obtained from pursuing a good project 2 may not be high enough to induce the agent to abandon project 1 when he has invested a high level of effort in it, while they may still be high enough that the agent might simply prefer to invest no effort in project 1 and always recommend change. For reasons of tractability and simplicity, we shall rule out this possibility. We assume

(A5). $$\frac{p_2^{hg}}{p_2^{hb}} > \frac{p_1^h}{p_1^\ell}$$

We will show that A5 and A1 are sufficient to guarantee that constraint (4.1) is never binding.

<u>Proposition 3</u>: *The solution to the principal's problem* (4.3) *entails: constraint* (4.1) *is not binding,* $w_1^s = \psi_1/(1-\rho r_g)$, $w_1^f = 0$, $w_2^{fg} = 0$, $p^{hg} w_2^{sg} = \max\{p_2^{hg}\psi_2^g \ , \ \frac{p_1^h \psi^1}{(1-\rho r_g)} + V_2^h]$, $r_b = 0$ *while* r_g^A *is given by:*

$$r_g^A = \begin{cases} 1, \ \text{if } \frac{p_1^h \psi_1}{1-\rho} \leq \max\left\{p_2^{hg}\psi_2^g - V_2^h, (1-\rho)(R_2^{hg} - V_2^h - R_1^h)\right\} \\ \frac{1}{\rho}\Big[1 - \min\Big\{\Big(\frac{p_1^h \psi_1}{R_2^{hg} - V_2^h - R_1^h}\Big)^{\frac{1}{2}}, \ \frac{p_1^h \psi_1}{(p_2^{hg}\psi_2^g - V_2^h)}\Big\}\Big], \text{ otherwise.} \end{cases} \qquad (4.4)$$

In this case, the organizational design must prevent the agent from always claiming that the alternative project is bad. This is done by increasing the reward if project 2 is undertaken and successful. The extra rent necessary to elicit thruthful behavior from the agent is given by

$$\rho r_g p_2^{hg}(w_2^{sg} - \psi_2^g) = \rho r_g \max\left\{0\ ,\ \frac{p_1^h \psi_1}{(1-\rho r_g)} - p_2^{hg}\psi_2^g + V_2^h\right\} \tag{4.5}$$

and it is increasing and convex in r_g; thus the bias towards the *status quo*. We can therefore write the expected labor cost as a function of the flexibility level as follows:

$$C^A(r_g) = p_1^h \psi_1 + \rho r_g p_2^{hg}\psi_2^g + \rho r_g \max\left\{0\ ,\ \frac{p_1^h \psi_1}{(1-\rho r_g)} - p_2^{hg}\psi_2^g + V_2^h\right\} \tag{4.6}$$

Let us define $\tilde{r}_g^A$ as the value of r_g for which $\frac{p_1^h\psi_1}{(1-\rho r_g)} = p_2^{hg}\psi_2^g - V_2^h$ if a solution in $[0,1]$ exists,[10] that is,

$$\tilde{r}_g^A = \frac{1}{\rho}\left[1 - \frac{p_1^h\psi_1}{(p_2^{hg}\psi_2^g - V_2^h)}\right].$$

The $C^A(r_g)$ function is illustrated on Figure 2 together with the $C^P(r_g)$ function (3.6) and the isoprofit curves of $\Pi(r_g, C)$.

[10] As before, we set $\tilde{r}_g^A = 0$ when $p_1^h\psi_1 < p_2^{hg}\psi_2^g - V_2^h$ and $\tilde{r}_g^A = 1$ when $\frac{p_1^h\psi_1}{(1-\rho)} > p_2^{hg}\psi_2^g - V_2^h$.

5. ASSIGNING AUTHORITY

In this section, we raise the following question. If either the agent or the principal, but not both, can observe θ, to whom should be attributed the responsibility to observe θ and to decide accordingly whether to abandon or pursue project 1 ? Should the principal (the residual claimant) be allowed to exercise her authority to decide on change or should this authority be delegated to the agent ? Retention of the authority by the principal or its delegation to the agent both present problems. The agent has vested interests in the pursuit of project 1 and there is no reason to believe that his interests coincide with that of the organization as a whole. On the other hand, the residual claimant may behave opportunistically in order not to pay the rent promised to the agent if project 1 were pursued and succeeded or in order to fool the agent in putting high effort in an alternative bad project. In both cases, agency costs may be required to limit opportunistic behavior. When θ is observed only by the principal, these extra rents are given by (3.5). When θ is observed only by the agent, these extra rents are given by (4.5). They are both increasing and convex in r_g. Hence it may be advantageous to create a bias towards the *status quo*. Furthermore:

Proposition 4: *Under A1 to A5, we obtain* $\tilde{r}_g^P \leq \tilde{r}_g^A$ *and* $r_g^P \leq r_g^A$ *and it is preferable (not necessarily strictly) to give the authority to the agent if only if:*

$$p_2^{hg}\psi_2^g - V_2^h \geq R_1^h - (R_2^{hb} - p_2^{hb}\psi_2^g). \tag{5.1}$$

The result of Proposition 4 is illustrated in Figure 2 for which we let $p_1^h \frac{\psi_1}{1-\rho} > p_2^{hg}\psi_2^g - V_2^h > R_1^h - (R_2^{hb} - p_2^{hb}\psi_2^g)$ which implies that $0 < \tilde{r}_g^P < \tilde{r}_g^A < 1$ and thus that it is strictly preferable to assign the authority to the agent.

[Insert Figure 2 here]

The minimal labor cost associated with a degree of flexibility r_g when the authority is assigned to the firm exceeds the labor costs when it is assigned to the agent if and only if (5.1) holds. Furthermore, since the optimal level of r_g when the authority is assigned to the agent is not smaller than $\tilde{r}_g^P$, the principal does strictly better by giving the authority to the agent.

The optimal incentive system when the agent has the authority to recommend change differs from the optimal incentive system when the principal is the one observing the signal θ. In the former case, the incentive system must induce the agent to accept to abandon the initial project and switch to the alternative one when the latter appears to be good, that is, when $\theta = g$. In order to provide the necessary incentive to the agent, w_2^{sg} is increased: the agent gets a better deal when the alternative project is a success and since $w_2^{sg} - w_2^{fg}$ is also increased, the agent is overinduced to provide a high level of effort. When the principal is the only one observing the signal on the quality of the alternative project, the incentive problem is to insure that the firm does not always recommend change. In order to provide the necessary credible incentive to the principal, w_2^{fg} is increased: the principal must commit to pay a rent to the agent when the alternative project is a failure. Since the wedge $w_2^{sg} - w_2^{fg}$ is kept constant (equal to ψ_2^g) to induce the agent to provide a high level of effort, the payment $w_2^{fg} > 0$ is similar to a upfront payment in case of a switch. This is meant to signal to the agent that the project is indeed good and that a high level of effort is profitable. Hence, the optimal incentive intensity is stronger when the agent is responsible for observing the signal θ, that is, has the authority to recommend change.[11]

[11] This is reminiscent of Milgrom and Roberts' (1992, chap. 12) discussion of the complementarities between discretion and incentives.

6. CONCLUSION

Using a simple model, we have shown that it is possible to generate an environment where agents are endogenously given the authority to decide on change, in particular to block change that the principal would have undertaken had they allowed themselves to be better informed. We show that inertia (bias towards the *status quo*) can be optimal from an *ex ante* point of view in the presence of (informational) rents and private information.

Inertia in organization may take many forms or come from many sources. Although we abstracted from those specific forms to concentrate on the fundamental trade-off between *ex ante* incentives and *ex post* flexibility, it is informative to consider those forms and sources. Let us briefly consider three settings, typical we think of more general situations. The three settings are examples of situations where only the agent observes the signal on the probability of success of the alternative project. A first setting relates to the fact, quite common in organizations, that career possibilities, bonuses and promotions, are linked to the successful *completion* of projects, or at least of some significant portion of a project. If that is so, one may expect that better informed agents will tend to pursue a project even if they know that an alternative project now represents a more profitable opportunity for the firm. Abandoning the initial project in favor of the alternative project will be detrimental to the agent's career. Hence, the firm's flexibility level will be suboptimal, even more so if those incentives for inflexibility are not properly taken into account in the firm's career evaluation process. It will in general be necessary to jointly determine the rewards accruing to the agent in the two mutually exclusive projects.[12] It may even be necessary to value and reward a recommendation to abandon a project coming from those who were responsible to make it a success by providing the necessary efforts to achieve its successful completion ! A second setting pertains

[12] In an interview with *The Economist* (1995.03.18), Livio DeSimone, Chairman and CEO of 3M, stressed that employees become less innovative if their job security is threatened and therefore, it is a policy of 3M to give such job security to its labor force. In order to avoid too much inertia, he has imposed tough innovation goals (30% of annual sales must come from products less than four years old; 10% from products introduced during the year) and very demanding organizational goals (marketing folks have direct contacts with scientists; R&D staff are directly involved in product strategy; cross-functional teams abound).

to the "political" cover-up of unfavorable information by agents. Such situations can occur because the efforts sunk by the agent in an initial position or project cannot be transferred to the alternative position or project. The new information, on the increased benefits associated with the alternative position or on the reduced benefits associated with the initial position, may be hidden or manipulated by the agent to make it appear less favorable to the alternative than it really is. It may again be necessary, from an organizational performance viewpoint, to value and reward the failure in making the initial position a success. Finally, a third general context refers to the situations in which an independent appraisal concludes that a partially completed project should be abandoned because its completion will involve additional costs which cannot be recuperated from the total future benefits to be generated by the project. Systematically applying the textbook principle *"bygones are bygones"* may lead to reduced ex ante efforts to make the initial project profitable. The principal may find necessary, and profitable, to commit ex ante to pursue such projects even if information, unfavorable to pursuing the project, is revealed to her.

In a recent paper, Aghion and Tirole (1994) show that the allocation of formal authority in organizations, that is the allocation of "rights" to decide, may differ significantly from the allocation of real authority, that is the allocation of "effective control" on decisions. The real authority is determined by the relevant information structure in the organization. In the principal-agent context, with the agent typically more informed than the principal (our second context above), an increase in the agent's real authority will produce initiative and effort but at the expense of less control and integration in the organization. Aghion and Tirole consider different ways to *credibly* increase the subordinate's or agent's real authority in a formally integrated structure with the supervisor or principal keeping the "legal" rights to decide: the work overload of supervisors, the design of lenient discipline rules for deviant behavior by the agent, the timing of background studies leading to an urgency of decision, the repeated interactions leading to the principal's reputation for non-intervention, improved performance measurement and finally the splitting of decision rights between multiple superiors through a matricial organizational form.

We have shown in this paper that flexibility in an organization is a somewhat more subtle and more elusive concept than what one may infer from the existing economic and management literature on the subject. More generally, there are procedures and institutions in organizations and firms which restrict and reduce the capacity or willingness to introduce and implement change. These procedures and institutions may be necessary to generate the optimal level of inertia. We showed that more flexibility in adapting to changing conditions or new information, typically known or observed by either the agent or the principal but not both, may come at the expense of efforts exerted up front by the agent to make the organization more successful. There is a trade-off in this context between *ex ante* efforts and *ex post* flexibility of adaptation. The principal may sometimes be better off to be the informed party and to keep herself the authority to recommend change and sometimes be better off to let the agent be the informed party and be the initiator of change. The current popular arguments for flexibility in production, human capital, financial structure and contracts, and more generally in organizations seem to have neglected the fundamental trade-off which we characterized here and which is likely to be present in many situations. Although we still have a long way to go to propose a general framework to study the factors behind the value of flexibility in organizations, we like to think that the current paper is a modest but positive step in that direction.

7. APPENDIX

Proof of Proposition 1: Clearly, when the signal θ is common knowledge and contractible, we have $w_1^f = w_2^{fg} = w_2^{fb} = 0$. The principal has no reason to make positive any of those payments in case of project failure. Moreover, if the principal wishes to elicit a high level of effort from the agent, conditions (2.1), (2.2) and (2.3) will be binding for the payment profile announced by the principal. Also, from the latter part of A2, the principal always prefers to elicit high effort in project 2. Hence, given some arbitrary switching rule (r_g, r_b), the best the principal can do is given by the expected profits:

$$[\rho(1-r_g)+(1-\rho)(1-r_b)]\max\{R_1^h - p_1^h \frac{\psi_1}{\rho(1-r_g)+(1-\rho)(1-r_b)}\ ,\ R_1^\ell\}$$
$$+\rho r_g[R_2^{hg} - p_2^{hg}\psi_2^g] + (1-\rho)r_b[R_2^{hb} - p_2^{hb}\psi_2^b].$$

$$< [\rho(1-r_g)+(1-\rho)(1-r_b)][R_1^h - p_1^h\frac{\psi_1}{(1-\rho r_g)}]$$
$$+\rho r_g[R_2^{hg} - p_2^{hg}\psi_2^g] + (1-\rho)r_b[R_2^{hb} - p_2^{hb}\psi_2^b]$$

$$\leq [(1-\rho r_g)][R_1^h - p_1^h\frac{\psi_1}{(1-\rho r_g)}] + \rho r_g[R_2^{hg} - p_2^{hg}\psi_2^g]$$

$$\leq [(1-\rho)][R_1^h - p_1^h\frac{\psi_1}{(1-\rho)}] + \rho[R_2^{hg} - p_2^{hg}\psi_2^g].$$

The first (strict) inequality follows from A2; the second inequality follows from A4 while the third follows from A3. The expected profits obtained from any switching rule (r_g, r_b) and effort levels e_1 and e_2 are therefore no greater than the profits obtained when $r_g = 1$, $r_b = 0$ and high effort is always elicited. *QED*

Proof of Proposition 2: Let us assume that constraint (3.1) is not binding (we will show that the solution to (3.3) without imposing (3.1) satisfies (3.1)). Since increasing w_1^f reduces the objective function and tightens the constraints, it is optimal to let $w_1^f = 0$. Since $R_1^h - p_1^h\frac{\psi_1}{1-\rho} \geq R_2^{hb} - p_2^{hb}(w_2^{sb} - w_2^{fb}) - w_2^{fb}$ by A4, the objective function is decreasing with r_b and reducing r_b weakens the constraints. It is therefore optimal to set $r_b = 0$. It is clearly optimal to set the wages such that constraints (2.1), (2.2) and (2.3) are binding.

It follows that $w_1^s = \frac{\psi_1}{(1-\rho r_g)}$ and $(w_2^{sg} - w_2^{fg}) = \psi_2^g$. Given this, (3.2) becomes

$$R_2^{hb} - p_2^{hb}\psi_2^g - w_2^{fg} \leq R_1^h - p_1^h \frac{\psi_1}{1-\rho r_g} \tag{3.2$'$}$$

and thus

$$w_2^{fg} = \max\{0\ ,\ (R_2^{hb} - p_2^{hb}\psi_2^g) - (R_1^h - p_1^h \frac{\psi_1}{(1-\rho r_g)})\}. \tag{7.1}$$

Using (7.1) together with the values or expressions derived above for r_b, w_1^f, w_1^s, w_2^{fg} and w_2^{sg}, the principal's problem (3.3) can be written as (3.4). In order to complete the proof, we need to show that constraint (3.1) is then always satisfied. This constraint (3.1) can then be rewritten as:

$$r_g[R_1^h - p_1^h \frac{\psi_1}{1-\rho r_g}] \leq r_g[R_2^{hg} - p_2^{hg}\psi_2^g - w_2^{fg}]. \tag{3.1$'$}$$

If $w_2^{fg} = 0$, then (3.1$'$) is satisfied from A3. If $w_2^{fg} > 0$, then (3.2$'$) must be binding and therefore (3.1$'$) becomes

$$r_g[R_2^{hb} - p_2^{hb}\psi_2^g] \leq r_g[R_2^{hg} - p_2^{hg}\psi_2^g]. \tag{3.1$''$}$$

If $(R_2^{hb} - p_2^{hb}\psi_2^g) \leq (R_2^{hg} - p_2^{hg}\psi_2^g)$, condition (3.1$''$) is satisfied for all $r_g \in [0,1]$; If $(R_2^{hb} - p_2^{hb}\psi_2^g) > (R_2^{hg} - p_2^{hg}\psi_2^g)$, then (3.4) is maximized for $r_g = 0$ and therefore (3.1$''$) is satisfied. Thus, (3.1) is always satisfied. *QED*

Proof of Corollary 1: When $p_1^h\psi_1 < (1-\rho)[R_1^h - (R_2^{hb} - p_2^{hb}\psi_2^g)]$, (3.2$'$) is never binding and therefore, the principal always reveal truthfully the value of the signal θ and no distortion from the common knowledge flexibility level is necessary. When $(1-\rho)[R_1^h - (R_2^{hb} - p_2^{hb}\psi_2^g)] < p_1^h\psi_1 < (1-\rho)^2[(R_2^{hg} - p_2^{hg}\psi_2^g) - (R_2^{hb} - p_2^{hb}\psi_2^g)]$, the principal must bear extra agency costs ($w_2^{fg} > 0$) to make her announcement of θ credible, but nevertheless the maximum of (3.4) is still obtained when $r_g = 1$. *QED*

Proof of Corollary 2: When (3.9) holds, the principal's profit (3.4) is a decreasing function of r_g. *QED*

Proof of Corollary 3: When $p_1^h\psi_1$ lies between the extreme values defined by (3.8) and (3.9), the optimum is either at $\frac{1}{\rho}\left[1-\left(\frac{p_1^h\psi_1}{(R_2^{hg}-p_2^{hg}\psi_2^g)-(R_2^{hb}-p_2^{hb}\psi_2^g)}\right)^{\frac{1}{2}}\right]$, the tangency point between the convex portion of the labor cost curve and an isoprofit curve, or at the kink $\frac{1}{\rho}\left[1-\max\{0,\frac{p_1^h\psi_1}{R_1^h-(R_2^{hb}-p_2^{hb}\psi_2^g)}\}\right]$ which is strictly between 0 and 1. *QED*

Proof of Corollary 4: Clear from the text.

Proof of Proposition 3: Let us assume away constraint (4.1); we will show that the solution without constraint (4.1) corresponds to the mechanism stated in the above proposition and the solution always satisfies constraint (4.1).

If $p_1^h\frac{\psi_1}{1-\rho}\leq p_2^{hg}\psi_2^g-V_2^h$, that is, if the expected rent associated with switching to the good project 2 is at least as large as the expected payment[13] from project 1 under the common knowledge switching rule $(r_g,r_b)=(1,0)$, then it is possible to implement the allocation as if θ were contractible: we can set $r_b=0$, $r_g=1$, $w_2^{sg}=\psi_2^g$ and $w_1^s=\frac{\psi_1}{1-\rho}$ and $w_2^{fg}=w_1^f=0$. Condition (4.2) is then satisfied and the agent has no incentive to misreport θ.

If $p_2^{hg}\psi_2^g-V_2^h<p_1^h\frac{\psi_1}{(1-\rho)}$, the agent will have an incentive to pretend that project 2 is bad even when $\theta=g$ in order to protect his rent which is larger when pursuing project 1. To induce the agent to truthfully reveal θ, he must be subject to a positive probability of switching if he announces that $\theta=b$ and/or receive a larger payment if project 2 is pursued and successful: we must have $r_b>0$ or $w_2^{sg}>\psi_2^g$, or both.

We now show that $r_b=0$. Given some arbitrary switching rule (r_b,r_g), the level of expected profit when $w_1^s=p_1^h\frac{\psi_1}{1-\rho r_g-(1-\rho)r_b}$, is given by:

$$\begin{aligned}(1-\rho r_g-(1-\rho)r_b)[R_1^h-p_1^h\frac{\psi_1}{1-\rho r_g-(1-\rho)r_b}]\\+\rho r_g[R_2^{hg}-p_2^{hg}(w_2^{sg}-w_2^{fg})-w_2^{fg}]\\+(1-\rho)r_b[R_2^{hb}-p_2^{hb}(w_2^{sb}-w_2^{fb})-w_2^{fb}]\end{aligned}\tag{7.2}$$

[13] The cost of effort V_1^h has been sunk by the time the switch is considered.

and constraint (4.2) can be rewritten as

$$r_g(p_2^{hg}(w_2^{sg}-w_2^{fg})+w_2^{fg}-V_2^h) \geq (r_g-r_b)\frac{p_1^h\psi_1}{1-\rho r_g-(1-\rho)r_b} + r_b \max_{e\in\{\ell,h\}}[p_2^{eg}(w_2^{sb}-w_2^{fb})+w_2^{fb}-V_2^e],$$

which implies that

$$r_g(p_2^{hg}(w_2^{sg}-w_2^{fg})+w_2^{fg}-V_2^h) \geq (r_g-\frac{1-\rho}{\rho}r_b)\frac{p_1^h\psi_1}{1-\rho r_g}. \tag{7.3}$$

Substituting (7.3) into (7.2), we obtain that for every switching rule (r_b, r_g) the principal's profits are no greater than:

$$(1-\rho r_g)R_1^h - p_1^h\psi_1 + \rho r_g\left[R_2^{hg}-\frac{p_1^h\psi_1}{(1-\rho r_g)}-V_2^h\right] - (1-\rho)r_b\left[(R_1^h-\frac{p_1^h\psi_1}{(1-\rho r_g)})-(R_2^{hb}-\left(p_2^{hb}(w_2^{sb}-w_2^{fb})+w_2^{fb}\right))\right]. \tag{7.4}$$

When $r_b=0$, the principal's profit (7.2) reaches this upper bound (7.4) which by A4 is a decreasing function of r_b. Hence the principal does better by setting $r_b=0$ and $w_1^s = p_1^h\frac{\psi_1}{(1-\rho r_g)}$.
With $r_b=0$, (4.2) can be written as

$$p_2^{hg}w_2^{sg} \geq p_1^h\frac{\psi_1}{(1-\rho r_g)}+V_2^h \tag{7.5}$$

If (7.5) is binding, giving w_2^{sg} as an increasing function of r_g, the principal's problem becomes:

$$\max_{r_g}\ (1-\rho r_g)R_1^h - p_1^h\psi_1 + \rho r_g\left[R_2^{hg}-\frac{p_1^h\psi_1}{(1-\rho r_g)}-V_2^h\right]. \tag{7.6}$$

The first order condition for r_g (for an interior solution) leads to

$$(1-\rho r_g) = \left(\frac{p_1^h\psi_1}{R_2^{hg}-V_2^h-R_1^h}\right)^{\frac{1}{2}}.$$

However, this value of r_g may fail to induce a high level of effort if $p_2^{hg}w_2^{sg}$ obtained from (7.5) is smaller than $p_2^{hg}\psi_2^g$. In that case, we must replace $p_2^{hg}w_2^{sg}$ with $p_2^{hg}\psi_2^g$ in (7.5) now binding and solve for r_g. Note that if $p_1^h\psi_1 \le (1-\rho)^2(R_2^{hg} - V_2^h - R_1^h)$, we have the corner solution $r_g = 1$; however $r_g = 0$ is impossible since $p_1^h\psi_1 < (R_2^{hg} - V_2^h - R_1^h)$ because of A3 and the existence of informational rents. Hence we have (4.4).

We must complete the proof by showing that (4.1) is satisfied. If $p_1^h\frac{\psi_1}{1-\rho} \le p_2^{hg}\psi_2^g - V_2^h$, we can verify that (4.1) is satisfied as follows. We have $p_1^h\psi_1 - V_1^h = \frac{p_1^\ell V_1^h}{(p_1^h - p_1^\ell)} > 0$; by assumption, we have $p_2^{\ell b} = 0$ and $V_2^\ell = 0$ and therefore, $[p_2^{\ell b}\psi_2^g - V_2^\ell] = 0$; we also have $p_2^{hb}\psi_2^g - V_2^h = p_2^{hb}\dfrac{V_2^h}{p_2^{hg} - p_2^{\ell g}} - V_2^h = \frac{p_2^{hb}V_2^h - (p_2^{hg} - p_2^{\ell g})V_2^h}{p_2^{hg} - p_2^{\ell g}} < 0$ by A1; thus $p_1^h\psi_1 - V_1^h \ge (1-\rho)\max_e[p_2^{eb}\psi_2^g - V_2^e] = 0$ and constraint (4.1) is satisfied.

If $p_1^h\frac{\psi_1}{1-\rho} > p_2^{hg}\psi_2^g - V_2^h$, then $w_1^s = \psi_1/(1-\rho r_g)$ and $r_b = 0$; the left hand side of (4.1) is then equal to $(1-\rho r_g)p_1^h w_1^s - V_1^h + (1-r_g)p_1^\ell w_1^s = (1-\rho)r_g p_1^\ell w_1^s$ since $e = h$ is optimal for $w_1^s = \psi_1/(1-\rho r_g)$ iff the probability of pursuing project 1 is no less than $1-\rho r_g$ and since $V_1^\ell = 0$ by assumption. Since (7.5), or (4.2), is binding, we have $p_1^h w_1^s = p_2^{hg}w_2^{sg} - V_2^h$, that is, $w_2^{sg} = \frac{p_1^h w_1^s + V_2^h}{p_2^{hg}}$ and therefore, the right hand side of (4.1) is equal to $(1-\rho)r_g\frac{p_2^{hb}}{p_2^{hg}}(p_1^h w_1^s + V_2^h) - V_2^h$. Conditions (4.1) can then be written as

$$(1-\rho r_g)(p_1^\ell p_2^{hg} - p_1^h p_2^{hb})w_1^s > ((1-\rho r_g)p_2^{hb} - p_2^{hg})V_2^h$$

which is satisfied since the right hand side is negative from A1 and the left hand side is positive from A5. Hence, (4.1) is satisfied. *QED*

Proof of Proposition 4: The first inequality follows from the definitions of $\tilde{r}_g^P$ and $\tilde{r}_g^A$. We have a strict inequality if (5.1) holds with a strict inequality. The result $r_g^P \le r_g^A$ is obtained from

$$\frac{\partial C^P(r_g)}{\partial r_g} \ge \frac{\partial C^A(r_g)}{\partial r_g} \text{ iff (5.1) holds.}$$

Finally, it is (strictly) preferable to give the authority to the agent if only if the principal attains in so doing a higher isoprofit curve. She does if and only if (5.1) holds (with a strict inequality). *QED*

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Figure 1

The Partial Flexibility Solution r_g^P

When the Principal Observes the Signal

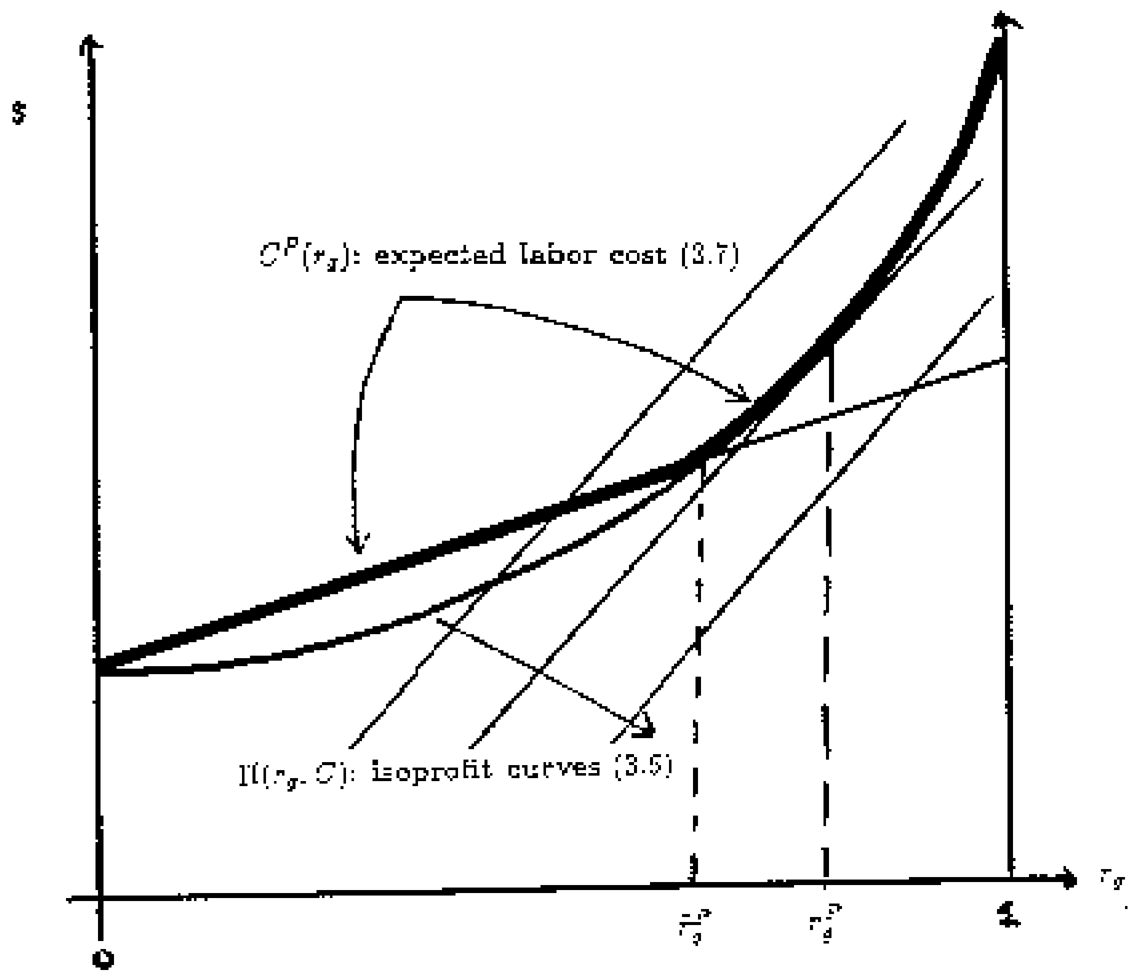
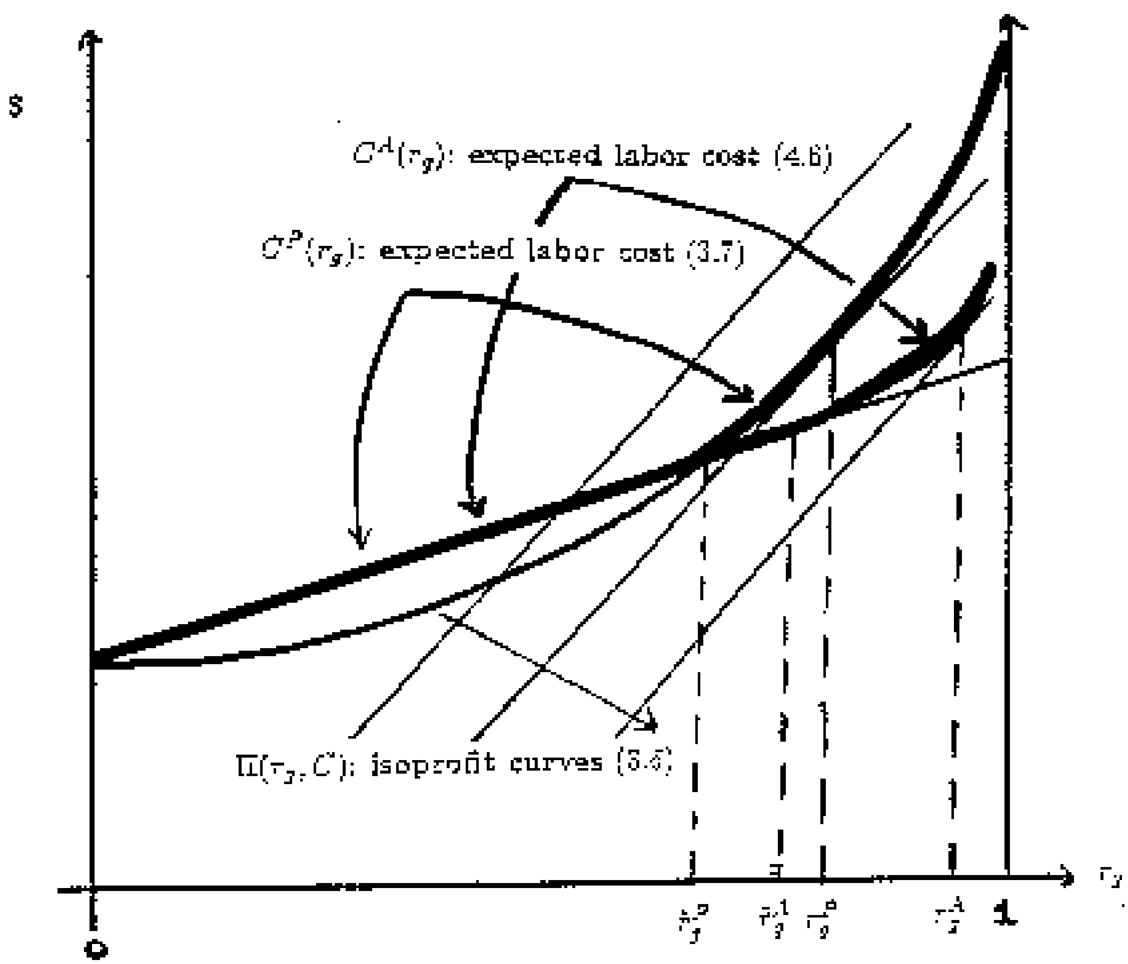


Figure 2

The Allocation of Authority to the Agent



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