Subjective evaluation of performance through individual evaluation interview: theory and empirical evidence from France*

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Abstract

Individual evaluation interviews have become a widespread practice. 52% of employees in French manufacturing firms over 50 employees declared an annual individual evaluation interview in 1997. However whereas the problem of constructing an optimal contract with subjective evaluation (which is defined simply as a signal in most papers) receives a large attention, firm-level evaluation interviews are strikingly left aside from economic analysis. This paper aims at identifying the underlying logics of individual evaluation interviews in the case of individual production and of team production. Especially, it aims at analyzing the relationships between effort, wage distribution within the firms and individual evaluation interviews. From a theoretical standpoint, three papers by Alchian and Demsetz (1972), by Che and Yoo (2001) and by MacLeod (2003) are closely related to our paper and from an empirical point of view, a recent paper by Engellandt and Riphahn (2004). We test in our paper four predictions. First, evaluation interviews have a positive impact on effort. Second, evaluation interviews increase the effort through two effects: the classical incentive effect and also a high selection effect. Third, evaluation interviews are associated with positive beliefs regarding wage and work recognition. Finally, evaluation interviews are associated with monetary gains for employees. These predictions are tested using a matched employer /employee survey on Computerization and Organizational Change (survey "Changements Organisationnels et Informatisation", C.O.I.), conducted in 1997 over a sample of about 4000 firms and 9000 employees.

Keywords: Subjective evaluation, Principal-Agent Model, Personnel Economics, Super-modularity.

JEL Classification: M50, M54.

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"If the economic organization meters poorly, with rewards and production only loosely correlated, then productivity will be smaller; but if the economic organization meters well productivity will be greater."

Alchian and Demsetz (1972, page 779)

1 Introduction

In the classical Principal-Agent model, if the Agent's level of effort is not observable by the Principal then the optimal contract must depend on any verifiable measure of the Agent's performance. Most papers take as verifiable measure, the output of the task performed by the Agent. And these papers construct the optimal wage in such a way that it is an increasing function of output. However according to MacLeod and Parent (1999) and Prendergast (1999), in real world, very few firms use such a mechanism but instead a mechanism in which the employees' bonus depend on a subjective evaluation of their performance by the Principal. Such mechanisms (in which the Agent's wage does not depend to a verifiable measure of performance but instead to a subjective one) are called Principal-Agent models with subjective evaluation : see MacLeod (2003) for a static analysis and Levin (2003) for a repeated game analysis. However in these analysis, the subjective performance measure is simply modeled as a private or public signal. It seems that evaluation, in general, are made through the so-called evaluation interviews which are now widespread in most OECD countries. In France for instance, 52% of employees in manufacturing firms over 50 employees declared in 1997 (according to the COI survey[1]) that they had an annual individual evaluation interview. Moreover, analyzing (using a panel data set describing 6500 employees of a large international company) the effect of annual individual evaluation over employee level of effort (measured by workers' days of absence and by overtime work), Engellandt and Riphahn (2004) find out that surprise bonus payments and flexibility in the evaluation of individual performances over time provide effective incentives for employee effort. There is therefore a need for a specific theoretical analysis of evaluation interviews. It is the purpose of this paper to provide theoretical insights into the role of evaluation interview. More precisely, we want to analyze the consequences of individual evaluation interviews on wage profiles (and of course on effort). In doing so, we are going to distinguish two different ways of organizing work: in teams or individually. When work is organized in teams, then the implementation of a task is shared between employees generating a need for cooperation and coordination. When work is "individualized" then each task is performed by an employee independently.

Concerning individual production, we propose a theoretical framework based on a Principal-Agent model with subjective evaluation of effort through an individual interview. Our model can be considered as a sub-model of the model of MacLeod (2003) but not completely for four reasons. First in our analysis,

[1] The COI survey is a matched employer/employee survey on Computerization and Organizational Change (survey "Changements Organisationnels et Informatisation"), conducted in 1997 by the French ministries of Labor (DARES), Industry (SESSI), Trade and Services (SCEES) and the French National Institute of Statistics (INSEE).

the individual evaluation interview is based upon some precise common knowledge criteria (which are accepted by both parties -Principal and Agent). Second we assume that the Principal's subjective evaluation of the Agent's effort takes into account the Agent's self-reports on a set of criteria. Third the production technology matters. Finally, we do not address the question of the strategy-proofness or the Nash-implementability of the individual interview mechanism.

Let us now briefly explain our formal analysis. Let $\Theta = \{0, 1, 2\}$ be the set of efforts' level where the maximal level of effort that the Agent can legally provide is $k = 2$. Let us call w_2^* the associated incentive wage. If the Principal implements the optimal wage w_2^* then the Agent will play an effort $k = 2$. Hence in the classical mechanism, there is no need for the Principal to evaluate ex-post the Agent's level of effort. So what is the role of individual evaluation interviews in the individual production ? In order to understand our explanation, let us stress out two characteristics of the classical incentive mechanism (without individual evaluation interviews). Suppose that the production can either be a success (with a probability which depends on the Agent's level of effort) or a failure. Therefore a first characteristic of the classical incentive scheme is that the Agent's wage will not directly depend on the level of effort, but instead on the success or the failure of the production. Of course, even if the Agent provides the maximal level of effort, the success of the production is not guaranteed. The second characteristic of classical incentive schemes is that if the Principal can choose between a sub-modular and a super-modular technology, he will always choose a super-modular one. The first reason is that when the production technology is super-modular, the probability that it is a success, is an increasing convex function of the effort (while this probability is an increasing concave function in the case of sub-modularity). The second one is that the agent's wage in the case of a super-modular production technology is lower than his wage in the case of a sub-modular production technology.

These two characteristics, from our point of view, may explain why it is difficult to implement a classical incentive scheme in real world. On the contrary, in an incentive scheme with individual evaluation interview, the Agent will get this wage (even if the production is a failure) if he has been evaluated by the Principal as having provided an effort of level $k = 2$. Moreover the Agent's wage in an incentive scheme with individual evaluation interview and super-modular production technology is higher than his wage in classical incentive scheme with super-modular technology. However the probability of getting this wage is smaller. Therefore the incentives schemes with evaluation interview will attract people having a low desutility of effort. Namely the incentive mechanism with evaluation interview always includes in addition to the normal incentive effect, a selection effect whose consequence is to attract the agents whose desutility of effort is the weaker. And this selection effect will increase the expected profit of the Principal since the probability of success of task is an increasing function of the agent's level of effort.

Concerning team production, even if the Principal faces the same problems as in individual production, the main issue in (see Alchian and Demsetz, 1972 or Holmstrom, 1982) is free riding.

Therefore in team production, the role of evaluation interviews is not re-

stricted to the ex-post evaluation (through an individual interview) of the Agents' level of effort. Indeed an ex-post evaluation of agents' level of effort will not prevent them from shirking (except if individual interview as a mechanism can detect with probability equal to 1 any agent who shirks).
Thus we develop the following argument. The Principal prefers to implement a supermodular technology production. However in this case there exist several Nash equilibria, among which the solution $(0, 0)$. Therefore in order to avoid the implementation of the equilibrium $(0, 0)$, it must be the case that firms enforce coordination among the agents. The issue is not new and is well documented in the literature: coordination can be obtained using non-monetary incentives or monetary incentives. A famous example of non-monetary incentives is the so-called "peer pressure" by Kandel and Lazear (1992). We show that ex-ante (to the production) individual evaluation interviews belong to the class of non-monetary coordinating incentives and therefore play exactly the same role -concerning the implementation of the equilibrium $(1, 1)$ - as "peer pressure". However if implementing ex-ante an evaluation interview solves the free-riding problem in team, the wage of the agents still depends to the conditional probability of success of the task. As in the individual production case, the Principal will implement an ex-post evaluation interview which aims is to evaluate the level of effort and therefore to condition the wage not on the success of the task but on the evaluation of the Agents' effort.

Of course our explanations of subjective evaluation through evaluation interterview are not exclusive. Indeed other explanations exist in sociology, theories of organizations or industrial relations. For instance, evaluation interviews are a "domination method" used by firms that intensify work by imposing both business-bureaucratic constraints and market constraints. Evaluation interviews may also contribute to elaborate the formalization of work organization. Lastly, evaluation interviews might deter social unrest within organizations in which the dispute potential is important [2].

We have derived from our theoretical analysis, four predictions that have been tested[3] using a matched employer/employee survey on Computerization and Organizational Change and distinguishing individual and collective workers. The predictions are the following. First, evaluation interviews have a positive impact on effort. Second, evaluation interviews increase the effort through two effects: the classical incentive effect and also a high selection effect. Third, evaluation interviews are associated with positive beliefs regarding wage and work recognition. Finally, evaluation interviews are associated with monetary gains for employees.

The paper includes five sections. The second section is devoted to our theoretical analysis of evaluation interviews in the case of individual production. In the third section, we analyse the role of evaluation interviews in the case of team production. In the fourth section, we test our predictions over the COI survey. Finally the fifth section concludes.

[2] Faced with the possibility of expressing themselves during interviews, employees would be less incited to contest management.

[3] The tests have been implemented using a propensity score methodology which allows to control for selections effects due to background characteristics.

2 Evaluation Interview in Individual Production

2.1 Basic setting

We want in this section to analyse the function of individual evaluation interview in a productive context where work is "individualised", that is designed in such a way that tasks are not shared between employees.

We consider (see Che and Yoo, 2001) a Principal-Agent framework in which production requires only one task. This task is performed by the Agent who makes an effort decision unobservable by the Principal. Production, that is the outcome of the task, is a random variable X that can either succeed ($X = 1$) or fail ($X = 0$) giving respectively R or 0 payoffs to the Principal. The Agent's individual effort denoted K (K is a random variable from the Principal's stand point) belongs to the set $\Theta = \{0, 1, 2\}$ which is the set of levels of effort *legally* possible. In other words, the maximal level of effort that the Principal can legally incite the agent to supply is $K = 2$. However the general set of levels of effort is $\Theta_g = \{0, 1, 2, 3, 4..., \overline{m}\}$. Let $Pr(X = 1|K = k) = q_k$ and $Pr(X = 0|K = k) = 1 - q_k$ respectively the conditional probability of success of the task given the Agent's level of effort k, and the conditional probability of failure of the task given the Agent's level of effort k. We will suppose that the Principal is risk-neutral, with a linear utility function $b(r) = r$ and that the Agent is risk-averse with a utility function $U(r, k) = u(r) - v(k)$ where u is an increasing and concave function such that: $u(0) = 0$, $u(r) \geq 0\ \forall r \geq 0$; and the Agent's desutility function of effort $v(k) = e \times k$ where the unit of effort noted e is strictly positive. Moreover the Agent's reservation utility is equal to zero. Finally we assume [4] that $1 > q_2 > q_1 > q_0 \geq 0$ and that $2q_1 \geq q_2$ (which guarantees that the participation constraint is fulfilled).

The relationship between effort and production is an important feature of the production technology. We will consider two alternatives: production is either super-modular or sub-modular. Let us then set the following definition concerning this property of the production technology.

Definition 1

Super-Modularity	$q_2 - q_1 \geq q_1 - q_0$
Sub-Modularity	$q_2 - q_1 \leq q_1 - q_0$

Broadly speaking when production is super-modular (respectively sub-modular), the return on effort is increasing (respectively decreasing) in the level of effort.

2.2 Classical incentive contracts

It is straightforward to see (and this is well known in the literature) that for each level of effort we have the following incentive wages:

[4] Over $\Theta_g = \{0, 1, 2, 3, 4..., \overline{m}\}$, we have $1 > q_{\bar{m}} > ... > q_3 > q_2 > q_1 > q_0 \geq 0$.

$$w_0^* = 0$$

$$\text{Sub-modularity:} \quad w_1^* = u^{-1}(e/(q_1 - q_0)) \quad w_2^* = u^{-1}(e/(q_2 - q_1))$$

$$\text{Super-modularity:} \quad w_1^* \text{ indeterminate} \quad w_2^* = u^{-1}(2e/(q_2 - q_0))$$

When the production technology is super-modular the Principal will implement the mechanism (w_2^*, $k = 2$), which is designed in such a way that the Agent plays the maximal level of effort.

When the production technology is sub-modular and if income R is not high $\left(R \leq \frac{q_2 u^{-1}(e/(q_2-q_1)) - q_1 u^{-1}(e/(q_1-q_0))}{q_2-q_1}\right)$, then the Principal will ask for the level of effort $k = 1$. Otherwise, he will ask for a level of effort $k = 2$.

However, if the principal can choose the production technology (sub-modular versus super-modular), he will always prefer a super-modular technology: on the one hand because the Agent's wage $u^{-1}(2e/(q_2 - q_0))$ is lower than in the sub-modular technology case, and on the other hand because the probability of success of the task is then a convex function of the level of effort.

2.3 Incentive mechanism with individual evaluation interview

One main message can be drawn from the previous subsection. It is about the potential conflict between the preferences of the Principal and those of the Agent concerning the production technology. Basically, the Principal always prefers a super-modular technology, while the Agent prefers a sub-modular one. Hence, although the incentive wage w_2^* respects the participation constraint, some agents may resist when the Principal implements a super-modular production technology. This resistance will be stronger when the firm moves from a sub-modular technology to a super-modular one with the same employees (indeed their wages will decrease[5]). A mechanism with evaluation interview could mitigate this potential resistance, because the Agent then gets a higher wage than w_2^*, the classical incentive wage with a super-modular production technology.

Let us first define what an individual evaluation interview is. The theoretical determination of the optimal evaluation interview is a problem of its own that we are not going to solve in this paper. This would imply a rigorous assessment of the optimal[6] set of criteria evaluation. But we are going to leave this problem aside by simply assuming that the Principal determines (seeking advice from the Agent) a finite set S of criteria (characteristics) that he considers important for estimating the Agent's effort. Let us call $v^s \in \Xi^s$ the true level of agent's criterion s ($s = 1$ to S). We will assume that it is a private information namely that v^s is a random variable which realization is only observed by the Agent

[5] The decreasing of wage after an organizational change is not only theoretical. For instance in their empirical seminal paper, Hamilton et al. (2003) show after that a move from an individual production to a team one, high productivity workers take earnings losses when joining a team.

[6] In the sense that it minimizes the evaluation error.

(ie. The Principal does not observe it). According to the revelation principle we can restrict ourselves to the following direct mechanism $\Sigma^s = (\Xi^s; g)$ where g is a result function,

$$g : \Xi^s \to \Xi^s$$
$$v^s \mapsto g(v^s)$$

Definition 2 *We call individual evaluation interview, the mechanism* $\Sigma = (\Sigma^1, ..., \Sigma^s, ...\Sigma^S; a)$ *where the* Σ^s $(s = 1, ...S)$ *are direct mechanisms and* a *is an aggregation function of marks resulting from the assessment of each criterion.*

$$a : \prod_{s=1}^{S} \Xi^s \to M$$

$$(g(v^1), ..., g(v^S)) \mapsto a(g(v^1), ..., g(v^S))$$

Where M *is a marks set.*

This definition calls to two remarks. First in order to construct his own evaluation of the Agent's performance, the Principal may use the Agent's self-evaluations. Second, we assume the bounded rationality of the Principal, generating potential errors in his evaluation of the Agent's level of effort (see also Assumption 1). Concerning this latter point, an interesting question from our point of view is to know whether it is theoretically possible to construct an incentive mechanism with individual evaluation interview when the Principal makes mistakes in his evaluation of the Agent's level of effort. Nonetheless in order to simplify we will assume that the probability of evaluation error is fixed and is common knowledge. To complete our comment of definition 2 let us remark that since the purpose of the evaluation interview is to get a subjective evaluation of effort, then the Principal can directly take $M = \Theta$.

Let I be the evaluation mark obtained by the Agent after the production process: $I \in \{0, 1, 2\} = \Theta$. If $I = 0$ or 1 then the agent does not receives a premium. If $I = 2$ then the agent receives a premium $\overline{p}$. Let us call p the premium variable. We thus have:

$$p = \begin{cases} \overline{p} & \text{if } I = 2 \\ 0 & \text{otherwise} \end{cases}$$

Of course, this mechanism must respect the participation and the incentive constraints. Moreover it must also be such as:

• the principal expected benefit is at least equal to his expected benefit in the classical mechanism,

• the agent's expected utility is at least equal to his expected utility in the classical mechanism (because classical mechanism is the benchmark).

We have formally for the Agent:

$$E[u(\overline{p})|k = 2] - 2e \geq 0 \tag{2.1}$$

$$E[u(\overline{p})|k = 2] - 2e \geq E[u(\overline{p})|k = 1] - e \tag{2.2}$$

$$E[u(\overline{p})|k=2]-2e \geq E[u(\overline{p})|k=0] \tag{2.3}$$

$$E[u(\overline{p})|k=2]-2e \geq E[u(w_2^*)|k=2]-2e \tag{2.4}$$

And for the Principal:

$$q_2[R-Pr(I=2)\overline{p}]+(1-q_2)[0-Pr(I=2)\overline{p}]-\alpha\overline{p} \geq q_2(R-w_2^*) \tag{2.5}$$

where $\alpha\overline{p}$ is the cost of the interview[7], $\alpha \in [0,1]$. Let us assume without loss of generality that $\alpha = 0$.

Let us set $\gamma_k^i = Pr(I=i|K=k)$, the probability that the Agent's level of effort were evaluated as being i when his true level of effort is k. And assume that:

Assumption 1: $\gamma_k^i > 0 \;\; \forall i, k$.

This assumption simply states that an individual evaluation interview is not strategy-proof and Nash-implementable mechanism.

Let us also set the following assumption:

Assumption 2: $\gamma_{k'}^2 = \gamma^{'}, \forall k^{'} \in \{0,1\}$.

This assumption implies that the probability of evaluating the Agent's effort equal to 2 when it is lower than 2 is independent from the true level of effort. Further, we define an evaluation system in the following way:

Definition 3 *We call evaluation system, denoted E, the profile*

$$E = \Big(\Theta = \{0,1,2\}, \{\gamma_k^i\}_{k,i}\Big)$$

Definition 4 *An evaluation system E is efficient in detecting a level of effort $k \in \Theta$ if $\gamma_k^k > \gamma_{k'}^k$, $\forall k^{'} < k,\ k^{'} \in \Theta$.*

Definition 5 *An evaluation system E is efficient if it is efficient for every level of effort. It is said inefficient otherwise.*

Let us go back to inequalities (2.1) to (2.5). They lead to the following program P_{max}:

$$\underset{\overline{p},\ \{\gamma_k^2\}}{Max}\ q_2R-(\gamma_2^2+\gamma_1^2+\gamma_0^2)\overline{p}$$

under the constraints:

$$(1) \qquad \gamma_2^2 u(\overline{p})-2e \geq 0$$

$$(2) \qquad (\gamma_2^2-\gamma_1^2)u(\overline{p})-e \geq 0$$

$$(3) \qquad (\gamma_2^2-\gamma_0^2)u(\overline{p})-2e \geq 0$$

$$(4) \qquad \gamma_2^2 u(\overline{p}) \geq q_2 u(w_2^*)$$

$$(5) \qquad (\gamma_2^2+\gamma_1^2+\gamma_0^2)\overline{p} \leq q_2 w_2^*$$

[7]That is to say the cost of an evaluation interview is measured by the time devoted to this interview. The Principal runs the interview and does not pays himself.

We are going to discuss some claims deriving from program P_{max} and highlighting different conditions under which the Principal implements individual evaluation interview when agents fulfil their task on their own.

Claim 1 *The efficiency of the Evaluation System for the level of effort 2 is a necessary condition to the existence of a solution for the program (P_{max}).*

Indeed the Evaluation System is not efficient for the level of effort 2 if $\gamma_2^2 \leq \gamma_1^2$ or $\gamma_2^2 \leq \gamma_0^2$. If $\gamma_2^2 \leq \gamma_1^2$, then there is no $\overline{p}$ which respects constraint (2). And if $\gamma_2^2 \leq \gamma_0^2$ then there is no $\overline{p}$ which respects constraint (3).

As a consequence of claim 1, we are going to restrict ourselves to the class of Evaluation Systems which are efficient for the level of effort 2. We want now to set a necessary and sufficient condition for the implementation of a mechanism with evaluation interview.

Claim 2 *If the production technology is sub-modular, then the following two conditions are equivalent*:

1. *It is possible to construct an incentive mechanism with evaluation interview.*
2. $\frac{q_2}{q_1} \geq \frac{2\gamma_2^2}{\gamma_2^2+\gamma_0^2}$

Condition (2) : $\frac{q_2}{q_1} \geq \frac{2\gamma_2^2}{\gamma_2^2+\gamma_0^2}$ is difficult to fulfill. Indeed let us recall that with a sub-modular technology, we have:

$$q_1 - q_0 > q_2 - q_1$$

Therefore we think that incentives mechanisms with evaluation interview will be rarely implemented when the production technology is sub-modular. In this case, the marginal return from increasing the effort from level 1 to level 2 is too low to compensate for the bounded rationality of the Principal.

Concerning super-modular technology it is easy to see that:

Claim 3 *Let us assume a super-modular technology then the two following conditions are equivalent.*

1. *It is possible to construct an incentive mechanism with evaluation interview.*
2. $\frac{\gamma_2^2}{\gamma_0^2} \leq \frac{q_2}{q_0}$

Condition (2) from claim 3 is not costly. For example it is trivially satisfied when $q_0 = 0$. How can it be interpreted ? Let us remark that $\frac{q_2}{q_0}$ is the ratio of the probability of success of the task when the level of effort is $k = 2$ to the probability of success of the task when the level of effort is $k = 0$, whereas $\frac{\gamma_2^2}{\gamma_0^2}$ is the ratio of probability of evaluating rightly the Agent's level of effort to be $k = 2$, to the probability of evaluating the Agent's level of effort to be $k = 2$ while he has provided an effort $k = 0$. In order to understand condition (2) from claim 3, we have to remind that the Principal receives income R only when the task succeeds. Within the mechanism with evaluation interview, the Agent only receives the premium $\overline{p}$ if he has been evaluated as having provided a level of effort equal to 2. Hence (contrary to the classical mechanism), the Agent's premium is independent from the result of the task he performs. Condition (2) tells that the relative increase in the probability of receiving the premium $\overline{p}$ when the Agent switches from the level of effort 0 to the level of effort 2, has to be smaller than the relative increase in the probability of success of the task (which is for the principal the probability of receiving income R), when the Agent switches from the level of effort 0 to the level of effort 2. Thus condition (2) can be viewed as a stochastic budget constraint. *So we can deduce from claim 3 that the incentive mechanisms with evaluation interviews have a high likelihood to be implemented when the production technology is super-modular.*

Claim 4 *If the production technology is super-modular. Then the optimal contract in the incentive mechanism with evaluation interview is:*
$\overline{p} = u^{-1}\left(\frac{2e}{\gamma_2^2-\gamma_0^2}\right)$
$\gamma_2^2, \gamma^{'}$ *such as*
$u^{-1}\left(\frac{2e}{\gamma_2^2-\gamma^{'}}\right) \leq \frac{q_2}{\gamma_2^2+2\gamma^{'}} u^{-1}\left(\frac{2e}{q_2-q_0}\right)$

Suppose now a super-modular production technology. Then two messages can be drawn from claim 4. According to the first message, the Agent's wage, $\overline{p} = u^{-1}\left(\frac{2e}{\gamma_2^2-\gamma_0^2}\right)$, within the incentive mechanism with evaluation interview is greater than his wage in the classical incentive mechanism, $w_2^* = u^{-1}\left(\frac{2e}{q_2-q_0}\right)$. Nonetheless the probability of receiving this wage is weaker: $\gamma_2^2 + \gamma_1^2 + \gamma_0^2 \leq q_2$.

In order to understand the second message, let us recall that in the classical optimal contract (with no evaluation interview) the Agent's wage is higher when the technology is sub-modular than when it is super-modular. If the firm moves from a sub-modular technology to a super-modular one with the same employees, the Principal may use evaluation interviews to mitigate potential resistance from the Agents: he will pay the same wage as in the case of a sub-modular technology with no evaluation interviews but he will reduce the probability for the Agent of getting this wage.

Namely if the Principal wants to pay the Agent for the wage corresponding to the effort $k = 2$ in the case of a sub-modular technology within the classical mechanism, then he will construct the incentive mechanism with evaluation interview in such a way that:

$$0 < \gamma^{'} \leq \frac{1}{3}\left(\frac{q_2 u^{-1}\left(\frac{2e}{q_2-q_0}\right)}{u^{-1}\left(\frac{e}{q_2-q_1}\right)^{sub}} - 2(q_2-q_1)^{sub}\right)$$

$$\gamma_2^2 = 2(q_2-q_1)^{sub} + \gamma^{'}$$

Where $(q_2-q_1)^{sub} = q_2 - q_1$ in the sub-modular technology case.

Indeed the wage corresponding to a sub-modular technology is $u^{-1}\left(\frac{e}{(q_2-q_1)^{sub}}\right)$.

Thus the principal will set $\overline{p} = u^{-1}\left(\frac{2e}{\gamma_2^2-\gamma_0^2}\right) = u^{-1}\left(\frac{e}{(q_2-q_1)^{sub}}\right)$

That is to say $\gamma_2^2 - \gamma_0^2 = 2(q_2 - q_1)^{sub}$. But according to claim 4 it must be the case that: $\overline{p} \leq \frac{q2}{\gamma_2^2+\gamma_1^2+\gamma_0^2} w_2^*$

Namely:

$$u^{-1}\Big(\frac{e}{q_2 - q_1}\Big) \leq \frac{q_2}{\gamma_2^2 + \gamma_1^2 + \gamma_0^2} u^{-1}\Big(\frac{2e}{q_2 - q_0}\Big)$$

$$\Rightarrow u^{-1}\Big(\frac{e}{q_2 - q_1}\Big) \leq \frac{q_2}{\gamma_2^2 + 2\gamma^{'}} u^{-1}\Big(\frac{2e}{q_2 - q_0}\Big)$$

Since

$$\gamma_2^2 = 2(q_2 - q_1)^{sub} + \gamma_0^2$$

then

$$u^{-1}\Big(\frac{e}{q_2 - q_1}\Big) \leq \frac{q_2}{2(q_2 - q_1)^{sub} + 3\gamma^{'}} u^{-1}\Big(\frac{2e}{q_2 - q_0}\Big)$$

and

$$\gamma^{'} \leq \frac{1}{3}\Bigg(\frac{q_2 u^{-1}\Big(\frac{2e}{q_2 - q_0}\Big)}{u^{-1}\Big(\frac{e}{q_2 - q_1}\Big)^{sub}} - 2(q_2 - q_1)^{sub}\Bigg).$$

2.4 Selection effect and over-intensification of work

According to the previous subsection, the Agent gets his wage $\overline{p}$ only if he has been evaluated by the Principal, playing an effort equal to 2 ; on the other hand this wage $\overline{p}$ is greater that the one in the classical incentive scheme (however the probability of getting $\overline{p}$ is weaker). Therefore we expect that the incentives schemes with evaluation interview will attract people having a low desutility of effort. The purpose of this subsection is to show it formally. Let us remind that $\Theta = \{0, 1, 2\}$ is the set of levels of effort legally possible but that the general set of levels of effort is $\Theta_g = \{0, 1, 2, 3, 4...\overline{m}\}$. Let us assume a continuum of agents but such that over $\Theta = \{0, 1, 2\}$ -the legal set of effort- agents have the same behavior with respect to their desutilities of effort. Therefore over $\Theta = \{0, 1, 2\}$ the Principal cannot offer a contract which depends on the Agent's type θ. Furthermore the Principal cannot construct a contract $(w_k, k \geq 3)$ because a court of justice may find from w_k the implicit level of effort (which is here illegal since it is higher than 2) that the Principal wants the Agent to provide. The desutility of effort is written as:

$$v_\theta(k) = \begin{cases} ke & \text{if } k \in \Theta = \{0, 1, 2\} \\ \\ (2 + \theta k)e & \text{with} \quad 0 \leq \theta \leq 1 \quad \text{if} \quad k \in \{3, 4, ...\overline{m}\} \end{cases}$$

Such a functional means that given a level of effort $k \geq 3$, the smaller the type θ, the weaker the Agent's desutility of effort. Why an Agent of type θ might increase his level of effort beyond the legal maximal level, without a monetary compensation (indeed, one can remark that the Agent's wage $\overline{p} = u^{-1}\big(\frac{2e}{\gamma_2^2 - \gamma_0^2}\big)$ does not change even if the Agent increases his effort beyond the required level)? The reason is that when the evaluation system satisfies the property set in definition 6 then if the Agent increases his level of effort beyond the required level $k = 2$, the probability of being detected (and thus of receiving the premium $\overline{p} = u^{-1}\big(\frac{2e}{\gamma_2^2 - \gamma_0^2}\big)$) as having provide a level of effort $k = 2$, increases.

Definition 6 *An evaluation system $E = (\Theta = \{0, 1, 2\}, \{\gamma_k^i\}_{k,i})$ includes an informal detection system of a given illegal level of effort $k^{'} \geq 3$ if:*

1. $\gamma_{k'}^2$ *is well defined*, and
2. $\gamma_{k'}^2$ *respects the following pseudo-monotony condition:* $\gamma_{k'}^2 \geq \gamma_k^2$, $\forall k \in \{2, 3, 4, ...k^{'} - 1\}$.

This definition does not contradict definition 4 which holds for all k, $k^{'} \in \Theta = \{0, 1, 2\}$. In order to understand definition 6, let us consider an agent of type $\theta = 0$. Then if he provides an effort $k = \overline{m}$, he has the same effort desutility than when providing an effort $k = 2$ with the certitude[8] of getting the wage $\overline{p} = u^{-1}\big(\frac{2e}{\gamma_2^2 - \gamma_0^2}\big)$. Such an agent is rational since when increasing his level of effort beyond the maximal legal level ($k = 2$) he increases his expected utility.

Claim 5 *Condition (2) is a necessary condition to Condition (1).*

1. *An agent provides a level of effort $k^{'}$ superior strictly to the maximal legal level.*
2. *The evaluation system $E = (\Theta = \{0, 1, 2\}, \{\gamma_k^i\}_{k,i})$ includes an informal detection system of the illegal level of effort $k^{'}$.*

Indeed on the one hand (1) implies:

$$\gamma_{k'}^2 u(\overline{p}) - (\theta k^{'} + 2)e > \gamma_2^2 u(\overline{p}) - 2e$$

Which gives:

$$(\gamma_{k'}^2 - \gamma_2^2)u(\overline{p}) > \theta k^{'} e$$

Since $\theta k^{'} e \geq 0$ it implies necessarily that $\gamma_{k'}^2 - \gamma_2^2 > 0$.
On the other hand (1) implies that for all $k \in \{3, ...\overline{m}\}$, $k \neq k^{'}$:

$$\gamma_{k'}^2 u(\overline{p}) - (\theta k^{'} + 2)e > \gamma_k^2 u(\overline{p}) - (\theta k + 2)e$$

Which gives:

$$(\gamma_{k'}^2 - \gamma_k^2)u(\overline{p}) > \theta(k^{'} - k)e$$

If $k \in \{3, ..., k^{'} - 1\}$, then we have $\theta(k^{'} - k)e \geq 0$. This latter point implies necessarily that $\gamma_{k'}^2 - \gamma_k^2 > 0$. And we get the desired result.

Moreover we get the following:

Claim 6 *The following two conditions are equivalent.*

1. *An agent provides a level of effort $k^{'}$ superior strictly to the maximal legal level.*

[8] The Agent will have considerably increase the probability of being evaluated as having provide an effort $k = 2$.

2. *Agent's type is* $\theta < \delta(k^{'})$ *with* $\delta(k^{'}) = \frac{2}{\overline{k}} \frac{(\gamma_{k^{'}}^2 - \gamma_k^2)}{(\gamma_2^2 - \gamma_0^2)}$ *where* $\overline{k} = k^{'} 1_{\{k=2\}} + (k^{'} - k) 1_{\{k \geq 3\}}$, $\forall k \in \{2, ..., k^{'} - 1, k^{'} + 1, ...\overline{m}\}$.

We can remark that condition (2) of claim (6), can be rewritten in the following way:

$$\frac{\theta \overline{k}}{2} < \frac{\gamma_{k^{'}}^2 - \gamma_k^2}{\gamma_2^2 - \gamma_0^2}$$

An interesting interpretation can then be drawn from it according to which there are two effects intervening in the Agent's decision of providing a higher effort that the maximal legal level 2. The first effect is in relation with the quantity $\frac{\gamma_{k^{'}}^2 - \gamma_k^2}{\gamma_2^2 - \gamma_0^2}$ which expresses the marginal variation (with respect to the situation where he provides the level of effort 2) of the probability that the agent were detected as having provided the level of effort 2 when he increases his level of effort beyond the required maximal legal level. *This marginal variation is the same for all agents whatever their types* θ. However there is a second effect we call *cost effect* expressed by the quantity $\frac{\theta \overline{k}}{2}$ which measures the effort's marginal desutility when an agent of a given type θ goes from effort 2 to a higher one. Given his type θ, the cost effect slows down the increasing of the Agent's level of effort. We can also remark that for a given level of effort, the smaller the type θ, the weaker the cost effect. Finally, claim 6 tells that an agent will decide to provide an effort beyond the maximal legal level 2 if the marginal variation of the probability of getting the associated premium $\overline{p} = u^{-1}\left(\frac{2e}{\gamma_2^2 - \gamma_0^2}\right)$ (which is the same for all agents) is above the marginal cost (which depends on his type θ and on the level of effort provided).

Moreover according to claim 6, the Agent provides a level of effort **at least equal** to a given level $k^{'}$ (strictly greater than the maximal legal level) if and only if his type is $\theta < \delta(k^{'})$ with $\delta(k^{'}) = \frac{2}{\overline{k}} \frac{(\gamma_{k^{'}}^2 - \gamma_k^2)}{(\gamma_2^2 - \gamma_0^2)}$ where $\overline{k} = k^{'} 1_{\{k=2\}} + (k^{'} - k) 1_{\{k \geq 3\}}$, $\forall k \in \{2, ..., k^{'} - 1\}$.

Let us illustrate this point with $k^{'} = 3$. An agent provides an effort at least equal to 3 if and only if his type θ is strictly weaker than $\frac{2}{3}\left(\frac{\gamma_3^2 - \gamma_2^2}{\gamma_2^2 - \gamma_0^2}\right)$. Thus the shape of the probability of detection γ_k^2 in the neighborhood of effort $k = 3$, will play a crucial role. For instance if γ_k^2 is highly strongly convex in the neighborhood of $k = 3$ in such a way that $\gamma_3^2 - \gamma_2^2 > \frac{2}{3}\left(\gamma_2^2 - \gamma_0^2\right)$ then all agents whatever their types will provide an effort at least equal to 3. Of course it seems more reasonable to think that γ_k^2 is rather concave in the neighborhood of $k = 3$, that is to say that $\gamma_3^2 - \gamma_2^2 < \gamma_2^2 - \gamma_0^2$. But even in this case there are still some individuals who can provide an effort at least equal to $k = 3$. Let us illustrate this point with $\gamma_0^2 = 0.1$, $\gamma_2^2 = 0.7$, $\gamma_3^2 = 0.9$. Then agents with type $\theta < \frac{2}{9}$ will provide an effort at least equal to k=3.

The important thing to keep in mind here, is that when supposing that evaluation system $E = (\Theta = \{0, 1, 2\}, \{\gamma_k^i\}_{k,i})$ includes an informal system of detection of the illegal level of effort $k = 3$ then the quantity $\theta < \frac{2}{3}\left(\frac{\gamma_3^2 - \gamma_2^2}{\gamma_2^2 - \gamma_0^2}\right)$ is always strictly positive. Namely the incentive mechanism with evaluation interview always includes in addition to the normal incentive effect, a selection effect whose consequence is to attract the agents whose desutility of effort is the weaker. Of course we do not say that the incentives mechanism with evaluation interview only attracts individuals which will provide an effort greater than the maximal level required by the Principal. Indeed we have assumed that the optimal contract constructed by the Principal is done from the legal set of efforts $\Theta = \{0, 1, 2\}$. And over this set, the agents have the same behavior with respect to disutilities of effort. Nevertheless a simple reasoning shows that the selection effect will be higher in the case of production with evaluation interview than in the case without evaluation interview. To conclude, production structure with super-modular technology and evaluation interview will lead to an over-intensification of work in the sense that the Agents will provide efforts above the maximal effort required by the Principal. Of course since the probability q_k of success of the task is, over $\Theta_g = \{0, 1, 2, 3, 4..., \overline{m}\}$, a monotone increasing function of the effort level k, then, assuming that the revenue R is high enough (i.e. $R \geq \overline{p}(\frac{\gamma_k^2+...+\gamma_3^2}{q_k-q_2})$), the selection effect increases $q_k R - \overline{p}(\gamma_k^2 + ... + \gamma_2^2 + \gamma_1^2 + \gamma_0^2)$: the *effective* expected profit of the Principal.

3 Evaluation Interview in Team Production

3.1 Basic Setting

The development of various managing devices favoring teamwork (quality circles, autonomous work groups, problem solving groups, project teams etc.) and thereby joint responsibility for complex tasks reveals that one of the main feature of the so-called new organizational forms is team production. For instance in their report on the British's Workplace Employment Relations Survey 2004 (WERS 2004), Kersley et al. (2005) point out that : *"Team-working was the common, with almost three-quarters (72 per cent) of workplaces having at least some core employees in formally-designated teams.."*. This empirical fact suggests to analyze the role of evaluation interviews in team production in Alchian and Demsetz (1972)' setting. Even if the two authors do not explicitely use a principal-agent model, their analysis can clearly be incorporated in a *principal-agent model with subjecive evaluation*. Indeed in such kind of model, the focus is on the employees and their evaluation.

We will consider the same framework as in the previous section, however the task (which is the same as in the individual production case) is now performed by a team of two agents who make an effort decision unobservable by the principal. Our definition of team (borrowed from Alchian and Demsetz, 1972) is very restricted here since only a global signal X concerning production is available. In particular the Principal cannot calculate the contribution of each agent to the production. Finally, let us recall that in the individual production case (see the previous section), the set of levels of effort legally possible was $\Theta = \{0, 1, 2\}$. Therefore in the team production case (in order to be consistent with the case of individual production) it must be the case (see Che and Yoo, 2001) that from the point of view of the Principal, the individual effort of agent i $(= 1, 2)$ denoted K_i belongs[9] to the set $\{0, 1\}$. The probability of success of the task

[9]Indeed the required total amount of effort for one task in team production is therefore the same as in the individual production case.

given the level of effort of the agents is : $Pr(X = 1|K_i = k_1, K_j = k_2) = p_{k_1 k_2}$; $i = 1, 2; j = 1, 2, i \neq j$.

Like in the previous section, we assume that : $p_{11} > p_{01} = p_{10} > p_{00} \geq 0$.

It is usual in the literature to set the following two properties of the team production technology. The first one is of course the super-modularity or sub-modularity.

Definition 7 *A production technology is super-modular (respectively sub-modular) if* $p_{11} - p_{10} \geq p_{10} - p_{00}$ *(*$p_{11} - p_{10} \leq p_{10} - p_{00}$ *).*

The other property is horizontal technological interdependence which measures the increase in the probability of success (i.e. in the productivity) when one agent increases his effort level, for a given effort level of the other team member. When they are positive, such interdependencies capture the fact that teamwork makes an employee's productivity more dependent on the effort expanded by his co-workers[10].

Definition 8 *The horizontal technological interdependency within team is measured by the quantity :*

$$\Delta_k = p_{k1} - p_{k0}$$

Since we have assume that $p_{11} > p_{01} = p_{10} > p_{00} \geq 0$ then $\Delta_0 = p_{01} - p_{00}$ and $\Delta_1 = p_{11} - p_{10}$ are strictly positive.

3.2 Classical optimal contract

The contract proposed by the principal is composed of two variables: the effort level required and the corresponding wage. The optimal wage is determined by the incentive compatible constraints and by the participation constraints. The participation constraint establishes that the agent's expected utility must be at least equal to his reservation utility and the incentive compatible constraint guarantees that the effort level chosen by the agent maximizes his expected utility. The participation constraint establishes that the agent's expected utility must be at least equal to his reservation utility and the incentive compatible constraint guarantees that the effort level chosen by the agent maximizes his expected utility.

In team production, only a global signal is available for the principal. Hence, he can only propose contracts with symmetric effort levels. $w^*_{k_1 k_2}$ is the optimal wage for effort levels k_1 et k_2 required to agents 1 and 2 with $w^*_{00} = 0$ and $w^*_{11} = u^{-1}\left(\frac{e}{p_{11} - p_{01}}\right)$. In team production, after signing the contract proposed by the principal, agents make their effort decision in the context of a coordination game. It is easy to see that this game leads to a unique Nash equilibrium $(1, 1)$ when $\Delta_1 < \Delta_0$ and to two Nash equilibria $(0, 0)$ and $(1, 1)$ when $\Delta_1 \geq \Delta_0$.

[10]According to the empirical studies, innovative organizational practices adopted at the firm level all tend to make one's work outcome more sensitive to the others' efforts rather than to "individualize" work by isolating workers from one another. The strong requirements of reorganized firms in terms of quality, time constraints, cost cut devices and delayering reinforce interactions by eliminating factors facilitating the absorption of local shocks such as a machine breakdown, a worker tiredness, a supply problem.

However w^*_{11} is a decreasing function of Δ_1. Hence ceteris paribus, firms will always prefer organizational forms characterized by both high horizontal interdependencies and super-modularity ($\Delta_1 \geq \Delta_0$) [11]. The problem is that in the case of super-modularity, the equilibrium $(1,1)$ is no longer unique. Therefore in order to avoid the implementation of the equilibrium $(0,0)$, it must be the case that firms enforce coordination[12] among the agents. The issue is not new and is well documented in the literature: coordination can be obtained using non-monetary incentives or monetary incentives[13]. A famous example of non-monetary incentives is the so-called "peer pressure" by Kandel and Lazear (1992). We will now show that individual interviews belong to the class of non-monetary coordinating incentives (and therefore play exactly the same role -concerning the implementation of the equilibrium $(1,1)$- as "peer pressure").

3.3 Ex-ante evaluation interview as a non-monetary incentive towards coordination

Firms use individual interviews as a non-monetary incentives device in order to reach the Pareto-optimal outcome. Indeed in such a moral hazard problem within team, each agent ignores whether his co-worker shirks or not. Each individual hence forms beliefs over his partner's strategy, and chooses an effort level given these beliefs. As argued by Osborne and Rubinstein (1994, Chapter 3, section 3.2) the probabilities ($Pr(k_i = 1)$ and $Pr(k_i = 0)$) may be interpreted as the players' beliefs about their peer's behavior. Unfortunately, it is easy to see that the only mixed strategies Nash equilibria are degenerated : $((1,0),(1,0))$ and $((0,1),(0,1))$. The meaning is that both agents make an effort decision $k_i = 1$ ($i = 1,2$) only if they are sure that their partner adopts the same strategy. If the principal wants agents to coordinate on the Pareto-optimal equilibrium, he must design organizational devices affecting the probabilities associated with each strategy. This is the reason why we argue in claim 7 that evaluation interviews represent a mean to generate an ex ante signal towards the other agents to reinforce their beliefs about the team spirit[14]. An important difficulty lies in the fact that the outcome of an evaluation interview is only known by the principal and the interviewed agent. It is therefore not public. In turn, it seems hard to figure out how the evaluation interview of an agent i would generate a signal (regarding himself) towards the other agents j, $j \neq i$. Though this may seem counter-intuitive at first sight, we will show that the individual evaluation interview is such that it does in fact make public the outcome of the interview. We assume that the interview is run before production takes place

[11] Indeed let Δ_1^a such that $\Delta_1^a < \Delta_0$ and Δ_1^b such that $\Delta_1^b \geq \Delta_0$. We have therefore : $w^*_{11}(\Delta_1^a) > w^*_{11}(\Delta_1^b)$.

[12] By coordination within the team, we mean any instrument which leads to the implementation of the Nash Pareto-Optimal equilibrium $(1,1)$.

[13] Concerning monetary coordinating incentives, when $\Delta_1 \geq \Delta_0$, the principal can propose a bonus w^{**}_{11} which motivates team members to coordinate, where $w^{**}_{11} = u^{-1}\left(\frac{e}{p_{01}-p_{00}}\right)+\varepsilon$, $\varepsilon > 0$. Of course when $\Delta_1 \geq \Delta_0$, since $u^{-1}\left(\frac{e}{p_{01}-p_{00}}\right) > u^{-1}\left(\frac{e}{p_{11}-p_{01}}\right)$ and $\varepsilon > 0$ then w^{**}_{11} (the coordination incentive bonus) is higher than w^*_{11}. Moreover, the higher the gap between Δ_1 and Δ_0, the higher the difference $w^{**}_{11} - w^*_{11}$: that is to say, the monetary cost of coordination incentives is increasing with the relative level of horizontal interdependence. Therefore the monetary cost (for the firms) of coordination incentives is hugh.

[14] In the sense of Alchian and Demsetz (1972), an agent has team spirit (or loyal) if he does not shirk when working in a team.

and that agent i's type $t_i \in \Lambda_i = \Lambda = \{H, L\}$ is a private information where H = "has team spirit" and L = "has no team spirit". The goal of the interview[15] is of course to make agents truthfully reveal their types.

Let now define the following[16] mechanism CDG:

> **1)** The interview is run over a population of n individuals, $n \geq 2$.
> **2)** The Principal knows (whithout loss of generality-see footnote 16) the proportion $\frac{n_0}{n}$ of agents who have team spirit, where $n_0 \geq 2$.
> **3)** The Principal runs the interview and if he observes that the number of individuals who declare to be of type H (labeled $\widehat{n}_0$) is strictly higher than n_0, then he knows that at least one individual (among the $\widehat{n}_0$) lies.
> In such a case, the Principal stops the process : *No team.*
> **4)** If $\widehat{n}_0 \leq n_0$, the Principal randomly selects two agents among the $\widehat{n}_0$ who declare to be of type H.
> **5)** Each interviewed individual only receives the outcome of his own interview.

It is easy to see that if the mechanism[17] CDG is common knowledge then:

Claim 7. *The mechanism CDG is strategy-proof.*

Claim 7 implies that CDG being common knowledge, when the Principal forms the team, each agent within the team infers that the other team member has team spirit, even though he does not observe the outcome of the other agent's interview. In other words, the mechanism CDG generates public signals[18] θ_i $(i = 1, 2)$ over the type of each team member. Besides, since CDG is strategy-proof, such public signals exactly coincide with the t_is.

Moreover CDG being common knowledge, when the Principal forms the team, each agent within the team fully trust in the reliability of the signals sent. Hence, before making his effort level decision, each agent can observe the realization of a signal $\theta_i \in \Lambda = \{H, L\}$, $i = 1, 2$, where θ_i is a random variable concerning the "team spirit" of player i. Lastly, let us remark that the principal knows that the agents take w_{11}^* into account when choosing their optimal effort levels, so that he keeps on paying the bonus after having observed the agents' type (H or L). Moreover, it follows directly from the definition of team spirit that the agents do believe that the signal t_i is perfectly correlated with the

[15]Our approach may be considered as traditional in the sense that it simply consists in elaborating a revelation mechanism (see for instance Barbera and Dutta, 2000). Another approach would consist in allowing a pre-play communication among agents (cheap-talk) during which the latter mutually send each other private messages over their types, such a communication being followed by a public checking of the messages sent (see Forges, 1990 ; Barani, 1992 ; Ben-Porath, 2003).

[16]If the principal does not know the proportion of agents who have team spirit, then this proportion is a random variable for him. Let us call it N and let us suppose that the principal knows its support $Sp = \left[\frac{n_{\inf}}{n}, \frac{n_{\sup}}{n}\right]$, with of course $n_{\inf} \geq 2$. If the principal takes $InfSp$ as the proportion of agents who have team spirit (that is if the principal is prudent) then the mechanism CDG is still strategy-proof.

[17]Of course the mechanism CDG can select people having the same demographic characteristics (gender, age, race,...) either because team spirit is objectively correlated with the agents' individual characteristics or because the principal and/or the agents have some prior beliefs concerning the demographic characteristics of people having team spirit.

[18]A public signal is not necessarily made explicitely public (by the principal).

effort variable of agent i, k_i, so that when agent i observes $\theta_j = H$ (respectively $\theta_j = L$), $i \neq j$, he believes that $k_j = 1$ (respectively $k_j = 0$) and it is then optimal to decide $k_i = 1$ (respectively $k_i = 0$). Thus when the mechanism CDG is implemented, the unique Nash correlated equilibrium is $(1, 1)$. Claim 7 is close in its spirit to a result by Prat (2002) showing that when there is a positive complementarity between workers in a team then this team should be composed of agents of the same type.

3.4 Combining an ex-ante individual evaluation interview with an ex-post one

According to the previous subsection, implementing ex-ante (ex-ante to the production) an evaluation interview solves the free-riding problem in team by selecting agents who have team-spirit. However the wage of these agents still depend to the probability of success of the task p_{11}. As in the individual production case, the Principal can implement an ex-post evaluation interview which aims is to evaluate the level of effort and therefore to condition the wage not on the success of the task but on the evaluation of the Agents' effort.

Let γ_0^1 (respectively γ_1^1) be the probability that the Agent's level of effort were evaluated as being 1 while his true level of effort is 0 (respectively 1). Let us assume that γ_0^1 and γ_1^1 are strictly positive; and that the evaluation system is efficient in detecting a level of effort 1 (that is to say $\gamma_0^1 < \gamma_1^1$). Then the Principal will maximise his profit $p_{11}R - 2\left(\gamma_1^1 + \gamma_0^1\right)\overline{p}$, [19] under the participation and incentives constraints and also under the constraint that his (the Principal) expected benefit is at least equal to his expected benefit in the mechanism with only an exante individual evaluation and under the constraint that the agents' expected utility is at least equal to their expected utility in the mechanism with only an exante individual evaluation. Formally we have :

$$\underset{\overline{p},\gamma_1^1,\gamma_0^1}{Max} \quad p_{11}R - 2\left(\gamma_1^1 + \gamma_0^1\right)\overline{p}$$

$$\begin{gathered} Constraints \\ \gamma_1^1 u\left(\overline{p}\right) - e \geq 0 \\ \gamma_1^1 u\left(\overline{p}\right) - e \geq \gamma_0^1 u\left(\overline{p}\right) \\ \gamma_1^1 u\left(\overline{p}\right) - e \geq p_{11} u\left(w_{11}^*\right) - e \\ p_{11}R - 2\left(\gamma_1^1 + \gamma_0^1\right)\overline{p} \geq p_{11}\left(R - 2w_{11}^*\right) \end{gathered}$$

It is easy to see that this program has two solutions:

- If $\frac{p_{11}}{p_{11}-p_{10}} > \frac{\gamma_1^1}{\gamma_1^1-\gamma_0^1}$ then $\overline{p} = u^{-1}\left[\frac{p_{11}}{\gamma_1^1} \times \frac{e}{p_{11}-p_{10}}\right]$ with γ_1^1 and γ_0^1 such that :
$$u^{-1}\left[\frac{p_{11}}{\gamma_1^1} \times \frac{e}{p_{11}-p_{10}}\right] \leq \frac{p_{11}}{\gamma_1^1+\gamma_0^1} \times u^{-1}\left[\frac{e}{p_{11}-p_{10}}\right]$$
- If $\frac{p_{11}}{p_{11}-p_{10}} \leq \frac{\gamma_1^1}{\gamma_1^1-\gamma_0^1}$ then $\overline{p} = u^{-1}\left[\frac{e}{\gamma_1^1-\gamma_0^1}\right]$ with γ_1^1 and γ_0^1 such that :
$$u^{-1}\left[\frac{e}{\gamma_1^1-\gamma_0^1}\right] \leq \frac{p_{11}}{\gamma_1^1+\gamma_0^1} \times u^{-1}\left[\frac{e}{p_{11}-p_{10}}\right]$$

[19] Where $\bar{p}$ is the Agent's wage when he has been evaluated as having provide the level of effort 1.

For each solution, the Principal can implement two kind of policy: either $\overline{p}$ (the agent's wage in the incentive mechanism with exante and expost evaluations) $\geq w_{11}^*$ (the agent's wage in the incentive mechanism with only an exante evaluation) and $\gamma_1^1 + \gamma_0^1$ (the probability of getting $\overline{p}$) $\leq p_{11}$ (the probability of getting w_{11}^*) or $\overline{p} < w_{11}^*$ and $\gamma_1^1 + \gamma_0^1 > p_{11}$. For instance, in the case of $\overline{p} = u^{-1}\left[\frac{p_{11}}{\gamma_1^1} \times \frac{e}{p_{11}-p_{10}}\right]$, if the Principal designs the mechanism in such a way that $p_{11} \geq \gamma_1^1$ then $\overline{p}$ will be greater than w_{11}^*, however the probability of getting $\overline{p}$ will be weaker than the probability of getting w_{11}^* $(\gamma_1^1 + \gamma_0^1 \leq p_{11})$. Likewise, if the Principal designs the mechanism in such a way that $p_{11} < \gamma_1^1$ then $\overline{p}$ will be weaker than w_{11}^*, however the probability of getting $\overline{p}$ will be greater than the probability of getting w_{11}^* $(\gamma_1^1 + \gamma_0^1 > p_{11})$. In the case of $\overline{p} = u^{-1}\left[\frac{e}{\gamma_1^1 - \gamma_0^1}\right]$, if the Principal designs the mechanism in such a way that $\gamma_1^1 - \gamma_0^1 \leq p_{11} - p_{10}$ then $\overline{p}$ will be greater than w_{11}^*, however the probability of getting $\overline{p}$ will be weaker than the probability of getting w_{11}^* $(\gamma_1^1 + \gamma_0^1 \leq p_{11})$. Likewise, if the Principal designs the mechanism in such a way that $\gamma_1^1 - \gamma_0^1 > p_{11} - p_{10}$ then $\overline{p}$ will be weaker than w_{11}^*, however the probability of getting $\overline{p}$ will be greater than the probability of getting w_{11}^* $(\gamma_1^1 + \gamma_0^1 > p_{11})$.

However we think that the Principal will implement a mechanism in which $\overline{p} \geq w_{11}^*$ and $\gamma_1^1 + \gamma_0^1 \leq p_{11}$ instead of a mechanism with $\overline{p} < w_{11}^*$ and $\gamma_1^1 + \gamma_0^1 > p_{11}$. The reason is that in the former, the effect of the selection effect on the Principal's effective expected profit will be higher. Indeed the smaller is $\gamma_1^1 + \gamma_0^1$ the higher will be the agent's effort in order to increase the probability $\sum_{i=0}^{k} \gamma_i^1$ to be evaluated playing an effort equal to 1. We can remark that concerning the selection effect, if $\gamma_2^1 - \gamma_1^1 \geq \gamma_1^1 - \gamma_0^1$ (that is if the evaluation technology is super-modular) then all the agents will play the level of effort $k = 2$ (instead of the required $k = 1$)[20]. More generally, if the evaluation system includes an informal sytem of detection system of an illegal level of work $(k \geq 3)$ then the agents of type $\theta < \frac{(\gamma_k^1 - \gamma_1^1)u(\bar{p}) - e}{ke}$ will play an effort $k \geq 3$.

4 Empirical tests

This section deals with the tests of the predictions listed in table 4.1 by mobilizing a French matched employer / employee database. Since the predictions concern causal inferences about the relative effects of evaluation interviews which can be viewed as a treatment and the data available is not based on the results of carefully conducted randomized experiment, propensity score analysis seems to be an appropriate tool.

This section is organized as follows. Subsection 4.1 briefly presents the data. Subsection 4.2 summarizes propensity score methodology. The results of data analysis are described in subsection 4.3.

[20]And if the revenue R is high enough $\left(i.e.\ R \geq \frac{\gamma_2^1 \overline{p}}{p_{22} - p_{11}}\right)$ then this overintensifisation of work will increase the Principal's effective expected profit.

Table 4.1: Predictions

Prediction 1	The agents' level of effort in incentive scheme with individual evaluation interview is higher than the level of effort in the classical incentive scheme.
Prediction 2	An incentive mechanism with evaluation interview always includes in addition to the normal incentive effect, a high selection effect whose consequence is to attract the agents whose desutility of effort is the weaker.
Prediction 3	Evaluation interviews are associated with belief regarding the Agent's ability to predict his wage.
Prediction 4	Evaluation interviews are associated with monetary gains for employees.

4.1 The Data

We use the COI survey which is a matched employer/employee survey on Computerization and Organizational Change (survey "Changements Organisationnels et Informatisation"), conducted in 1997 by the French ministries of Labor (DARES), Industry (SESSI), Trade and Services (SCEES) and the French National Institute of Statistics (INSEE) and conceived and coordinated by the *Centre d'Etudes de l'Emploi*. In this survey, both employer representatives and small sample of randomly selected employees within firms (2 or 3 per firm) are interviewed. For a detailed description of the survey, see Greenan and Hamon-Cholet (2001).

Our analysis focuses on the sample of firms over 50 employees in the manufacturing industry. We select a sub-sample of 2904[21] employees. Interviewed employees belong to the core workforce of the firm because they all have at least 1 year of seniority. The labor force section of *COI* survey includes questions about collective work which allow to build up five different measures of interactions between employees in the course of the work process (see appendix 1 for detailed questions). Table 4.2 displays the distribution of the dummy variables associated with these measures. These different measures are correlated but not equivalent. Therefore the breakdown of workers between individuals and collective workers depends on the measure used. Actually we think that each measure contributes to define collective work taking into account the varieties of work organization. Consequently, we build up a dummy variable that takes the value 1 (the value 0) if at least (less than) 3 dummies takes the value 1. According to this variable we have 1537 individual workers and 1367 collective workers.

Table 4.3 gives the distribution of individual evaluation interviews according to our synthetic binary indicator of collective work. About 15% and about 22% of evaluated workers are respectively individual workers and collective workers while there are more individual workers (i.e, 52.9%) than collective workers (47.1%).

[21] In the full sample there are 4295 individuals. However in our analysis we do not take into account employees with supervision activities (1214 individuals) or employees working part time (177 individuals). The former combine a position of Principal and of Agent that we have not investigated theoretically, while part time leads to badly measured effort and wages.

Table 4.2: Five measures of interactions between employees in the course of the work process [a]

	Frequency	Percent
measure 1: Teamwork		
No (0)	1422	48.97
Yes (1)	1482	51.03
measure 2: Time spent in teamwork		
Less than 1/4 (0)	2045	70.42
1/4 or more (1)	859	29.58
measure 3 Communication in the firm		
Weak (0)	1019	35.09
Strong (1)	1885	64.91
measure 4: Benefit from others' help		
Weak (0)	1537	52.93
Strong (1)	1367	47.07
measure 5: Participation into meetings		
Weak (0)	1557	53.62
Strong (1)	1347	46.38

[a] See A. of appendix 1 for the construction of these measures.

Table 4.3: Evaluation among individual workers and collective workers

	Individual Workers	Collective Workers
Evaluation		
Yes	445 (15.32%)[a]	637 (21.9%)
No	1092 (37.6%)	730 (25.13%)
Total	1537(52.9%)	1367(47.1%)

[a] Percentage with respect to the analysed subsample of 2904 employees.

At this stage a simple way to test our predictions is to consider evaluation interviews as treatments and to evaluate the effect of this treatement on the chosen variables for measuring effort, wages, and beliefs about wages. More precisely, let t a dummy variable equal to 1 if the employee declares being evaluated and 0 otherwise, then 3 quantities are interesting for us. The first is the average treatement effect over the whole population, written C; the second is the average treatement effect over the treated individuals, written C_1; and the third is the average treatement effect over the non treated individuals, written C_0.
More precisely, let Y the chosen variables for measuring effort, wages, and beliefs about wages. Then C measures the variation of Y that would be observed if the whole population was treated; C_1 is an evaluation of the effect of the treatement in the usual sense since it concerns the treated population; and C_0 is a propective evaluation in the sense that it measures what would happen if the non treated population was treated. Thus, we have:

$$C = E[Y_1 - Y_0] \tag{4.1}$$

$$C_1 = E[Y_1 - Y_0 | t = 1] \tag{4.2}$$

$$C_0 = E[Y_1 - Y_0 | t = 0] \tag{4.3}$$

Where Y_1 is the observed value of Y that results when receiving treatment (that is when being evaluated), Y_0 is the observed value of Y that results when do not receiving treatment (that is when do not being evaluated), and $E[\ .\ ]$ denotes expectation in the population.
Intuitively, an estimate of an average treatement effect could be the difference between the average of Y over the population of treated individuals and its average over the population of non treated individuals, that is,

$$\overline{Y}_1 - \overline{Y}_0 \tag{4.4}$$

Where $\overline{Y}_1$ and $\overline{Y}_0$ are respectively the average of Y for treated (evaluated employees) and the non treated (non evaluated employees).
This estimate is given in table 4.4 for a set of variables from the labor force section of the COI survey (see appendix 1 for more details on the underlying questions). We find that differences in these variables between evaluated and non evaluated employees are all significatively positives. In particular: according to prediction 1 there are more evaluated employees than non-evaluated employees that work sometimes more than ordinarily, that make propositions to improve the work process, and they show on average a greater level of effort; according to prediction 3 evaluated employees have a greater ability to predict their wages; according to prediction 4 an evaluated employee earn on average 12.8 % more than a non evaluated one. Note however that for collective workers the evaluation effects are slightly weaker with a difference between evaluated and non evaluated employees that work sometimes more than ordinarily which is no more significant.

However, broadly speaking the main problem when evaluating the effect of a treatement is that for each individual we only observe

$$Y = t \times Y_1 + t \times Y_0 = \begin{cases} Y_1 & \text{if } t = 1 \\ Y_0 & \text{if } t = 0 \end{cases}$$

Then it can be shown that the comparison of means between treated and non treated individuals can be the cause of a selection bias since the data does not result from a randomized experiment. And when testing evaluation effects (on effort, wage, beliefs about wages) there is a need to control for naturally occurring systematic differences in background characteristics between the treated population and the non treated population, which would not occur in the context of a randomized experiment. Moreover, according to prediction 2, individual evaluation interview affects employees effort trough a selection effect associated to desutility and an incentive effect which in our case is estimated by the average treatment (evaluation) effect. Therefore in order to estimate the average treatment (evaluation) effect it is also necessary to control for the selection bias due to desutility. Although, it seems difficult to control "directly" for this selection effect because desutility is not an observable characteristic, we can assume that desutility is grounded on observable background characteristics, and hence controlling for them allows to control for the selection effect due to desutility.
Thus it is necessary to control for background characteristics in order to estimate the effect of individual evaluation interview. And our choice is to use

the propensity score methodology introduced by Rosenbaum and Rubin (1983), which addresses this situation by reducing the entire collection of background characteristics to a single "composite" characteristic that appropriately summarizes the collection.

Table 4.4. Average differences between evaluated and no evaluated workers

	Individual workers	Collective workers
Working more than ordinarily[a]		
evaluated	0.5169	0.5965
no evaluated	0.4478	0.5795
difference [b]	0.069**[c] (13.34 %)	0.017 (2.84 %)
Employee's propositions to improve the work process[d]		
evaluated	0.5978	0.7928
no evaluated	0.4661	0.6575
difference	0.132*** (22.03 %)	0.135*** (17.06 %)
Employee's effort[e]		
evaluated	0.2628	0.3444
no evaluated	0.2213	0.2743
difference	0.042*** (15.79 %)	0.07*** (20.3 %)
Annual net wage		
evaluated	16853	18027
no evaluated	14751	15780
difference	2101 *** (12.46 %)	2247*** (12.46%)
Annual net wage in logarithm		
evaluated	9.6525	9.7181
no evaluated	9.5279	9.6029
difference	0.125 *** (1.295 %)	0.115*** (1.18%)
Employee's ability to predict his wage[f]		
evaluated	0.611	0.6724
no evaluated	0.442	0.5384
difference	0.169*** (27.65 %)	0.134*** (19.92 %)

[a] Response is either "yes" or "no".

[b] *** $p - value < 0.01$, ** $0.01 \leq p - value < 0.05$, * $0.05 \leq p - value < 0.1$

[c] Percentage of average response variable for evaluated workers is in parentheses.

[d] Response is either "yes" or "no".

[e] See B. of appendix 1 for the construction of this variable.

[f] See C. of appendix 1 for the construction of this variable.

4.2 Propensity score methodology

Propensity score technology allows to correct the selection bias by matching individuals according to their propensity score which is the estimated probability of receiving treatment (of being evaluated) given background characteristics. Moreover, the results of Rosenbaum and Rubin (1983) allow to construct a group of treated individuals and a group of non treated ones comparables in accordance to their propensity score. And we can use a non parametric *Kernel matching estimator* proposed by Heckman, Ichimura, and Todd (1997, 1998) which under some regularity assumptions is convergent and asymptotically normal.

Broadly speaking, in this estimator each non treated individual takes part in the construction of a *counterfactual* of each treated individual, that is to say of an estimate of what would be the response for the treated individual if he was in the non treated population. And the importance of each non treated individual

in this construction varies as the distance between his propensity score and that of the treated individual.
Moreover, since in order to estimate the treatment effect we have to construct for each treated individual a *counterfactual* from individuals in the non treated population, we must have a set of non treated individuals which have propensities scores close to the propensity score of the treated individual. In other words a *counterfactual* can only be constructed for the individuals whose propensity score belongs to the intersection between the support of the propensity score distribution of the treated individuals and the support of the propensity score distribution of the non treated individuals. Consequently an important point in the estimation concerns the determination of the *common support* of the propensity score distributions. Thus, the estimation proceeds as follows:

- The propensity score is estimated from a logistic model. That is, treatment (evaluation) is the explained variable, background characteristics are the explanatory variables, and the estimated probability of receiving treatment given background characteristics is the propensity score.
- The common support is computed as the intersection between the propensity score for the treated group and the propensity score for the control group.
- We estimate the treatment causal effect using a non parametric *Kernel matching estimator* proposed by Heckman, Ichimura, and Todd (1997, 1998).
- The estimate standard deviation is computed by bootstrap.

4.3 Results

Logistic regression results

Appendix 3 presents the parameters estimated of the logistic model for the binary outcome "evaluated/not evaluated". These results give evidence about the existence of a selection bias insofar as it appears that for individual workers and for team workers, interview evaluation is not randomly implemented. However differences appears between them.

More precisely, in the case of individual workers we find *ceteris paribus* that among the socio-demographic characteristics of the employee that we have take into account, being in the firm since 1 to 2 years (rather than since 11 years or more) and having a middle management professional type (rather than an unskilled one) have a positive and significative effect on the probability of being evaluated with p-values of respectively 0.0079 and 0.0011. We find, with a lower degree of significativity ($0.01 < \text{p-value} < 0.05$) that being a women have a negative effect on the probability of being evaluated, while being in the firm since 7 to 10 years (rather than since 11 years or more), and having an executive professional type (rather than an unskilled one) have positives effects on this probability.
Among the general characteristics of the firm, a firm size of 1000 employees and more (rather than 99 and less) have a positive effect on the probability of being

evaluated with a p-value of 0.0140. There are 5 industry sectors with significative and positive effects on the probability of being evaluated: *pharmaceutical, perfumes, and cleaning products* with a p-value<0.0001; *chemicals, rubber, and plastic products* with a p-value of 0.0166, *electrical and electronic equipment* with a p-value of 0.0433, *electrical and electronic components* with a p-value of 0.0271; and *shipbuilding, aircraft, and railway* with a p-value of 0.0814.
There is only one other variable with a significative effect on the probability of being evaluated. It is the I*SO 9001, ISO 9002, EAQF Certification* which have a positive effect on this probability. Its p-value is 0.0034.

In the case of team workers the socio-demographic characteristics with significatives effects on the probability of being evaluated are not the same than those in the case of individual workers. Indeed, for team workers it is a second level of education, and a third level of education (rather than " with no degree") which increases the probability of being evaluated with p-values respectively of respectively 0.06, and 0.04. Among the general characteristics of the firm a firm size of 500 to 999 employees (rather than 99 and less) have a positive effect on the probability of being evaluated with a p-value of 0.0007. There are 3 industry sectors having a significative effect on the probability of being evaluated: *printing, press, publishing* (p-value of 0.0577); *chemicals, rubber, and plastic products* (p-value of 0.0091); *pharmaceutical, perfumes, and cleaning products* (p-value of 0.0006); *shipbuilding, aircraft, and railway* (p-value of 0.00915). The first and latest of these sectors have a negative effect on the probability of being evaluated while as in the case of individual workers the other two sectors have a positive effect.
A firm computerization intensity of 2 and of 3 have a postitive and significative effect on the probability of being evaluated with p-values of respectively, 0.0786 and 0.0320. There are also two organizational practices of the firm which have both a positive effect on the probability of being evaluated. The first is the *ISO 9001, ISO 9002, EAQF Certification* (p-value of 0.0108), and the second the 5*S method or Total Productive Maintenance(TPM) method* (p-value of 0.0086). Finally, a share of production workers participating in problem solving groups of respectively "10% to 50%" and "50% and more" have a positive and significative effect on the probability of being evaluated with p-values of respectively 0.0122 and 0.0166.

Propensity score results in the case of individual production

The first estimate we have to consider is that of C_1 since it measures an average treatment effect in the usual sense (that is over the treated population). In this case we find that all the effects are positive but that the only significatives ones, for a level lesser than 10%, are the effect on the variable *employee's proposition to improve the work process* which is significative at the 1% level, and the effect on the variable *employee's ability to predict his wage* which is also significative at the 1% level. Hence the first result go in the sense of prediction 1, and the second result in the sense of prediction 3. Moreover the fact that the effect on the two other variables measuring effort is no longer significative but that it remains positive, indicates that there is high selection effect, although it is impossible with our methodology to say what in this selection effect is due to the desutility of effort.

The estimation of C and C_0 gives effects that are all positive. And they are significative for the following variables: *working more than ordinarily* (significative at the 10% level), *employee's proposition to improve the work process* (significative at the 1% level), *Employee's effort* (significative at the 5% level), and *Employee's ability to predict his wage* (significative at the 1% level).

Table 4.5: Propensity score estimates of average treatments effects (ATE) for individual workers

	estimates	std[a]	student
global ATE (C)			
Working more than ordinarily	0.057959	0.030	1.77354
Employee's propositions to improve the work process	0.11393	0.033	3.45566
Employee's effort	0.039254	0.017	2.15004
Annual net wage	143.002	380.032	0.52957
Annual net wage in logarithm	0.012790	0.022	0.80632
Employee's ability to predict his wage	0.14785	0.020	7.22552
ATE on evaluated workers (C_1)			
Working more than ordinarily	0.056438	0.032	1.52169
Employee's proposition to improve the work process	0.094715	0.033	2.85082
Employee's effort	0.033579	0.628	0.29807
Annual net wage	298.586	427.125	0.77281
Annual net wage in logarithm	0.022008	0.023	1.08989
Employee's ability to predict his wage	0.14863	0.021	6.96854
ATE on non evaluated workers (C_0)			
Working more than ordinarily	0.058587	0.031	1.74328
Employee's proposition to improve the work process	0.12186	0.035	3.46067
Employee's effort	0.041596	0.019	2.14896
Annual net wage	78.7760	394.627	0.37427
Annual net wage in logarithm	.008985076	0.024	0.62366
Employee's ability to predict his wage	0.14753	0.021	6.82398

[a] Standard deviation is computed using bootstrap with 300 simulations
Support over 300 simulations: $min = 1352$; $max = 1501$; $mean = 1426.48$

Propensity score results in the case of team production

In the case of C_1 all the effects are positive and outside the case of the variable *Working more than ordinarily* these effects are significative. More precisely, the effects on the variables *Employee's propositions to improve the work process*, *Employee's effort*, and *Employee's ability to predict his wage* are significative at the 1% level, and the effects on the *Annual net wage* and on the *Annual net wage in logarithm* are significative at the 5% level. Hence these results go in the sense of prediction 1, 3, and 4. And we can also observe that the effects are lesser than those obtained by average difference indicating that there is a selection effect.

In the case of C and C_0 the previous effects are also observed. However, in these two cases the effect on the variable *Working more than ordinarily* is negative and for C_0, it is significative at the 1% level. Moreover in this latter case the effect on the *Annual net wage in logarithm* is no longer significative.

Table 4.6: Propensity score estimates of average treatments effects (ATE) for team workers

	estimates	std[a]	student
global ATE (C)			
Working more than ordinarily	-.001461069	0.030	0.20169
Employee's propositions to improve the work process	0.092088	0.028	3.06834
Employee's effort	0.064261	0.015	4.19518
Annual net wage	985.993	428.112	2.04036
Annual net wage in logarithm	0.041866	0.020	1.88218
Employee's ability to predict his wage	0.10508	0.019	5.57450
ATE on evaluated workers (C_1)			
Working more than ordinarily	.002398046	0.031	0.09683
Employee's proposition to improve the work process	0.10179	0.030	3.24448
Employee's effort	0.065878	0.016	4.35131
Annual net wage	1308.04	533.770	2.03018
Annual net wage in logarithm	0.057090	0.022	2.18520
Employee's ability to predict his wage	0.099549	0.020	5.07651
ATE on non evaluated workers (C_0)			
Working more than ordinarily	-.004679831	0.019	5.57450
Employee's proposition to improve the work process	0.083995	0.030	2.51172
Employee's effort	0.062912	0.016	3.64055
Annual net wage	717.382	401.551	1.74526
Annual net wage in logarithm	0.029168	0.021	1.36110
Employee's ability to predict his wage	0.10969	0.020	5.38851

[a] Standard deviation is computed using bootstrap with 300 simulations
Support over 300 simulations: $min = 1124$; $max = 1304$; $mean = 1229.03$

Before concluding let us consider the table 4.7 where C, C_1, and C_0 are ranked. In the case of individual production we observe that for all the variable measuring the employee's effort we have $C_0 > C > C_1$, while for the variables concerning wage and the *employee's ability to predict his wage* we have $C_1 > C > C_0$. Hence in the former case although the effect of the individual evaluation interview is positive it would be greater if it had concerned the whole population and the population of non evaluated workers. And in the latter case the effect of evaluation will be lesser over the whole population and the population of non evaluated workers than its effect over the population of evaluated workers.
In the case of team production outside the the case where C_1 and C_0 are negative and the effect on the *employee's ability to predict his wage*, we have $C_1 > C > C_0$.

Table 4.7: Ranking of estimates of C, C_1, and C_0

	Individual production	Team production
Working more than ordinarily	$C_0 > C > C_1$	$C > C_1 > C_0$ with C_1,$C_0 < 0$
Employee's propositions to improve the work process	$C_0 > C > C_1$	$C_1 > C > C_0$
Employee's effort	$C_0 > C > C_1$	$C_1 > C > C_0$
Annual net wage	$C_1 > C > C_0$	$C_1 > C > C_0$
Annual net wage in logarithm	$C_1 > C > C_0$	$C_1 > C > C_0$
Employee's ability to predict his wage	$C_1 > C > C_0$	$C_0 > C > C_1$

5 conclusion

In this paper we proposed a theoretical framework based on a Principal-Agent model with subjective evaluation of effort through an individual interview. It allowed us to analyze the effects of the implemtation of an incentive mechanism with individual evaluation interview over the employee's level of effort, over his wage, and his beliefs regarding his wage. We derived four predictions. First, evaluation interviews have a positive impact on effort. Second, evaluation interviews increase the effort through two effects: the classical incentive effect and also a high selection effect. Third, evaluation interviews are associated with positive beliefs regarding wage and work recognition. Finally, evaluation interviews are associated with monetary gains for employees. The tests have been implemented using a propensity score methodology which allows to control for selections effects due to background characteristics. The effects of evaluation interview are weaker than those obtained without control of background characteristics indicating selection effects. Nonetheless in most cases, we get the predicted effects of evaluation interviews. In particular, the effect of evaluation interview on effort is positive and frequently significative, and the effect on beliefs regarding wage is always positive and significative. Finally we want to stress that the selection effect that we calculate is simply a proxy of the theoretical selection effect set in sections 2 and 3 (according to the latter, firms which implement evaluation interviews attract people whose desutility of effort is the weaker).

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Appendix 1: Variables constructed from the labor force section of the COI survey

A. Measures of Collective Work.

Measure 1: Teamwork

This measure is associated to the question asked to the employees: "Do you sometimes do your work in group or collectively?"
Responses are either "yes" or "no".

Measure 2: Time spent in teamwork

This measure is constructed from the question asked to employees: "How much of your working time does work in group or collectively takes?
Almost all the time,
more than a quarter of your time,
less than a quarter of your time".

Measure 3: Communication in the firm

This measure is constructed from the following 4 questions asked to the employees: "Apart from your superiors, are there other persons that give you indications on what you have to do? (responses are either "yes" or "no", or it does not apply)
(1) "Colleagues you usually work with?"
(2) "Other persons or departments in the firm?"
"Apart from your subordinates do you give indications to other persons on what they have to do? (responses are either "yes" or "no", or it does not apply)
(3) "Colleagues you usually work with?"
(4) "Other persons or departments in the firm?"
Then a "Weak" communication corresponds to only 0 or only 1 answer "yes" among these 4 questions, and a "Strong" communication to at least 2 answers "yes" among the 4 questions.

Measure 4: Benefit from others' help

The measure is constructed from the following 3 questions asked to the employees: "If you have a temporary excess workload or if you are uneasy with a difficult task are you helped by..." (responses are either "yes" or "no", or it does not apply)
(1) "Your superiors?"
(2) "Colleagues you usually work with?"
(3) "Other persons or departments in the firm?"
Then a "Weak" benefit from others' help corresponds to 0 or only 1 answer "yes" and a "Strong" benefit from others' help at least 2 answers "yes" among the 3 questions.

Measure 5: Participation into meetings

The measure is constructed from the question asked to the employees: "How frequently do you participate into meetings in the context of your work? (at least once a year)
Then a "Weak" participation into meetings corresponds to 0 or only one meeting a year and a "Strong" participation into meetings corresponds to at least 2 meetings a year.

B. Employee's effort.

This variable is built from the answers to the followings 5 questions asked to the whole sample of employees:

(1) "do you work more than ordinarily?" (response is either "yes" or "no");
(2) "do you work less than ordinarily?" (responses is either "yes" or "no" or it does not apply);
(3) "do you work more than ordinarily for personals reasons?" (responses is either "yes" or "no" or it does not apply);
(4) "do you work less than ordinarily for personals reasons?" (responses is either "yes" or "no" or it does not apply);
(5) "do you do propositions in order to improve the work process?" (response is either "yes" or "no").

Employee's effort is then the ratio the number of "yes" given to these 5 questions to the number of questions where the employee answered "yes" or "no".

C. Employee's ability to predict his wage

This variable is built from the answers to the 8 questions asked to whole sample of employees: "Which elements have an influence on your wage or on your promotion"? (for each element response is either "yes" or "no" or it does not apply):

(1) to do a high-quality work;
(2) to carry assignments to the letter;
(3) to be in good terms with the boss (bosses);
(4) to be in good terms with the colleague(s),
(5) To take up training courses,
(6) to learn how to use new technologies;
(7) The firm's performances;
(8) other reasons.

Employee's ability to predict his wage is then the ratio of number of "yes" given to these 8 questions to the number of questions where the employee answered "yes" or "no".

Appendix 2: Variables constructed from the Firm section of the COI survey

A. Firms' computerization intensity

This variable in constructed from the question near to the firms:
"did/do your firm realize/ realized data transfers by means a computer interface" (responses are either "yes" or "no"):

(1) "within the management service?"
(2) "between management and production service?"
(3) "between management and suppliers, subcontractors?"
(4) "between management and client firms?"
(5) "between management et social organisms public power?"
(6) "between conception services and production ?"
(7) "between conception and suppliers, subcontractors?"
(8) "Within the production services or between manufacture unities?"
(9) "between production and suppliers, subcontractors?"
(10) " between production and client firms?"

Then intensity 1 corresponds to 0 or 1 "yes"; intensity 2 corresponds to 2 or 3 "yes"; intensity 3 corresponds to 4 or 5 "yes"; and intensity 4 corresponds to 5 or more than 5 "yes". Reference is then intensity 1.

B. Average number of task each type of individual is responsible for (NMT)

This variable is constructed from the question asked to the firms: "In general who is/was authorized in 1997 to...(more than 1 answer possible among Management/Production Worker/Specialist)":

(1) adjust installations;
(2) perform first level maintenance;
(3) allocate tasks to production workers;
(4) inspect quality of supplies;
(5) inspect quality of production;
(6) participate in performance improvements;
(7) participate in project teams;
(8) stop production in case of an incident;
(9) troubleshoot in case of an incident;
(10) start production again in case of an incident.

The qualitative variable NMT with 4 items is constructed as follows:

$NMT \geq 1.7$ (joint responsibility of indirect task)
$1.4 \leq NMT < 1.7$ (medium sharing of responsibility)
$1 < NMT \leq 1.4$ (low sharing of responsibility)
$NTM \leq 1$ (disjoined responsibilities).

And reference is $NTM \leq 1$.

Appendix 3: Logistic regression results for the binary outcome "Evaluated/Not evaluated"

A. The case of individual production.

Parameter	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	-2.0329	0.3485	34.0305	<.0001
Socio-demographic characteristics of the employee				
•Gender[a]	-0.2524	0.1519	2.7595	0.0967
•Age[b] :				
15 to 24	-0.1760	0.4762	0.1366	0.7116
25 to 39	-0.0446	0.1963	0.0515	0.8205
40 to 49	0.2130	0.1865	1.3044	0.2534
•Years in the firm[c] :				
1 to 2	0.6301	0.2374	7.0452	0.0079
3 to 6	0.2496	0.1952	1.6355	0.2010
7 to 10	0.3229	0.1756	3.3827	0.0659
•Level of education[d]:				
Vocational training (CAP and BEP)	-0.0175	0.1503	0.0135	0.9074
Second level education (BAC)	-0.0885	0.2581	0.1177	0.7316
Third level education	-0.0496	0.2607	0.0363	0.8489
•Professional type[e]:				
Executives	0.6554	0.3603	3.3089	0.0689
Middle management	0.7697	0.2356	10.6728	0.0011
Clerk	0.3463	0.2461	1.9801	0.1594
Skilled blue collar	-0.0568	0.1670	0.1156	0.7339
General characteristics of the firm				
•Firm size[f]:				
100 to 499	-0.0328	0.1744	0.0355	0.8506
500 to 999	0.0294	0.2264	0.0168	0.8968
1000 and more	0.6202	0.2525	6.0334	0.0140
•Industry sector[g]:				
Mineral products	0.4561	0.3481	1.7165	0.1901
Textile	0.4668	0.3269	2.0391	0.1533
Clothing and leather	-0.2872	0.4127	0.4845	0.4864
Wood and paper	0.1410	0.3348	0.1773	0.6737
Printing, press, publishing	0.2648	0.3902	0.4605	0.4974
Production of propellants and fuels	1.0360	1.4831	0.4880	0.4848
Chemicals, rubber, and plastic products	0.6593	0.2753	5.7342	0.0166
Pharmaceutical, perfumes, and cleaning products	1.7797	0.3673	23.4742	<.0001
Foundry and metal work products	-0.0104	0.2843	0.0013	0.9709
Mechanical engineering	0.1636	0.2718	0.3625	0.5471
Household equipment	0.0894	0.3122	0.0821	0.7745
Electrical and electronic equipment	0.9187	0.4546	4.0840	0.0433
Electrical and electronic components	0.6605	0.2988	4.8870	0.0271
Automobile	0.3523	0.3630	0.9420	0.3318
Shipbuilding, aircraft, and railway	0.6672	0.3829	3.0367	0.0814

[a] Reference is "men".
[b] Reference is "50 and more".
[c] Reference is "11 and more".
[d] Reference is "with no degree except CEP or BEPC".
[e] Reference is "unskilled blue collar".
[f] Reference is "99 and less".
[g] Reference is "food industries".

Appendix 3: Logistic regression results for the individual workers case

Parameter	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Firms' computerization intensity[h]				
intensity 2	0.0295	0.1914	0.0238	0.8773
intensity 3	0.1274	0.2034	0.3923	0.5311
intensity 4	0.0664	0.2266	0.0860	0.7694
Obstacles to the organizational changes				
Tensions between the services[i]	-0.2390	0.1760	1.8428	0.1746
Tensions with the shareholders[i]	0.0501	0.2123	0.0558	0.8133
Difficulties in the relations with the other firms[i]	0.0393	0.1899	0.0429	0.8359
Difficulties to school or to reclassify the staff[i]	-0.0221	0.1621	0.0186	0.8915
Non executive staff adaptations and establishment problems[i]	-0.0908	0.1751	0.2688	0.6041
Executive staff adaptations and establishment problems[i]	0.2754	0.1679	2.6886	0.1011
Clashes with the staff (petitions, strikes,...)[i]	-0.0970	0.2035	0.2271	0.6337
Use of new organizational devices				
ISO 9001, ISO 9002, EAQF Certification[j]	0.4734	0.1616	8.5854	0.0034
Other certification or total quality management[j]	0.0457	0.1394	0.1073	0.7432
Value analysis, functional analysis, or "AMDEC" method[j]	0.00832	0.1633	0.0026	0.9593
5S method or Total Productive Maintenance (TPM) method[j]	0.2457	0.1768	1.9307	0.1647
Organization in profit centers[j]	0.1212	0.1398	0.7517	0.3859
Formal in-house customer/ supplier contracts[j]	0.0257	0.1402	0.0335	0.8547
System of "Just in time" delivery[j]	0.1323	0.1786	0.5483	0.4590
System of "Just in time" production[j]	-0.0757	0.1793	0.1785	0.6727
Evolution in hierarchical layers between 1994 and 1997[k]				
1 and more	-0.0725	0.2648	0.0750	0.7842
-1	-0.1617	0.1748	0.8556	0.3550
-2 and less	0.1750	0.2874	0.3707	0.5426
Team work				
•Share of production workers participating in self managed teams[l]:				
10% to 50%	-0.1373	0.1965	0.4879	0.4849
50% and more	0.1451	0.2585	0.3149	0.5747
•Share of production workers participating in problem solving groups[l]:				
10% to 50%	0.3005	0.1927	2.4314	0.1189
50% and more	0.5594	0.3928	2.0281	0.1544
• Share of production workers participating in project teams[l]:				
10% to 50%	0.1398	0.1958	0.5101	0.4751
50% and more	-0.9496	0.5843	2.6415	0.1041
•Share of others workers participating in self managed teams[l]:				
10% to 50%	0.1439	0.2051	0.4921	0.4830
50% and more	-0.1158	0.3478	0.1108	0.7392

[h] Reference is "intensity 1". See A. of appendix 2 for the construction of this variable.
[i] The variable is equal to 1 when the firms states that such an obstacle has been either "quite important", or "important", or "very important", and 0 when she states that it has been "unimportant".
[j] Response is either "yes" or "no".
[k] Reference is "0".
[l] Reference 10 % and less.

Appendix 3: Logistic regression results for the individual workers case

Parameter	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
•Share of others workers participating in problem solving groups[l]:				
10% to 50%	-0.1922	0.2010	0.9143	0.3390
50% and more	-0.0789	0.3770	0.0438	0.8343
•Share of others workers participating in project teams[l]:				
10% to 50%	-0.2005	0.1941	1.0673	0.3016
50% and more	0.3645	0.3384	1.1598	0.2815
•Who is/was authorized in 1997 to participate in project teams?:				
Management[m]	-0.2209	0.1608	1.8877	0.1695
Production worker[m]	0.0596	0.1448	0.1694	0.6806
Specialist[m]	-0.2073	0.1627	1.6232	0.2027
•Average number of task each type of individual is responsible for[n]:				
1.1 to 1.4	-0.0469	0.1864	0.0635	0.8011
1.5 to 1.7	0.1619	0.2226	0.5292	0.4669
1.8 and more	0.3439	0.2386	2.0764	0.1496

[l] Reference 10 % and less.
[m] Response is either "yes" or "no".
[n] Reference is ≤ 1. See B. of appendix 2 for the construction of the variable.

B. The case of team production.

Parameter	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	-1.7432	0.3745	21.6633	<.0001
Socio-demographic characteristics of the employee				
•Gender[a]	-0.1403	0.1523	0.8481	0.3571
•Age[b]:				
15 to 24	0.5015	0.4257	1.3880	0.2387
25 to 39	0.2781	0.2295	1.4691	0.2255
40 to 49	0.2781	0.2295	1.4691	0.2255
•Years in the firm[c]:				
1 to 2	-0.2096	0.2443	0.7363	0.3908
3 to 6	0.1818	0.1820	0.9972	0.3180
7 to 10	0.0170	0.1730	0.0097	0.9217
•Level of education[d]:				
Vocational training (CAP and BEP)	0.1829	0.1567	1.3621	0.2432
Second level education (BAC)	0.4481	0.2421	3.4263	0.0642
Third level education	0.5279	0.2645	3.9823	0.0460
•Professional type[e]:				
Executives	0.5416	0.3485	2.4147	0.1202
Middle management	0.1200	0.2284	0.2761	0.5993
Clerk	-0.0121	0.2972	0.0017	0.9675
Skilled blue collar	-0.1469	0.1743	0.7101	0.3994
General characteristics of the firm				
•Firm size[f]:				
100 to 499	0.3510	0.1765	3.9524	0.0468
500 to 999	0.7059	0.2080	11.5179	0.0007
1000 and more	0.1941	0.2422	0.6426	0.4228
•Industry sector[g]:				
Mineral products	-0.2853	0.3202	0.7942	0.3728
Textile	0.3355	0.4096	0.6708	0.4128
Clothing and leather	-0.1220	0.3734	0.1068	0.7439
Wood and paper	-0.4769	0.3661	1.6974	0.1926
Printing, press, publishing	-0.8333	0.4390	3.6032	0.0577
Production of propellants and fuels	1.2745	0.9040	1.9877	0.1586
Chemicals, rubber, and plastic products	0.6759	0.2593	6.7962	0.0091
Pharmaceutical, perfumes, and cleaning products	1.2302	0.3578	11.8237	0.0006
Foundry and metal work products	-0.2956	0.2752	1.1535	0.2828
Mechanical engineering	-0.0338	0.2637	0.0164	0.8980
Household equipment	0.1161	0.3083	0.1418	0.7065
Electrical and electronic equipment	0.3344	0.3679	0.8263	0.3633
Electrical and electronic components	0.1719	0.2950	0.3396	0.5601
Automobile	-0.2314	0.3329	0.4832	0.4870
Shipbuilding, aircraft, and railway	-0.6255	0.3706	2.8479	0.0915

[a] Reference is "men".
[b] Reference is "50 and more".
[c] Reference is "11 and more".
[d] Reference is "with no degree except CEP or BEPC".
[e] Reference is "unskilled blue collar".
[f] Reference is "99 and less".
[g] Reference is "food industries".

Appendix 3: Logistic regression results for the team workers case

Parameter	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Firms' computerization intensity[h]				
intensity 2	0.3321	0.1888	3.0940	0.0786
intensity 3	0.4203	0.1960	4.5997	0.0320
intensity 4	0.3323	0.2140	2.4118	0.1204
Obstacles to the organizational changes				
Tensions between the services[i]	-0.0540	0.1773	0.0927	0.7608
Tensions with the shareholders[i]	-0.2445	0.2312	1.1179	0.2904
Difficulties in the relations with the other firms[i]	-0.0976	0.1999	0.2382	0.6255
Difficulties to school or to reclassify the staff[i]	0.0598	0.1538	0.1513	0.6973
Non executive staff adaptations and establishment problems[i]	0.0411	0.1639	0.0629	0.8020
Executive staff adaptations and establishment problems[i]	0.1569	0.1589	0.9750	0.3234
Clashes with the staff (petitions, strikes,...)[i]	-0.1195	0.1930	0.3833	0.5358
Use of new organizational devices				
ISO 9001, ISO 9002, EAQF Certification[j]	0.4089	0.1604	6.4964	0.0108
Other certification or total quality management[j]	0.1545	0.1389	1.2379	0.2659
Value analysis, functional analysis, or "AMDEC" method[j]	-0.0932	0.1582	0.3470	0.5558
5S method or Total Productive Maintenance (TPM) method[j]	0.4285	0.1631	6.8979	0.0086
Organization in profit centers[j]	0.1763	0.1351	1.7015	0.1921
Formal in-house customer/ supplier contracts[j]	0.1045	0.1380	0.5728	0.4492
System of "Just in time" delivery[j]	-0.3277	0.1778	3.3980	0.0653
System of "Just in time" production[j]	0.1577	0.1781	0.7846	0.3757
Evolution in hierarchical layers between 1994 and 1997[k]				
1 and more	-0.0279	0.2610	0.0114	0.9150
-1	-0.0204	0.1629	0.0156	0.9005
-2 and less	-0.3818	0.2959	1.6652	0.1969
Team work				
•Share of production workers participating in self managed teams[l]:				
10% to 50%	0.0247	0.1780	0.0193	0.8895
50% and more	0.0651	0.2613	0.0620	0.8033
•Share of production workers participating in problem solving groups[l]:				
10% to 50%	0.4672	0.1863	6.2869	0.0122
50% and more	0.8599	0.3590	5.7362	0.0166
• Share of production workers participating in project teams[l]:				
10% to 50%	-0.0944	0.1838	0.2640	0.6074
50% and more	-0.0239	0.4492	0.0028	0.9575
•Share of others workers participating in self managed teams[l]:				
10% to 50%	-0.3616	0.1983	3.3244	0.0683
50% and more	-0.2979	0.3314	0.8082	0.3687

[h] Reference is "intensity 1". See A. of appendix 2 for the construction of this variable.
[i] The variable is equal to 1 when the firms states that such an obstacle has been either "quite important", or "important", or "very important", and 0 when she states that it has been "unimportant".
[j] Response is either "yes" or "no".
[k] Reference is "0".
[l] Reference 10 % and less.

Appendix 3: Logistic regression results for the team workers case

Parameter	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
•Share of others workers participating in problem solving groups[l]:				
10% to 50%	0.1016	0.2065	0.2419	0.6229
50% and more	0.2644	0.3815	0.4801	0.4884
•Share of others workers participating in project teams[l]:				
10% to 50%	0.1084	0.1851	0.3428	0.5582
50% and more	0.0786	0.3393	0.0537	0.8168
•Who is/was authorized in 1997 to participate in project teams?				
Management[m]	-0.3374	0.1701	3.9368	0.0472
Production worker[m]	-0.1134	0.1475	0.5912	0.4420
Specialist[m]	0.1610	0.1591	1.0239	0.3116
•Average number of task each type of individual is responsible for[n]:				
1.1 to 1.4	0.0988	0.1917	0.2656	0.6063
1.5 to 1.7	0.1538	0.2221	0.4796	0.4886
1.8 and more	-0.1319	0.2414	0.2984	0.5849

[l] Reference 10 % and less.
[m] Response is either "yes" or "no".
[n] Reference is ≤ 1. See B. of appendix 2 for the construction of the variable.