E C O N O M I C S   B U L L E T I N

A theoretical framework for incentives in the public sector

Laurent Franckx
Royal Military Academy of Belgium

Isabelle Brose
Royal Military Academy of Belgium

Abstract

This note considers the provision of incentives in public organizations that face the following three constraints. First, no lateral entry is possible. Second, the outside opportunities of bureaucrats are independent of their performance. Third, the organization cannot design incentive schemes with stochastic wage bills. In our incentive scheme., the organization contains three jobs. Every period, the organization recruits two agents for the ``field" jobs. At the end of the period, one agent is put in retirement and the other is promoted to the ``executive" job. An agent will be promoted if he has obtained the highest performance on the managerial aspects of the ``field" job, and has passed an endogenous standard of performance on the technical aspects of this ``field" job. This system (1) provides incentives for optimal efforts in the ``field" job AND (2) improves on a purely random allocation system of the "executive". There are problems of time consistency, though.

We would like to thank Thiery Boschman for useful suggestions.
Citation: Franckx, Laurent and Isabelle Brose, (2004) "A theoretical framework for incentives in the public sector." *Economics Bulletin*, Vol. 10, No. 2 pp. 1−8
Submitted: April 5, 2004. **Accepted:** April 8, 2004.
URL: http://www.economicsbulletin.com/2004/volume10/EB−04J40002A.pdf

1 Introduction

This paper is concerned with the provision of incentives in the subset of public organizations that face the following three constraints.

First, the "executive" levels[1] in the hierarchy can only be occupied by people with previous experience as "field managers". Thus, no lateral entry is possible.

Second, because of the specificity of the tasks executed "on the field", the outside opportunities of bureaucrats are independent of their performance as "field manager" (see Williamson [19, p. 326]).

Third, the organization faces a fixed budget, and can therefore not design incentive schemes such that the total wage bill depends stochastically on performance.

As suggested by Rose-Ackerman [18], this third constraint implies that incentives should be provided by the prospect of promotion to a better paid job inside a predetermined hierarchical structure.

We will therefore propose the following incentive scheme. The organization contains three jobs: one "executive" job, and two "field" jobs. Every period, the organization recruits two agents for the "field" jobs. At the end of the period, one agent is put in retirement and the other is promoted to the "executive" job (and the agent who previously held this post is now put in retirement). An agent will be promoted if he has obtained the highest performance on the managerial aspects of the "field" job, and has passed some endogenous standard of minimal performance on the technical aspects of this "field" job (in a sense to be made precise below).

We will show below that the system we describe here (1) provides the necessary incentives for optimal efforts in the "field" job AND (2) reveals a signal of the agents' ability as "executives" and therefore improves on a purely random promotion system.

We have thus an incentive scheme that is, on the one hand, purely intern to the organization and that, on the other hand, takes into account the problem of the organization's hierarchy - neither "pure" tournament theory nor "pure" career concern models allow to tackle both problems simultaneously (see Burgess and Metcalfe [3, p. 26]).

2 The model

Let the "executive" job be denoted by H, and the two "field" jobs by L. Let the agents be labeled $i = 1, 2$. In his "field" job, agent i executes two types of tasks, a managerial (denoted M) and a technical (denoted T). Let the tasks be labeled $j = M, T$.

The effort devoted on each task j, $a_{ij} \geq 0$, is unobservable.

However, at the end of the period, the organization observes a signal α_{iT} for the technical task:

[1] Following the terminology used in Wilson's classic work on bureaucracy [20], this refers to the top levels in the hierarchy.

$$\alpha_{iT} = a_{iT} + \theta_{iT} \tag{1}$$

θ_{iT} is a stochastic variable, which can reflect both measurement errors and fundamental differences in abilities across the agents - this distinction does not matter for the technical task. We will assume that it is possible to measure performance on the technical task according to a cardinal scale, and that θ_{iT} has a density that is defined for $\theta_{iT} > 0$ only. Therefore, it is impossible to observe $\alpha_{iT} < 0$. θ_{1T} and θ_{2T} are distributed independently.

Similarly, at the end of the period, the organization observes signals α_{iM} for the managerial task:

$$\alpha_{iM} = a_{iM} + \eta_{iM} + \epsilon_{iM} \tag{2}$$

We assume that $\eta_{iM} \sim N(0, \sigma_\eta^2)$ and that $\epsilon_{iM} \sim N(0, \sigma_\epsilon^2)$. Thus, both terms are distributed identically across agents. We also assume that η_{iM} and ϵ_{iM} are independent.

While ϵ_{iM} is a "pure noise" term, η_{iM} will be interpreted as a talent that is specific to the agent. Therefore, although it is unknown to the agents and the organization before effort has been undertaken, it is assumed to remain constant after α_{iM} has been observed.

This interpretation of η_{iM} and ϵ_{iM} is coherent with what is usual in "career concern" models [1, 5, 9].

The organization pays a fixed wage w_H to the promoted agent.

The organization's benefits from the two jobs are separable.

If agent i gets promoted, then the organization's gross benefits from the "executive" job depend, on the one hand, on the agent's effort levels in period 2 and, on the other hand, on the agent's managerial talent η_{iM}. Effort in period 2 depends on a complex array of non-contractible terms (an agent's own beliefs and personal motivation, fear of public disclosure of possible incompetence, peer pressure, social conditioning in the first period, etc) and is left exogenous here.[2] Therefore, in the second period, we can denote the organization's gross benefits by $B_{PH}(\eta_{iM})$, and the organization's net payoff is: $B_{PH}(\eta_{iM}) - w_H$. Of course, we assume that $\frac{dB_{PH}}{d\eta_{iM}} > 0$.

The agent who gets promoted obtains net benefits $w_H + B_H(.)$ where B_H are the net non-monetary benefits he receives from the "executive" job; if he is put in retirement, he gets his total benefits B_r from leisure and pension payments. Following Meyers [13], the agent commits to accept a proposed promotion.

Let us now consider the "field" job. The organization's expected gross benefits from agent i's effort are : $B_{PL}\left(a_{iM}, a_{iT}\right)$. Again, we assume that the agents get a fixed wage w_L. The agents' gross benefit from effort in the "field" job is assumed to be independent of the agents' talent $B_L\left(a_{iM}, a_{iT}\right)$ - there is thus perfect *ex ante* symmetry between the agents.

To simplify notation, let $W_1 \equiv w_H + B_H$ and $W_2 \equiv B_r$. The expected discounted value of agent i's period 2 payoff is $\overline{W} \equiv \delta\left(P_i W_1 + (1 - P_i) W_2\right)$,

[2] This idea is now commonly accepted in models of bureaucratic behavior - see for instance Besley and Ghatak [2], Francois [7] and Williamson [19].

where P_i is the probability that agent i gets promoted and δ is the discount rate (assumed the same for all agents). We shall describe below the rules of the game that determine P_i.

As in Prendergast [17, p. 22] and conventional "career concern" models [5, 9], we assume that the agents are risk neutral in order to emphasize the behavioral responses.

For agent i, his expected payoffs at the beginning of his employment are :

$$B_i = w_L + B_L\left(a_{iM}, a_{iT}\right) + \delta\left(P_i W_1 + (1 - P_i) W_2\right). \tag{3}$$

Let us now specify the "rules of the game".

The organization compares the performance of the agents in their managerial task (thus, it holds a "tournament" with respect to this task). This type of incentive scheme is appropriate if the absolute levels of performance are not public information, and therefore not legally enforceable (see for instance Malcomson [12] for a detailed argument), which seems plausible for a rather vague task as "management".

However, the organization must also provide incentives for effort on the technical task. Therefore, in order to enter the tournament on the managerial task (subjective evaluation) and have a chance to get the "executive" job, agents must first perform well in the technical task. As performance in the technical task can be measured according to a cardinal scale, it is possible to contract upon the absolute value of performance. Therefore, to perform well means that $\alpha_{iT} \geq T^*$, where T^* is a performance standard determined by the organization.

Three cases are possible:

- Both agents perform well on the technical task: $\alpha_{1T} \geq T^*$ and $\alpha_{2T} \geq T^*$. Both agents enter the tournament on the managerial task and the agent with the highest value of α_{iM} wins the "executive" job.

- Both agents perform badly on the technical task: $\alpha_{1T} < T^*$ and $\alpha_{2T} < T^*$. As lateral entry is impossible and *somebody* must be promoted to the "executive" job, we assume that both agents will be allowed to enter the tournament on the managerial task to win the "executive" job. As the agents know the rule of the game, they can anticipate that the tournament is the same whether or not both of them meet the required T^*. As there is no repeated interaction between the agents, we can however safely assume that they cannot collude to fail to meet T^*.

- If one agent performs well and the other poorly, then there is no managerial tournament, and the organization promotes the agent i for whom $\alpha_{iT} \geq T^*$.

The organization is able to commit itself to this scheme.

Now note that: $P\left(\alpha_{iT} \geq T^*\right) = 1 - G_T\left(T^* - a_{iT}\right)$, where G_T is the cumulative distribution function of θ_{iT}. To simplify notation, let $G_{iT} = G_T\left(T^* - a_{iT}\right)$.

Similarly, $P(\alpha_{1M} > \alpha_{2M}) = G_M(a_{1M} - a_{2M})$, where G_M is the cumulative distribution function of $\eta_{2M} + \epsilon_{2M} - \eta_{1M} - \epsilon_{1M}$, which is normally distributed with zero mean and variance $\sigma_M^2 = 2\left(\sigma_\eta^2 + \sigma_\epsilon^2\right)$.

Hence,

$$P_1 = [1 - G_{1T}][1 - G_{2T}] G_M + G_{1T} G_{2T} G_M + [1 - G_{1T}] G_{2T}.$$

and $P_2 = 1 - P_1$.

3 The interaction between the agents

Let us first turn to the agents' problem. First note that all period 2 elements in the agents' payoff function are exogenous in this model. The only decision variables are the period 1 effort levels, which only affect period 2's payoffs through the probability of getting promoted.

Following the standard approach in moral hazard problems, we assume that the organization wants to induce a positive amount of effort. Therefore, we characterize the FOC for an interior solution (where $W = W_1 - W_2$):

$$\frac{\partial B_i}{\partial a_{ij}} = \delta \frac{\partial P_i}{\partial a_{ij}} W + \frac{\partial B_L(.)}{\partial a_{ij}} = 0. \tag{4}$$

Now note that (where $g_{iT} = \frac{\partial G_{iT}(.)}{\partial a_{iT}}$)

$$\frac{\partial P_1}{\partial a_{1T}} = g_{1T}\left[2G_{2T}G_M(.) - G_{2T} - G_M(.)\right] \tag{5}$$

$$\frac{\partial P_2}{\partial a_{2T}} = -g_{2T}\left[1 + 2G_{1T}G_M(.) - G_{1T} - G_M(.)\right] \tag{6}$$

and (where $g_{iM} = \frac{\partial G_M(a_{1M} - a_{2M})}{\partial a_{iM}} = (-1)^{i+1} \frac{1}{2\sqrt{\pi \sigma_M^2}} e^{-\frac{1}{2}\frac{(a_{1M} - a_{2M})^2}{2\sigma_M^2}}$):

$$\frac{\partial P_i}{\partial a_{iM}} = g_{iM}\left(1 + 2G_{1T}G_{2T} - G_{1T} - G_{2T}\right) \tag{7}$$

Suppose now that there exists a symmetric, interior Nash equilibrium between the agents: $a_{1j} = a_{2j} = a_j > 0$. If this is the case, then $G_M(a_{1M} - a_{2M}) = \frac{1}{2}$ and $G_T(T^* - a_{1T}) = G_T(T^* - a_{2T})$.

Substituting this in (5) and (6) yields $\frac{\partial P_i}{\partial a_T} = -\frac{1}{2} g_T$. Therefore, agent i's FOC (4) with respect to the technical task reduces to (where $b_T = \frac{\partial B_L(.)}{\partial a_T}$):

$$\frac{1}{2}\delta W g_T = -b_T \tag{8}$$

Similarly, (7) simplifies to: $\frac{\partial P_i}{\partial a_M} = g_{iM}\left(2G_T(G_T - 1) + 1\right)$ and the FOC with respect to the managerial task reduces to (where $b_M = \frac{\partial B_L(.)}{\partial a_M}$):

$$\delta W \frac{1}{2\sqrt{\pi\sigma_M^2}} \left(2G_T\left(G_T - 1\right) + 1\right) = -b_M \tag{9}$$

We shall assume here that the second order conditions for the agents are satisfied.

4 The optimal contract

Total expected surplus at the beginning of the game is

$$\sum_{i=1}^{2} \left[B_{PL}\left(a_{iM}, a_{iT}\right) + B_L\left(a_{iM}, a_{iT}\right)\right] + \delta\left(\frac{1}{2}\left[\sum_{i=1}^{2} B_{PH}(\eta_{iM}) + B_H\right] + B_r\right)$$

On the one hand, the FOCs for the first-best effort levels in the first period are given by: $\frac{\partial B_{PL}(.)}{\partial a_T} = -b_T$ and $\frac{\partial B_{PL}(.)}{\partial a_M} = -b_M$. On the other hand, the surplus in the second period does not depend on the effort levels in the first period, but only on the talent of the agent who gets selected. Given the symmetry of the problem, both agents face the same *ex ante* probability of getting promoted.

Therefore, the problem for the organization is: choose w_L, W_1, W_2 and T^* such that the organization's expected surplus is maximized, taking into account the agents' incentive compatibility and participation constraints.

As the agent's talent is organization-specific, we do not need to take into account his participation constraint in the second period, but only his prior participation constraint.

It is then absolutely straightforward to verify that W_1 and T^* can be chosen to induce the first-best effort levels, while w_L and W_2 will then be used to satisfy the participation constraint. This result should not surprise us: it has been shown before that with risk neutral agents, the first-best can be obtained, both with tournaments and with fixed standards (see Lazear and Rosen [11]).

Moreover, as the organization can anticipate the equilibrium levels of effort, it also knows the value of $\eta_{iM}+\epsilon_{iM}$ after the observation of α_{iM}. Following standard arguments on Bayesian inference (see for instance Johnston [10, p.512]), we see that: $E(\eta_{iM}|\alpha_{iM}, a_{iM}) = \frac{\frac{\alpha_{iM} - a_{iM}}{\sigma_\epsilon^2}}{\frac{1}{\sigma_\epsilon^2} + \frac{1}{\sigma_\eta^2}}$ and $var(\eta_{iM}|\alpha_{iM}, a_{iM}) = \frac{1}{\frac{1}{\sigma_\epsilon^2} + \frac{1}{\sigma_\eta^2}}$.

Therefore, in a symmetric equilibrium $E(\eta_{1M}|\alpha_{1M}, a_M) > E(\eta_{2M}|\alpha_{2M}, a_M)$ if and only if $\alpha_{1M} > \alpha_{2M}$.

This implies immediately:

Proposition 1 *If the principal can commit to his incentive scheme, then he can induce the first-best effort levels in both tasks in the "field" job. Moreover, if both agents pass (or fail) the performance test on the technical task, then he promotes the agent with the highest expected managerial ability, given the equilibrium strategies and observed performance.*

There are basically two possible problems with this scheme.

First, it is possible that the player with the highest *estimated* talent does not win the contest because he fails to pass the go/no go test. Therefore, we have a problem of time consistency: the organization might end up promoting the player with the lowest estimated talent.

Indeed, suppose that the organization cannot commit to its incentive scheme. Then, in the only subgame perfect equilibrium with symmetric strategies, the organization ignores the score on the technical task, promotes the agent with the highest performance on the managerial task, and the agents undertake zero effort on the technical task.

However, as performance on the technical task is verifiable, there is a way to circumvent this problem: the establishment of independent administrative courts. If the organization does not fulfill its commitments, then a disadvantaged agent can always sue the organization. Thus, administrative courts can be used as commitment devices.

Taking into account the symmetry of the problem, the *ex ante* probability that the organization would like to deviate from its commitment is $\pi = [1 - G_T] G_T$. It is again straightforward to verify that the value of the performance standard that minimizes π, taking into account the agents' incentive compatibility constraints, is $T^* = 0$: let both agents always enter the managerial tournament. As $T^* = 0$ will, in general, not induce the first-best effort levels, this shows clearly the conflict between providing incentives and minimizing the risk of promoting the wrong agent.

This problem could of course be solved if "passing the test" on the technical task would be rewarded with a premium in the second period, but without interfering with the tournament on the managerial task. However, this would again introduce stochasticity in the total wage bill for the organization.

Second, it is still possible that the organization does not promote the agent with the highest talent. Let the probability of promoting agent 1 while agent 2 has the highest managerial talent be denoted by $P(1|\hat{2})$.

If no managerial tournament takes place, then $P(1|\hat{2})$ is simply the prior $\frac{1}{2}$.

If the managerial tournament does take place, then, given the equilibrium strategies: $P(1|\hat{2}) = P(\eta_{1M} + \epsilon_{1M} > \eta_{2M} + \epsilon_{2M} | \eta_{2M} > \eta_{1M})$. Let $\eta = \eta_{1M} - \eta_{2M}$; this is normally distributed with zero mean and variance $2\sigma_\eta^2$. Let $\epsilon = \epsilon_{1M} - \epsilon_{2M}$; this is normally distributed with zero mean and variance $2\sigma_\epsilon^2$. Then $P(1|\hat{2}) = \frac{P(0>\eta, \epsilon>-\eta)}{P(0>\eta)}$.

As $P(0 > \eta) = \frac{1}{2}$, we obtain that (using the normality and independence of ϵ and η):

$$P(1|\hat{2}) = 2P(0 > \eta, \epsilon > -\eta) = 2 \int_{-\infty}^{0} \left(\int_{-\eta}^{\infty} \frac{1}{2\pi\sqrt{2\sigma_\eta^2 2\sigma_\epsilon^2}} e^{-\frac{1}{2}\left(\frac{\eta^2}{2\sigma_\eta^2} + \frac{\epsilon^2}{2\sigma_\epsilon^2}\right)} d\epsilon \right) d\eta.$$

Let $\frac{\eta}{\sqrt{2}\sigma_\eta} = \rho \cos \vartheta$ and $\frac{\epsilon}{\sqrt{2}\sigma_\epsilon} = \rho \sin \vartheta$. Then

$$P(1|\hat{2}) = \frac{1}{\pi 2 \sigma_\eta \sigma_\epsilon} \int_{\frac{\pi}{2}}^{\pi - \arctan \frac{\sigma_\eta}{\sigma_\epsilon}} \left(\int_0^\infty e^{-\frac{1}{2}\rho^2} \begin{vmatrix} \sqrt{2}\sigma_\eta \cos \vartheta & -\sqrt{2}\sigma_\eta \rho \sin \vartheta \\ \sqrt{2}\sigma_\epsilon \sin \vartheta & \sqrt{2}\sigma_\epsilon \rho \cos \vartheta \end{vmatrix} d\rho \right) d\vartheta,$$

which further simplifies to: $P(1|\hat{2}) = \frac{1}{\pi} \int_{\frac{\pi}{2}}^{\pi - \arctan \frac{\sigma_\eta}{\sigma_\epsilon}} \left(\int_0^\infty e^{-\frac{1}{2}\rho^2} \rho d\rho \right) d\vartheta$ or: $\frac{\pi - 2 \arctan \frac{\sigma_\eta}{\sigma_\epsilon}}{2\pi}$.

Therefore, for any value of σ_η, $\frac{\partial P(1|\hat{2}))}{\partial \sigma_\epsilon} > 0$, $\frac{\partial^2 P(1|\hat{2})}{\partial (\sigma_\epsilon)^2} < 0$ and $\lim_{\sigma_\epsilon \to \infty} P(1|\hat{2}) = \frac{1}{4}$. This is illustrated in Figure (1).

Therefore:

Proposition 2 *The probability that the least talented agent gets promoted increases in the variance of the "pure noise" term, and decreases in the variance of the "hidden talent". However, this probability is always lower than with a purely random promotion system.*

5 Areas for further research

We believe that the framework we have provided here is a more realistic description of the incentive issues public organizations face than either pure tournament or pure career concern models.

However, in order to arrive at further insights, several extensions are necessary.

First, following Lazear and Rosen's seminal comparison of piece rates, tournaments and fixed standards [11], we need to introduce prior differences in the characteristics of the agents. We need to investigate in particular what this implies with respect to the selection of public servants.

Second, public organizations sometimes do not even have the freedom to determine their wage structure. If this is the case, then their only instrument is the number of "executive" jobs compared to "field" jobs. However, our model considers an extremely simple hierarchy. In reality, there are also intermediate levels. Clearly, an increase in the number of intermediate layers increases the precision of the estimate of managerial ability (see Meyers [13]), but at a cost (for instance, an increase in the number of layers of communication). An organization must also decide how to structure itself, for instance according to functional or to regional lines.

Third, we have ignored the possibility of collusion (or, on the opposite, sabotage actions) between agents, or between different layers inside the hierarchy. Similarly, it could be useful to model the "social conditioning" that we have assumed exogenous.

Finally, even if no lateral entry is possible, it is possible that agents still have outside options that depend on their observed performance, at least if their tasks also contain aspects that are valuable outside the organization.

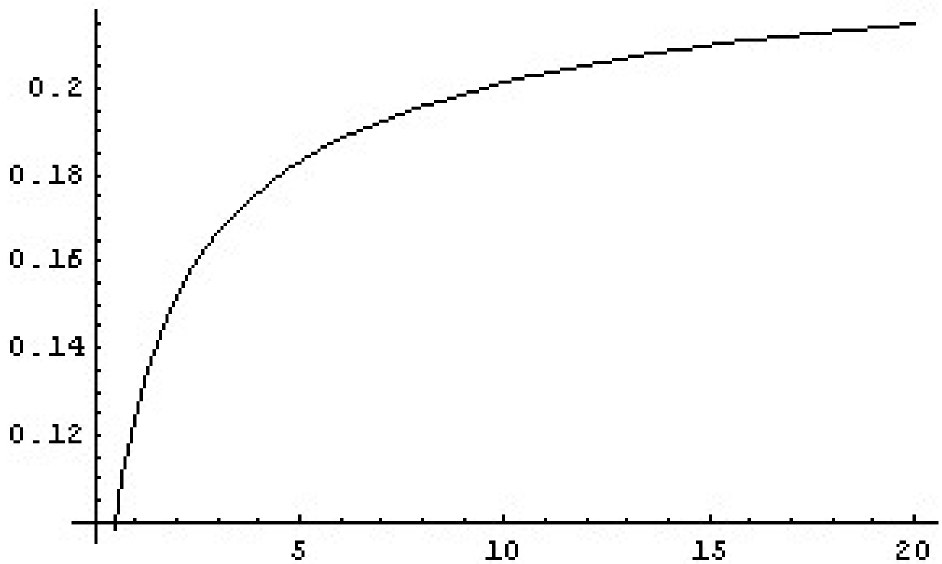

Figure 1: $P(0 > \eta, \eta + \epsilon > 0)$ for $2\sigma_\eta^2 = 1$ and $2\sigma_\epsilon^2 \in [0.5, 20]$

References

[1] Alesina, A. and Tabellini, G. (2004), Incentives in Markets, Firms and Governments, *CEPR Discussion Paper 4252*

[2] Besley, T. and Ghatak, M. (2003), Incentives, choice and accountability in the provision of public services, *IFS Working Papers W03/08*, Institute for Fiscal Studies

[3] Burgess, S. and Metcalfe, P. (1999), Incentives in organisations: A selective overview of the literature with application to the public sector, *CMPO Working Paper 99/016*

[4] Clark, D.J. and Riis, C. (2001), Rank Order Tournaments and Selection, *Journal of Economics*, Nr. 73, 2, pp.167-191.

[5] Dewatripont, M, Jewitt, I. and Tirole, J. (1999), The economics of career concerns, part I: comparing information structures, *Review of Economic Studies* 66, 183-198

[6] Dewatripont, M, Jewitt, I. and Tirole, J. (1999), The economics of career concerns, part II: application to missions and accountability of government agencies, *Review of Economic Studies* 66, 199-217

[7] Francois, P. (2000), 'Public service motivation' as an argument for government provision, *Journal of Public Economics*, 78, 275-299.

[8] Green, J.R., Stokey, N.L. (1983), A Comparison of Tournaments and Contracts, *Journal of Political Economy* 91, 349-364.

[9] Holmstrom, B (1999), Managerial incentive problems: a dynamic perspective, *The Review of Economic Studies*, 66 , 169-182

[10] Johnston, J. (1984), Econometric Methods, 3rd edition, McGraw Hill

[11] Lazear, E.P., Rosen, S. (1981), Rank Order Tournaments as Optimum Labor Contracts, *Journal of Political Economy* 89, 841-864.

[12] Malcomson, J.M. (1986), Rank-order contracts for a principal with many agents, *Review of Economic Studies*, vol. 53, pp. 807-817.

[13] Meyers, M. (1992), Biased Contests and Moral Hazard: Implications for Career Profiles, *Annales d'Economie et de Statisque*, 25-26, 166-187

[14] O'Keeffe, M. Viscusi, W. Zeckhauser, R. (1984), Economic contests : comparative reward schemes, *Journal of Labor Economics*, 2, n 1, pp. 27-56.

[15] Prendergast, C. (1992), Career development and specific human capital collection, *Journal of Japanese and International Economics*, 6, n 3, pp. 207-227.

[16] Prendergast, C. (1993), The role of promotion in inducing specific human capital aquisition, *Quarterly Journal of Economics*, 108, n 2, pp. 523-534

[17] Prendergast C. (1999) The Provision of Incentives in Firms, *Journal of Economic Literature* 37, 7-63.

[18] Rose-Ackerman, Susan (1986), Reforming Public Bureaucracy through Economic Incentives?, *Journal of Law, Economics and Organization*, 2, pp. 131-161

[19] Williamson, O.E. (1999), Public and Private Bureaucracies: A Transaction Cost Economics Perspective, *Journal of Law, Economics and Organisation*, 15, 306-342

[20] Wilson, J. Q. (1989), Bureaucracy: what government agencies do and why they do it, New York, Basic Books