Theoretical and Applied Economics
Volume XIX (2012), No. 5(570), pp. 5-18

Optimal Labor Contracts with Asymmetric Information and More than Two Types of Agent

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Abstract. *In the paper we discuss the optimal labor agreements between workers and firms in the situation of asymmetric information. Using a standard adverse selection model, we analyze the optimality of the labor contracts when it is the firm which has private information affecting the results of the contractual relationship. We propose an alternative procedure to solve the optimization problem, using the informational rents as variables. In the last part of the paper we derive and comment the features of the optimal labor contracts in asymmetric information.*

Keywords: optimal labor contract; incentives; adverse selection.

JEL Codes: D82, D86, L21, J41.
REL Codes: 7J, 12F, 17C.

1. Introduction

When firm hire workers, they have a lot of instruments to optimize the return on labor: bonuses, profit sharing, promotions etc. A remuneration schedule must be based on a set of verifiable results of the employee's activity. Hence, the features of labor contracts depend on whether or not these results are observable and verifiable and can be included in those contracts.

The theory of labor contracts started with the papers of Azariadis (1975), Baily (1974) and Gordon (1974), who presented models in which the workers performance is verifiable and explained the rigidity of real wages, but their models failed in explaining underemployment and unemployment.

Moving away from the classical situation of symmetric information, the theory of optimal labor contracts in asymmetric information was devoted, generally speaking, to solve the problem of risk sharing and optimal incentives. Azariadis (1983) proved that when entrepreneurs are better informed about the state of nature than are their workers, this private information generally results in a suboptimal allocation of both risk and worker's effort. Using different models, Green and Kahn (1983), Grossman and Hart (1983), Chari (1983) and Cooper (1983) assumed that workers cannot observe the values of some uncertain variables affecting the relationship; in such a situation the existence of asymmetric information generated some possible explanation for underemployment and involuntary unemployment. Hart (1983) showed that the Principal has an incentive to reveal the true state of nature if a long working time is linked to higher wages.

Ito (1989) extended the model of Grossman and Hart (1983) of optimal labor contracts in asymmetric information about firm's profitability and proposed a model allowing employment to vary over time. He described the impact of ex-post Pareto improving renegotiations on the optimal contract.

When both participants – employee and employer – have different risk aversions, Rosen (1985) and Malcomson (1999) analyzed the optimal risk sharing and pointed out that the workers remuneration and the firm's profit always vary in the same direction. Lazear (1986, 1999, 2000) analyzed the evolution of compensation schemes and the influence of financial incentives on the behavior and the performance of workers. Other authors (Fehr, Falk, 1999, Fehr, Schmidt, 2000) suggested that explicit incentives can also have counterproductive effects.

Recent developments concerning the problem of optimal labor contracts dealt with the design of incentive schemes in risk and uncertainty situations such as: the link between the consumption level and the design of optimal labor contracts (Postlewaite et al., 2008), the influence of incentive contracts on the total factor productivity (Bental, Demougin, 2006), incentives, promotions and tournaments (Kvaloy, Olsen, 2006, Gurtler, Krackel, 2010, Hart, Ma, 2010), incentives and multitasking (Schottner, 2008).

Our approach is somewhat similar with that described by Green and Kahn (1983). They analyzed the optimal labor agreements and the dependence of workers wages on employment when this level is completely controlled by the firms. The purpose of the present paper is to extend this analysis for the case where the firm having private information can have one of three types of profitability levels. We also propose an alternative procedure to solve the optimization problem, using the informational rents as variables.

The paper is organized as follows. In Section 2 we outline the basic assumptions used in the paper. In the next section the features of the optimal contracts in symmetric information are detailed. In Section 4 we define the optimization problem in the situation of asymmetric information and we propose a procedure to solve it. The Section 5 presents a full characterization of the optimal incentive contracts. The paper ends with the main conclusions and discusses some possible future developments.

2. The basic assumptions

Our approach is based on a standard Principal-Agent model, analyzed in both situations, symmetric and asymmetric information. We assume that one of the participants has private information about some characteristics affecting the results of the contractual agreement. This situation corresponds to an adverse selection problem.

In Green and Kahn (1983), the principal is represented by a union or a set of workers providing labor force to a firm. For simplicity, we consider a labor contract between one firm and one worker, the basic framework being the same with that of the cited authors.

The model is a monoperiod one, and the principal (the worker) has the preferences represented by the following utility function:

$$U(l,w)=u(w)-v(l)$$

where:

l is the labor force provided by the worker;

w is the wage paid by the employer (the firm);

$v(l)$ is the worker's disutility of providing l units of labor (working time).

Note that the principal's utility function is additive separable in wages and effort, and the functions $u(\cdot)$ and $v(\cdot)$ have the properties: $u' > 0, u'' < 0$ (the principal is risk averse) and $v' > 0, v'' > 0$ respectively.

The firm (the Agent) has the following objective function:

$$\Pi(l,w) = \theta f(l) - w$$

where:

$f(l)$ is the firm's revenues obtained by the firm using l units of labor, with $f' > 0, f'' < 0$;

θ represents an efficiency parameter characterizing the firm's technology (the profitability level) and is the firm's private information.

We also assume, with any loss of generality, that the Agent has an outside opportunity utility level $\underline{u} = 0$ (zero reservation utility).

The principal has all the bargaining power in determining the labor contract with the firm.

The economic contractual variables of the problem to be solved are then: the labor force l and the worker's wage w.

3. The optimal contract in symmetric information

In the situation of symmetric information, the Principal knows the firm's technology, here characterized by the efficiency parameter θ. The optimization problem to be solved is written as:

$$\max_{l,w} \left[u(w) - v(l) \right]$$

$$s.t.$$

$$\theta f(l) - w \geq 0$$

$$l \geq 0, w \geq 0$$

The Lagrangean for the above problem is:

$$L(l,w,\lambda) = u(w) - v(l) + \lambda \left[\theta f(l) - w \right]$$

The optimal solution (assuming an interior solution) satisfies the following first order conditions:

$$\frac{\partial L}{\partial l} = 0 \text{ or } -v'(l) + \lambda \theta f'(l) = 0 \quad (1)$$

$$\frac{\partial L}{\partial w} = 0 \text{ or } u'(w) - \lambda = 0 \quad (2)$$

$$\frac{\partial L}{\partial \lambda} = 0 \text{ or } \theta f(l) - w = 0 \quad (3)$$

We get from (2) that $\lambda = u'(w) > 0$ and hence the Agent's participation constraint is binding at the optimum.

Using the conditions (1) and (2), we get the features of the optimal contracts in the situation of symmetric information (the first best solution), denoted by (l^*, w^*):

- at the optimum, the firm (Agent) gets no more than his reservation utility level:

$$\theta f(l^*) - w^* = 0$$

So, the firm's technology is perfectly known by the Principal, he can extract the Agent's informational rent.

- at optimum, the marginal profit of the firm is equal to the worker's marginal rate of substitution, i.e.:

$$\theta f'(l^*) = \frac{v'(l^*)}{u'(w^*)}$$

Therefore, the resulting contract satisfies the Pareto efficiency condition.

4. The optimal contract in asymmetric information

Suppose now that the efficiency parameter θ describing the firm's technology is the firm's private information. Moreover, we consider that this parameter can take one of three possible values, $\theta \in \{\theta^G, \theta^M, \theta^B\}$, with $\theta^G > \theta^M > \theta^B$ and the corresponding probabilities are $P(\theta = \theta^i) = \pi^i, i = G, M, B$. We also have $\Delta\theta = \theta^G - \theta^M = \theta^M - \theta^B > 0$.

In this case the Principal offers a menu of contracts $\{(l^G, w^G), (l^M, w^M), (l^B, w^B)\}$, one for each type of Agent, hoping that each Agent will select the contract designed for him. The Principal's optimization problem is now:

$$\max_{l^G, w^G, l^M, w^M, l^B, w^B} \left\{ \pi^G \left[u(w^G) - v(l^G) \right] + \pi^M \left[u(w^M) - v(l^M) \right] + \pi^B \left[u(w^B) - v(l^B) \right] \right\}$$

with the following constraints:

▪ participation constraints:

$$\theta^G f\left(l^G\right) - w^G \geq 0 \tag{4}$$

$$\theta^M f\left(l^M\right) - w^M \geq 0 \tag{5}$$

$$\theta^B f\left(l^B\right) - w^B \geq 0 \tag{6}$$

▪ incentive compatibility constraints:

$$\theta^G f\left(l^G\right) - w^G \geq \theta^G f\left(l^M\right) - w^M \tag{7}$$

$$\theta^G f\left(l^G\right) - w^G \geq \theta^G f\left(l^B\right) - w^B \tag{8}$$

$$\theta^M f\left(l^M\right) - w^M \geq \theta^M f\left(l^B\right) - w^B \tag{9}$$

$$\theta^M f\left(l^M\right) - w^M \geq \theta^M f\left(l^G\right) - w^G \tag{10}$$

$$\theta^B f\left(l^B\right) - w^B \geq \theta^B f\left(l^M\right) - w^M \tag{11}$$

$$\theta^B f\left(l^B\right) - w^B \geq \theta^B f\left(l^G\right) - w^G \tag{12}$$

▪ sign constraints:

$$l^G \geq 0, w^G \geq 0, l^M \geq 0, w^M \geq 0, l^B \geq 0, w^B \geq 0$$

Definition. A menu of contracts $\left\{\left(l^G, w^G\right), \left(l^M, w^M\right), \left(l^B, w^B\right)\right\}$ is incentive feasible if it satisfies both sign constraints, participation constraints and incentive compatibility constraints (4)-(12).

The model transformed using the informational rents as variables

Let:

$$U^i = \theta^i f\left(l^i\right) - w^i, i = G, M, B$$

be the *informational rent* of the Agent having the profitability level θ^i.

With this change of variables, the participation constraints (4)-(6) become simple sign constraints:

$$U^G \geq 0 \tag{13}$$

$$U^M \geq 0 \tag{14}$$

$$U^B \geq 0 \tag{15}$$

The incentive compatibility constraint given by (7) can be rewritten as:

$$\theta^G f\left(l^G\right) - w^G \geq \theta^G f\left(l^M\right) - \theta^M f\left(l^M\right) + \theta^M f\left(l^M\right) - w^M$$
$$= \Delta\theta f\left(l^M\right) + \theta^M f\left(l^M\right) - w^M$$

or $U^G \geq U^M + \Delta\theta f\left(l^M\right)$ (16)

Similarly, the other incentive constraints are transfomed:

$$U^G \geq U^M + \Delta\theta f\left(l^M\right) \quad (16)$$

$$U^M \geq U^B + \Delta\theta f\left(l^B\right) \quad (17)$$

$$U^G \geq U^B + 2\Delta\theta f\left(l^B\right) \quad (18)$$

$$U^M \geq U^G - \Delta\theta f\left(l^G\right) \quad (19)$$

$$U^B \geq U^M - \Delta\theta f\left(l^M\right) \quad (20)$$

$$U^B \geq U^G - 2\Delta\theta f\left(l^G\right) \quad (21)$$

The objective function expressed in terms of informational rents and effort levels is given by:

$$\max_{\substack{l^G,U^G,l^M,\\ U^M,l^B,U^B}} F(\cdot) = \left\{\pi^G\left[u\left(\theta^G f(l^G) - U^G\right) - v\left(l^G\right)\right] + \pi^M\left[u\left(\theta^M f(l^M) - U^M\right) - v\left(l^M\right)\right] + \right.$$
$$\left. + \pi^B\left[u\left(\theta^B f(l^B) - U^B\right) - v\left(l^B\right)\right]\right\}$$

Due to the huge number of constraints, the new optimization problem, even simpler than the first one, is still complex. Before solving, we will try to reduce it. The next section presents a sequential procedure to determine which of the constraints are the relevant ones and relevant at the optimum.

Reducing the problem

Analyzing the participation constraints, only that one assigned to the least efficient technology is relevant. The following proposition states this result.

Proposition 1. If the constraint $U^B \geq 0$ is satisfied, then the constraints $U^M \geq 0$ and $U^G \geq 0$ are also true.

Proof

The upward local incentive constraints (17) and (18) together with $U^B \geq 0$ yield to:

$$U^M \geq U^B + \Delta\theta f\left(l^B\right) \geq \Delta\theta f\left(l^B\right) \geq 0$$

and,

$$U^G \geq U^B + 2\Delta\theta f\left(l^B\right) \geq 2\Delta\theta f\left(l^B\right) \geq 0$$

Note that if $l^B > 0$, then the constraints hold strictly.

The above result has a straightforward economic interpretation: if the Agent with the type B accepts the contract and the worker supplies labor (the labor is strictly positive), then the profit for the other types of firm, M or G, is positive; these types of firm get more than their reservation utility level.

Next, we state a well known result of the incentive theory, the *implementability condition*, which is used to compare the optimal values of the economic variable involved (the worker's effort).

Proposition 2. If the set of incentive feasible contracts is nonempty, then:

$l^G \ge l^M \ge l^B$ (*The Implementability condition CI*)

Proof

We use the upward local constraints and adding them we get:

- from $U^G \ge U^M + \Delta\theta f\left(l^M\right)$ and $U^M \ge U^G - \Delta\theta f\left(l^G\right)$ it follows that:

  $\Delta\theta f\left(l^G\right) \ge \Delta\theta f\left(l^M\right)$

  or $l^G \ge l^M$;
- in the same way, from $U^M \ge U^B + \Delta\theta f\left(l^B\right)$ and $U^B \ge U^M - \Delta\theta f\left(l^M\right)$ it follows that:

  $\Delta\theta f\left(l^M\right) \ge \Delta\theta f\left(l^B\right)$

  or $l^M \ge l^B$.

In what follows we ignore the downward global and incentive constraints. Later on we will prove that the solution derived for the reduced problem satisfies these constraints. Hence, the optimization problem to be solved has only one relevant participation constraint (that one corresponding to the type B) and the upward incentive constraints (16)-(18). But we are now interested in determine which of the remaining constraints are binding at the optimum.

Proposition 3. At the optimum, the participation constraint $U^B \ge 0$ is binding.

Proof

Suppose this is not true and $U^B > 0$. Let $\varepsilon > 0$ be a small positive value such that $U^B - \varepsilon \ge 0$. We define the menu of contracts $\left\{\left(l^G, U^G - \varepsilon\right), \left(l^M, U^M - \varepsilon\right), \left(l^B, U^B - \varepsilon\right)\right\}$ and this menu is incentive feasible. Using that the function $u\left(\cdot\right)$ is strictly increasing we get:

$$F\left(l^G,U^G-\varepsilon,l^M,U^M-\varepsilon,l^B,U^B-\varepsilon\right)=\pi^G\left[u\left(\theta^G f(l^G)-U^G+\varepsilon\right)-v\left(l^G\right)\right]+$$
$$+\pi^M\left[u\left(\theta^M f(l^M)-U^M+\varepsilon\right)-v\left(l^M\right)\right]+\pi^B\left[u\left(\theta^B f(l^B)-U^B+\varepsilon\right)-v\left(l^B\right)\right]>$$
$$>F\left(l^G,U^G,l^M,U^M,l^B,U^B\right)$$

And this contradicts the optimality of the solution $\left\{\left(l^G,U^G\right),\left(l^M,U^M\right),\left(l^B,U^B\right)\right\}$.

Therefore, at the optimum, the profit obtained by the firm B is equal to its reservation value.

In conclusion, we have:

$$U^B=0 \tag{22}$$

In addition, we have already shown that the remaining participation constraints (for types M and G) are also satisfied.

Proposition 4. The upward global constraint (18) is implied by the local incentive constraints (16) and (17).

Proof

Combining the constraints (16) and (17) and using the monotonicity of the function $f\left(\cdot\right)$ and the implementability condition we get:

$$U^G\geq U^M+\Delta\theta f\left(l^M\right)\geq U^B+\Delta\theta f\left(l^B\right)+\Delta\theta f\left(l^M\right)\geq$$
$$\geq U^B+\Delta\theta\left(f(l^B)+f(l^M)\right)\geq U^B+2\Delta\theta f\left(l^B\right)$$

Hence, we can ignore the upward global incentive constraint when solving the problem.

Next, we show that the two remaining incentive constraints of the optimization problem are binding at the optimum.

Proposition 5. The upward local incentive constraint (17) is binding at the optimum.

Proof

Indeed, suppose that strict inequality holds, i.e.: $U^M>\Delta\theta f\left(l^B\right)$.

The solution $\left(l^G,U^G-\varepsilon,l^M,U^M-\varepsilon,l^B,0\right)$ is feasible for a small positive value $\varepsilon>0$. The constraint (16) can be written as:

$$U^G-\varepsilon\geq U^M-\varepsilon+\Delta\theta f\left(l^M\right)$$

On the other hand, we now have:

$$U^G\geq U^M+\Delta\theta f\left(l^M\right)>\Delta\theta f\left(l^B\right)+\Delta\theta f\left(l^M\right)\geq 2\Delta\theta f\left(l^B\right).$$

Then, the constraint (18) is also satisfied (for a small value $\varepsilon > 0$). But we have already stated this result in the Proposition 4.

Since the objective function has a higher value for the new allocation:

$$F\left(l^G, U^G - \varepsilon, l^M, U^M - \varepsilon, l^B, 0\right) = \pi^G\left[u\left(\theta^G f(l^G) - U^G + \varepsilon\right) - v\left(l^G\right)\right] +$$
$$+\pi^M\left[u\left(\theta^M f(l^M) - U^M + \varepsilon\right) - v\left(l^M\right)\right] + \pi^B\left[u\left(\theta^B f(l^B)\right) - v\left(l^B\right)\right] >$$
$$> F\left(l^G, U^G, l^M, U^M, l^B, 0\right)$$

this contradicts the optimality of the solution.

Therefore, at the optimum, the following holds:

$$U^M = \Delta\theta f\left(l^B\right) \tag{23}$$

Proposition 6. The upward local constraint (16) is binding at the optimum.

Proof

We can prove the proposition in the same way we did above.

Suppose that $U^G > \Delta\theta\left(f\left(l^B\right) + f\left(l^M\right)\right)$.

Then, the feasible solution $\left(l^G, U^G - \varepsilon, l^M, \Delta\theta f\left(l^B\right), l^B, 0\right)$ is strictly better than the optimal solution $\left(l^G, U^G, l^M, \Delta\theta f\left(l^B\right), l^B, 0\right)$, and this is a contradiction.

Therefore, at the optimum, we have:

$$U^G = \Delta\theta\left(f\left(l^B\right) + f\left(l^M\right)\right) \tag{24}$$

5. Characterizing the optimal contracts in asymmetric information

Taking into account all the results from the previous propositions and ignoring for a while the downward local and global constraints, the optimization problem is significantly reduced. Next, we use the expressions for the informational rents given in (22)-(24). The principal's problem becomes:

$$\max_{\substack{l^G,U^G,l^M,\\ U^M,l^B}} F(\cdot)=\Big\{\pi^G\Big[u\Big(\theta^G f(l^G)-U^G\Big)-v\Big(l^G\Big)\Big]+\pi^M\Big[u\Big(\theta^M f(l^M)-U^M\Big)-v\Big(l^M\Big)\Big]+$$
$$+\pi^B\Big[u\Big(\theta^B f(l^B)\Big)-v\Big(l^B\Big)\Big]\Big\}$$

s.t.

$U^M=\Delta\theta f\left(l^B\right)$

$U^G=\Delta\theta\Big(f\left(l^B\right)+f\left(l^M\right)\Big)$

The constraints are binding at the optimum and hence we can replace the variables U^M and U^G into the objective function. We finally get an unconstrained optimization problem:

$$\max_{l^G,l^M,l^B} F^R(\cdot)=\Big\{\pi^G\Big[u\Big(\theta^G f(l^G)-\Delta\theta\Big(f\left(l^B\right)+f\left(l^M\right)\Big)\Big)-v\Big(l^G\Big)\Big]+$$
$$+\pi^M\Big[u\Big(\theta^M f\left(l^M\right)-\Delta\theta f\left(l^B\right)\Big)-v\Big(l^M\Big)\Big]+\pi^B\Big[u\Big(\theta^B f(l^B)\Big)-v\Big(l^B\Big)\Big]\Big\}$$

The first order conditions are the following:

$$\frac{\partial F^R(\cdot)}{\partial l^G}=0 \text{ or } \pi^G\Big[u'(\cdot)\theta^G f'\left(l^G\right)-v'\left(l^G\right)\Big]=0 \qquad (25)$$

$$\frac{\partial F^R(\cdot)}{\partial l^M}=0 \text{ or}$$
$$-\pi^G\Delta\theta u'(\cdot)f'\left(l^M\right)+\pi^M\Big[u'(\cdot)\theta^M f'\left(l^M\right)-v'\left(l^M\right)\Big]=0 \qquad (26)$$

$$\frac{\partial F^R(\cdot)}{\partial l^B}=0 \text{ or}$$
$$-\pi^G\Delta\theta u'(\cdot)f'\left(l^B\right)-\pi^M\Delta\theta u'(\cdot)f'\left(l^B\right)+\pi^B\Big[u'(\cdot)\theta^B f'\left(l^B\right)-v'\left(l^B\right)\Big]=0 \qquad (27)$$

Later on, we will use these conditions in order to characterize the optimal menu of contracts. We must now show that the ignored constraints are also satisfied at the optimum.

Since the informational rents are given by the relations (22)-(24), the downward local constraint (19), $U^M\geq U^G-\Delta\theta f\left(l^G\right)$, becomes:

$$\Delta\theta f\left(l^B\right)\geq\Delta\theta\Big(f\left(l^B\right)+f\left(l^M\right)\Big)-\Delta\theta f\left(l^G\right)$$

or $\Delta\theta f\left(l^G\right)\geq\Delta\theta f\left(l^M\right)$

and this is true, using the implementability condition and the monotonicity of the function $f(\cdot)$.

In a similar manner, the downward local constraint (20), $U^B \geq U^M - \Delta\theta f(l^M)$, can be written as:

$$0 \geq \Delta\theta f(l^B) - \Delta\theta f(l^M)$$

or $\Delta\theta f(l^M) \geq \Delta\theta f(l^B)$, which is also true.

The downward global constraint (21), $U^B \geq U^G - 2\Delta\theta f(l^G)$, becomes:

$$0 \geq \Delta\theta\left(f(l^B) + f(l^M)\right) - 2\Delta\theta f(l^G)$$

or $2f(l^G) \geq f(l^B) + f(l^M)$, which is also true from the same implementability condition and the increasing function $f(\cdot)$.

We can now fully characterize the second best solution. The main features are summarize in the following theorem.

Theorem. In the situation of asymmetric information, the optimal menu of contracts $\left\{\left(\bar{l}^G, \bar{w}^G\right), \left(\bar{l}^M, \bar{w}^M\right), \left(\bar{l}^B, \bar{w}^B\right)\right\}$ entails:

A. The *optimal level of labor* assigned to the firm G, $\bar{l}^G$, and the corresponding *optimal wage* $\bar{w}^G$ satisfy the efficiency condition:

$$\theta^G f'\left(\bar{l}^G\right) = \frac{v'\left(\bar{l}^G\right)}{u'\left(\bar{w}^G\right)}$$

This type of firm gets a positive *informational rent*, which is dependent on the optimal labor offered to the firms with types B and M:

$$\bar{U}^G = \Delta\theta\left[f\left(\bar{l}^B\right) + f\left(\bar{l}^M\right)\right]$$

B. The *optimal level of labor* assigned to the firm M, $\bar{l}^M$, and the corresponding *optimal wage* $\bar{w}^M$ satisfy the first order condition:

$$\theta^M f'\left(\bar{l}^M\right) = \frac{v'\left(\bar{l}^M\right)}{u'\left(\bar{w}^M\right)} + \frac{\pi^G}{\pi^M}\Delta\theta\frac{u'\left(\bar{w}^G\right)}{u'\left(\bar{w}^M\right)} f'\left(\bar{l}^M\right)$$

This type of firm gets a positive *informational rent*, which is dependent on the optimal labor offered to the firm:

$$\bar{U}^M = \Delta\theta f\left(\bar{l}^B\right)$$

C. The *optimal level of labor* assigned to the firm B, $\bar{l}^{B}$, and the corresponding optimal wage $\bar{w}^{B}$ satisfy the first order condition:

$$\theta^{B} f'\left(\bar{l}^{B}\right)=\frac{v'\left(\bar{l}^{B}\right)}{u'\left(\bar{w}^{B}\right)}+\frac{\pi^{G}+\pi^{M}}{\pi^{B}}\Delta\theta\frac{u'\left(\bar{w}^{G}\right)+u'\left(\bar{w}^{M}\right)}{u'\left(\bar{w}^{B}\right)}f'\left(\bar{l}^{B}\right)$$

This type of firm gets no informational rent, $\bar{U}^{B}=0$.

6. Conclusions

In this paper we extended the problem of designing the optimal labor agreements first introduced by Green and Kahn (1983). We adapted their model to the case where the adverse selection parameter characterizing the firm's private information is represented by its profitability level. The central goal of the paper was to derive the features of the optimal labor contracts in the situation of asymmetric information when the parameter takes three possible values. If the firm has high profitability level, the optimal contract is Pareto efficient, while the firm gets a positive informational rent due to the informational advantage it has. The principal must give up this rent in order to determine the agent to reveal his private information. On the other hand, the optimal contracts designed for the firm with medium or low profitability level are not longer Pareto efficient. The inefficiency is directly dependent on the spread of uncertainty regarding the efficiency parameter and of course on the functional form of the objective functions.

We showed that the presence of asymmetric information affects the form of the optimal labor contracts, but our analysis is not complete. We here assumed that the union has full bargaining power, but it is also plausible that the firm has the bargaining power. We could be interested if the short term contract can be extended or adapted for a longer period of time and if a long term contract is Pareto efficient. Of course, further work should be done concerning these problems.

Acknowledgements

This work was cofinanced from the European Social Fund through Sectoral Operational Programme Human Resources Development 2007-2013, project number POSDRU/1.5/59184 "Performance and excellence in postdoctoral research in Romanian economics science domain".

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