Information Structure, Labor Contracts and the Strategic Use of Debt*

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Abstract

We introduce information structure as a variable to explain differences in salary profiles and rates of separation among firms. More specifically, we prove that in the case of symmetrical information in the worker-firm relation the salary contract is of the spot type and firm's financial structure is irrelevant in wage setting. In the case where workers have private information on their type, the work contract is such that firms integrate a higher total wages bill into their future investment decisions. We also show that debt can improve welfare and permit the establishment of optimal work contracts. Moreover, in this case, debt is higher in the most specific firms. We also show how the quality of workers within a firm affects its financial structure, which identifies another determinant of debt-equity ratio. Two conclusions are drawn from this work: (i) the affirmation that more specific firms have lower debt ratios (Williamson, 1985) *and offer flatter tenure-salary profiles is not always true; and (ii) the benefits of seniority in the firm may be explained as part of a contractual solution meant to sort out smart applicants from others.*

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1 Introduction

In the economic theory literature the use of debt is explained at least by two factors. On the one hand, it serves to find funds to finance projects. On the other hand, it is a strategic matter; and it is this second point that we treat in this work. Brander and Lewis [1986] signal that, in an oligopolistic environment where decisions on production and financial structure are taken successively, debt is a strategic instrument allowing firms to take a more aggressive production stance against their competitors. This paper treats the strategic issue of debt as it plays out in the job market. It was motivated by the following line of reflection: In the case where investors can dictate a firm's capital structure and where it is costly to monitor the productivity or output of workers, an appropriately selected financial structure may suffice to establish an optimal work contract. One example is that of the debt contract which can set the stage for contracts of the promote or fire type[1] (*up-or-out*). Similarly, a firm can choose a high level of debt to push its workers to work harder, so that the firm can pay its debts and keep its employees.

In theoretical studies, the relationship between financial structure and labor contracts has been dealt with from different aspects among which we can distinguish two categories:

1. If a firm operates on the basis of a long-term relationship with its workers and if these workers are expected to invest in specific human capital, the firm's capital structure will affect their future jobs. The choice to invest in specific, non-transferable human capital, will, in this case, be affected by the capital structure and the optimal financial structure will then be determined endogenously so as to take this problem into account (Jaggia and Thakor, 1994). A direct implication is that the return on seniority must take into account the firm's financial situation. The most debt-laden firms are thus the most likely to make budget cuts. These cuts most often take the form of cuts in jobs or in the number of working hours. This job insecurity, coupled with the fear of losing specific investment, leads workers to demand higher salaries at the start of the contract, thus generating a flatter salary-seniority curve.

2. In models of uncooperative interplay or those where negotiating powers are problematic, the most debt-laden firms prove to be the most

[1] See Kahn and Huberman [1988] for labor contracts of this type.

aggressive in their strategies towards employees. In this sort of models, the foregone conclusion is that the union cannot extract more income than the firm's net profit (once all obligations to creditors have been honored). By issuing debt, the firm is obliged to pay its creditors as soon as it turns a profit. These payments thus limit the surplus on which the negotiation is based[2]. Dasgupta and Sengupta [1993], in particular, show that debt can improve total welfare. Their model is based on the idea that, in a context where surplus is shared according to each party's negotiating powers, financing by debt can alleviate the underinvestment problem. Another problem signaled by Perotti and Spier [1993] is the obligation to renegotiate labor contracts when the firm is unable to pay the salaries promised in the contract. In this case, exchanging equity by debt is advantageous because it reduces the surplus open to negotiation. In the case where shareholders can alter the capital structure by exchanging equity for debt, Perotti and Spier show that this will result in a poor allocation of risk, leading risk averse workers to demand a higher equilibrium salary. Other papers have also dealt with the effect of debt on unions (Sarig, 1988, Bronars and Deere, 1991 as well as Wells, 1992).

The objective of this paper is to look at the role information structure plays in designing labor contracts and to analyze the effect a hypothetical absence of commitment on labor contracts would have on financial structure. These two points are viewed under different hypotheses about the relationship between information structure and the job market. This work is also concerned with how the specificity of fixed assets affects salary profiles and separation rates as well as the debt level. One conclusion of this paper challenges the prediction that more specific firms have lower debt (Williamson, 1985). This result contrasts with that of the Jaggia and Thakor model [1994] which shows that the most specific firms tend to choose lower debt ratios and to offer salary profiles that vary less with seniority. It also contrasts with that of Titman [1984] who shows that firms offering less easily replaceable goods or those requiring after-sales service have lower debt ratios. In their empirical studies, Titman and Wessels [1988] include dismissal rates[3], research and development spending, and sales costs as measures of the firm's specificity and find a negative relation between the debt ratio and the degree of the firm's specificity. However, it is not clear that the variables used for

[2] Empirical studies indeed show the effect of unions' negotiating power on the assignment of salaries. See Abowd and Lemieux [1993].

[3] This is a prediction of the human-capital theory.

firm's specificity capture only this effect.

In this paper we show how deferred compensation as designed by Becker and Stigler [1974] can be a way to induce partial self-selection of the workers. Returns to seniority may thus be explained as part of a contractual solution meant to sort out high ability candidates from lower ones. In the literature this type of contractual solution is only discussed in models with moral hazard (see for example, Jaggia and Thakor, 1994).

The rest of the paper is organized as follows: In Section 2 we present the general model. In Sections 3 and 4, we derive the financial and labor contracts, depending on the presence or absence of adverse selection. We discuss the implications of each model and the characteristics of the contracts. In Section 5 we compare the results obtained in each of the two models and analyze the implications, on both financial structure and on labor contracting. Different econometric issues are discussed in Section 6. The last section is devoted to concluding remarks. All the proofs, unless made in the text, are provided in the Appendix.

2 The Model

We consider a firm which has its operations through two periods. At the start of the first period, the firm has access to a project which requires an initial investment of I_0 and the work of one employee. The return on this investment is noted as x and is random. The distribution density function is expressed as $f(x/z)$, where z represents the type of worker. In its second period, the firm has the option to continue or to liquidate the project. Unlike Perotti and Spier [1993] the financial structure in the second period is not important since external investors do not participate in the second period investment. The return on this investment is noted as $y(z)$. The firm's economy also includes a bank which can serve as an external investor. We also suppose that if the firm does not invest in the second period, it can recuperate a fraction ($\delta < 1$) of its initial capital from the first period. Thus, the smaller the fraction of initial capital to be recuperated, the weaker the pressure to liquidate the project and redeploy the investment elsewhere. On the other hand, a high δ offers investors the opportunity of recuperating δI_0 to invest in other types of enterprises. In the framework of this model, δ is thus interpreted as a measure of the specificity of the investment in fixed assets and may be viewed as a measure of the capital's depreciation.[4]

[4] In the case where δ is interpreted as a measure of depreciation, the value of I_1 can be supposed to be equal to $(1 - \delta)I_0$.

2.1 Hypotheses and Information Structure

All economic agents are risk neutral. The production level x is observed by the firm without cost, but it is not observable by the worker. We suppose that the bank can observe x, using a technology costing c. Information on types of individuals will be dealt with from two angles. We begin with the case where it is symmetrical, then take up the case where it is the worker's private knowledge, meaning that the firm and the bank have no certain knowledge about the type of worker. We suppose that there is an alternative, spot-type market where the salaries in each period are noted as u_1 and u_2. The hypothesis that the alternative salary is the same for everybody can be justified by the fact that work in this sector is the sort of manufacturing in which skill is not an important production factor.

In the first period, each worker decides to work for the firm or in the alternative sector. The firm makes two decisions in the second period: *i*) the decision whether or not to invest and *ii*) if to invest, whether or not the same worker will be kept on or replaced by another.

In addition, it is supposed that $f(x/z)$ verifies the $MLRP$ condition[5]:

$$\frac{\partial}{\partial x}\left(\frac{f_z\left(x/z\right)}{f\left(x/z\right)}\right) \geq 0 \text{ for all } x \text{ and } z.$$

A priori beliefs about types of workers are expressed by the probability density function $p(z)$. Finally, it is supposed that $z \in [0, Z]$; $x \in [0, X]$ and $y(z)$ is an increasing function[6] in z which shows the importance of skill for the firm. We also suppose that the set defined by

$$\{z/y\left(z\right) - \delta I_0 - u_1 - u_2 \geq 0\}$$

is not empty, so that it is possible for the firm to pay the whole second-period salary for certain types of workers.

2.2 Contracts Structure

At the start of the first period, the firm participates to two types of contracts: a labor contract $(w_1, w_2, l\left(x\right))$ is offered to the worker on a take-it-or-leave-it basis, where w_i is wage at period i, for $i = 1$, 2 and $l\left(x\right)$ is the probability that the worker will remain in the firm at period 2 given the realized output x in the first period. The second contract is a standard debt contract

[5] Monotone likelihood ratio property.

[6] We can write $y\left(z\right) = \int yg\left(y/z\right)dy$ where the distribution function $g(y/z)$ verifies the condition of first-order stochastic dominance.

$(F, \min(x, D))$ which is negotiated with the bank, where F is the amount that the bank pays out at the start of period and D is the reimbursement at the end of the period (debt face value).

The sequence of events is summarized in the next figure:

(Figure 1, here)

3 Model with Information Symmetry on z

Let's suppose that all economic agents share the same opinions about types of workers. We distinguish two cases:

i) First case: $\int_{[0,Z]} y(z)\, p(z)\, dz - \delta I_0 - u_2 < 0$

This inequality means that it is more profitable to the firm facing a negative NPV project to liquidate the project. This means that if the firm decides to fire the worker, then it would not invest in the second period.

Rules of decision at the end of the first period: At the end of the first period, the firm observes x and updates its opinions on the type of worker; these new opinions are given by Bayes' rule, explicitly:

$$p(z/x) = \frac{f(x/z)\, p(z)}{\int_{[0,Z]} f(x/u)\, p(u)\, du} \text{ for } x \in [0, X]. \tag{1}$$

With its new beliefs, the firm evaluates the return on the second-period investment. For a performance x , the expected return is given by $E_x(y)$. After evaluating this expression, the firm decides whether or not to invest in the second period.

The following lemma will simplify the characteristics of optimal contracts:

Lemma 1 *(Milgrom,* 1981) $E_x(y) = \int_{[0,Z]} y(z)\, p(z/x)\, dz$ *is increasing in* x*, where* $p(z/x)$ *is given by* (1).

Lemma 1 stipulates that the higher the first-period production level, the greater the expected level of production in the second period. Given Lemma 1, we can prove the following corollary.

Corollary 1 *Given wages* w_1 *and* w_2*, the firm will keep the worker and invest in the second period if and only if first-period production exceeds* $\overline{x}$*, solution implicitly contained in the following equation*

$$E_x(y) - \delta I_0 - w_2 = 0.$$

According to the firm's rule of decision, the utility for a worker with wages w_1, w_2 and the employment rule defined in Corollary 1, is given by the expression

$$w_1 + w_2 \int_{[0,Z]} \int_{[\overline{x},X]} f(x/z)\, p(z)\, dxdz + u_2 \int_{[0,Z]} \int_{[0,\overline{x}]} f(x/z)\, p(z)\, dxdz.$$

We write this expression as $U(w_1, w_2, \overline{x})$.

Using Corollary 1, the firm's decision problem in this case is written as:

$$\begin{aligned} \max_{w_1, w_2, \overline{x}} \pi &= \int_{[0,Z]} \int_{[0,X]} x f(x/z)\, p(z)\, dxdz - w_1 \\ &+ \int_{[0,Z]} \int_{[\overline{x},X]} (E_x(y) - \delta I_0 - w_2)\, f(x/z)\, p(z)\, dxdz + \delta I_0 \end{aligned}$$

subject to

$$U(w_1, w_2, \overline{x}) \geq u_1 + u_2 \tag{2}$$

$$w_2 \geq u_2 \tag{3}$$

The non-switching constraint (3) takes into account the fact that the worker cannot make a commitment to stay in the firm if his second-period salary is lower than the alternative salary.

At the optimum, constraint (2) is binding. By substituting constraint (2) in the objective function and by differentiating with respect to w_2 and δ, we obtain

$$\frac{\partial}{\partial w_2} \pi = -\left[\int_{[0,Z]} f(\overline{x}/z)\, p(z)\, dz \right] (w_2 - u_2) \frac{\partial}{\partial w_2} \overline{x}(.) \tag{4}$$

and

$$\frac{\partial}{\partial \delta} \overline{x}(.) = \frac{I_0}{\frac{d}{dx} E_x(y)} \geq 0. \tag{5}$$

The expression in equation (4) is negative, which shows that at the optimum the second-period salary is chosen so that constraint (3) is binding. The result is summarized in the following proposition:

Proposition 1 *In a world where the worker has the same beliefs about its type than the firm, the solution to the firm's decision problem is as follows:*

The firm will invest in the second period and keep the same worker if and only if the output of the first period exceeds a certain level $\overline{x}$, solution implicitly contained in the equation

$$E_x(y) - \delta I_0 - u_2 = 0. \tag{6}$$

In this case, salaries are expressed by
$\overline{w}_1 = u_1$
and
$\overline{w}_2 = u_2$.

The proof of Proposition 1 is built on the monotonicity of $E_x(y)$ given in Lemma 1 and on the absence of any commitment on the part of the firm.

The solution shows that if the firm can hope to extract no information from the worker, it will assume as much responsibility as possible in the decision to invest in the second period. This is observed in the fact that a low second-period salary does not cause any inefficiency in the decision to invest. The contract is also not open to renegotiation, since the worker and the firm cannot agree on a salary lower than u_2. The worker can not get any higher salary from any external labor market since the output of the first period is a private information to the firm. Moreover, the firm will always respect its commitment to invest and maintain the worker, since this is in its interest. The production threshold $\overline{x}$ acts as a restraint on the firm's debt-making capacity. From this stems a cost for debt if its level exceeds $\overline{x}$. In this case, it is clear that the firm's financial structure will affect the value of the project.

The sign in equation (5) shows that the probability that the firm will reinvest in the second period is higher when its capital is more specific. This is due to the fact that the firm has less incentive to transfer its capital to another type of investment, resulting in a lower risk of job loss in the second period.

ii) Second case: $\int_{[0,Z]} y\left(z\right) p\left(z\right) dz - \delta I_0 - u_2 \geq 0$

This corresponds to the case where the firm can hire a new worker and pay him the u_2 salary, knowing that, on average, it will make a positive profit. The firm will thus still be disposed to invest in the second period even if the worker is dismissed.

Proposition 2 *In the case where the firm is still disposed to invest in the second period and in a world with information symmetry, the salary contract will be as follows:*

$\overline{w}_1 = u_1$
and
$\overline{w}_2 = u_2$.

In this case, the firm will keep the worker, if the first-period production level exceeds $\overline{x}$*, solution implicitly contained in the equation*

$$E_x(y) - \int_{[0,Z]} y\,(z)\,p\,(z)\,dz = 0. \tag{7}$$

In the opposite case, the firm will hire a new worker.

In this model where information is symmetrical and incomplete, the solution is of the *up-or-out* type and salaries are assigned as on a *spot* market. The idea behind this last type of contract is that workers are not aware of their type and that the firm cannot use labor contracts to distinguish among them.

One also should note that even if wages are fixed, the total worker's expected payoff depends on performance since employment on the second period ($l\,(x)$) is a function of productivity.

3.1 Financial Structure

The corollary following from Propositions 1 and 2 is that capital structure in no way affects the labor contract. Indeed, since the salary contract is of the *spot* type, the worker need not worry about the possibility of bankruptcy in the second period. The reverse is, however, false. In fact, the labor-contract solution shows that if the first-period production exceeds a certain level, the firm should reinvest as it will have a good evidence of the worker's skill. This makes it possible to determine a cost for debt, if its level exceeds $\overline{x}$. Since all types of workers will accept the labor contact, and since the financial contract is a standard debt then the financial contract would be given by

$\overline{F} = I_0$ and $\overline{D}$ is solution to[7]:

$$\begin{aligned} I_0 &= \int_{[0,\overline{D}]} \int_{[0,Z]} xf\,(x/z)\,p\,(z)\,dxdz \\ &+\overline{D} \int_{[\overline{D},X]} \int_{[0,Z]} f\,(x/z)\,p\,(z)\,dxdz - u_1. \end{aligned} \tag{8}$$

[7] Debt is priced by the market at the competitive rate and we assume that the interest rate is nil.

Note that even if the shape of the financial contract is exogenous, the debt face value is endogenous to our model since it depends on the quality of workers hired by the firm.

We should now discuss the relation between $\overline{D}$ and $\overline{x}$. Two cases are possible:

a) $\overline{D} \leq \overline{x}$, in this case the firm investment decision at the second period is optimal. In fact, the firm debt is lower than the output level that gives a good signal about the worker's ability. In this situation we have a complete independence between labor and financial market.

b) $\overline{D} > \overline{x}$, and if shareholders are incapable of putting any equity in the project there will be a loss of efficiency in terms of investment. This loss of efficiency occurs when the output of the first period lies in $\left[\overline{x}, \overline{D}\right]$. However, the wage contract remains acceptable by workers.

4 Model with Asymmetric Information

4.1 A Contract with Commitment as Benchmark

In the model with symmetric information, the separation between firm and worker, if there is any, takes place at the end of the first period. In this model, however, and since workers know their types, the firm can use an appropriately selected labor contract to make the selection at the beginning of the first period. By offering a contract which satisfies the participation constraint, the firm can attract only good types of workers. In this section, we turn to the case where the firm will face a negative NPV project if it decides to hire a new worker in the second period[8], i.e.

$$\int_{[0,Z]} y(z)\, p(z)\, dz - \delta I_0 - u_2 < 0.$$

One implication of this inequality is that the firm will have no interest in replacing a worker by another one, which implies that investment and employment decisions are the same. We model the firm's decision to keep the worker by a variable $l(.)$, where $l(x)$ represents the probability that the firm will keep the worker, given that the first-period production level is x. This modelling allows us to deal with the general case where the firm plays with mixed strategies.

[8] The other case will not be dealt with here. The reasoning is analogous to that of the model in the preceding section.

Given a labor contract $(w_1, w_2, l(.))$ the utility for a type-z worker is expressed as

$$w_1 + \int_{[0,X]} [l(x) w_2 + (1 - l(x)) u_2] f(x/z) dx.$$

Let's write this expression as $U_z(w_1, w_2, l(.))$.

Definition 1 *Let a labor contract* $(w_1, w_2, l(.))$. *We say that* $(w_1, w_2, l(.))$ *is an up-or-out contact if there exists a parameter* a *such that*

$$l(x) = \begin{cases} 1 \text{ if } x \geq a \\ 0 \text{ if } x < a. \end{cases}$$

In the next proposition, we show that *up-or-out* contracts are always preferred by the firm, which facilities the resolution of the firm's decision problem.

Proposition 3 *For any labor contract* $(w_1, w_2, l(.))$, *there always exists an up-or-out contract that is preferred by the firm.*

From this proposition, we can restrict the analysis to *up-or-out* contracts.

To simplify the firm decision problem, we start by analyzing the second period participation constraint of the worker:

$$w_2 \geq u_2.$$

Two cases are possible:

1. The participation constraint is binding:

$$w_2 = u_2.$$

We then have the following result:

Proposition 4 *When the second period participation constraint of the worker is binding, then:*

$$\overline{\overline{w}}_1 = u_1$$

and all workers' types accept the contract. The firm invests and keeps the worker in the second period if and only if the first period output is greater than $\overline{x}$ *solution of equation* (6).

The proof of Proposition 4 is obvious. In this case, the firm obtains the same profit level as in the case of symmetrical information. Let us write this profit as π^*. The labor contract from Proposition 4 is consistent over time: the firm shall not deviate from initial strategy at the beginning of period 2.

2. The participation constraint is not binding:

$$w_2 > u_2.$$

In that case, we have the following proposition:

Proposition 5 *When the participation constraint of the worker in second period is not binding, then there exists a $z^* \in [0, Z]$, such that the labor contract solves the following:*
$\overline{\overline{w}}_1 = 0$
$\overline{\overline{w}}_2 = y(z^*) - \delta I_0$.
Moreover, the firm invests in second period if and only if the output in the first period is greater than $\overline{\overline{x}}$ solution of:

$$(y(z^*) - \delta I_0 - u_2) \int_{[\overline{\overline{x}}, X]} f(u/z^*)\, du - u_1 = 0.$$

Finally, z^* is the solution of the following maximization problem $(P2)$:

$$\max_z \int_{[z,Z]} \int_{[0,X]} x f(x/t) \frac{p(t)}{\int_{[z,Z]} p(m)\, dm} dx dt$$
$$+ \int_{[z,Z]} \int_{[\overline{\overline{x}}, X]} [y(t) - y(z)] f(x/t) \frac{p(t)}{\int_{[z,Z]} p(m)\, dm} dx dt + \delta I_0$$

subject to:

$$[y(z) - \delta I_0 - u_2] \int_{[\overline{\overline{x}}, X]} f(u/z)\, du - u_1 = 0. \tag{9}$$

A solution to $(P2)$ exists since constraint (9) is compact.

We write the corresponding profit as π^{**}. Since the nature of the labor contract, it is easy to see that types $z > z^*$ obtain a salary greater than their opportunity ways.

We are now ready to derive the general solution to the firm decision under asymmetrical information.

Proposition 6 *When workers know their types, then the optimal labor contract between the firm and the worker is the following:*

i) When $\pi^{**} < \pi^*$*, then the optimal contract solves:*

$\overline{\overline{w}}_1 = u_1$

$\overline{\overline{w}}_2 = u_2$.

In this case all types of workers accept the labor contract and the firm invests in the second period if and only if $x \geq \overline{x}$.

ii) When $\pi^{**} > \pi^*$*, the optimal contract becomes:*

$\overline{\overline{w}}_1 = 0$

$\overline{\overline{w}}_2 = y(z^*) - \delta I_0$

where z^* *is the solution of* $(P2)$*. In this case, the firm keeps the worker and invest in the second period if and only if the first period output is greater than* $\overline{\overline{x}}$ *obtained as an implicit solution to:*

$$(y(z^*) - \delta I_0 - u_2) \int_{[\overline{\overline{x}}, X]} f(u/z^*)\, du - u_1 = 0. \tag{10}$$

We can rewrite (10) and obtain

$$\overline{\overline{w}}_2 = u_2 + \frac{u_1}{\int_{[\overline{\overline{x}}, X]} f(u/z^*)\, du},$$

and the expected payoff for a worker of type z is:

$$u_2 + u_1 \frac{\int_{[\overline{\overline{x}}, X]} f(u/z)\, du}{\int_{[\overline{\overline{x}}, X]} f(u/z^*)\, du}. \tag{11}$$

From expression (11) we see that the expected payoff is a fixed payment (u_2) increased with a bonus tied to the worker's performance. Anticipation of this bonus means that all other types except $z < z^*$ will refuse to work for the firm[9]. As for the first-period salary, it is set at its lowest level. The analogy can be made with models with deferred compensation, the initial low wage is what is called the period where workers 'posts a bond'. This bond depends on ability which induces a 'self-selection' from workers' side.

Unlike the model without asymmetric information, the firm integrates a higher total wages bill into its decision to invest in the second period, in order to attract good workers. This salary increase will create a higher probability that the project will not continue in the second period for bad type workers, thereby increasing the probability the worker will be out of a job. This way of discriminating between workers caused a loss of effectiveness, resulting in insufficient investment in the second period.

[9] In fact, $\frac{\int_{[\overline{\overline{x}}, X]} f(u/z) du}{\int_{[\overline{\overline{x}}, X]} f(u/z^*) du} \leq 1$ if and only if $z \leq z^*$.

4.2 Labor Contract Time Inconsistency and the Role of Debt

The problem with the labor contract described in Proposition 5 is that it is time inconsistent. The firm cannot, in fact, ex-post, make the commitment to respect it, and will prefer to keep the worker even if the production level falls below $\overline{\overline{x}}$. The idea behind this is that the firm knows that the worker is of type $z \geq z^*$. All workers will anticipate this *expost* behavior and will accept the initial contract. The firm will then be unable to make types-separation if appropriate instrument is not added. The firm must thus make a credible commitment to respect the contract offered and to stop the project if the first-period output is lower than $\overline{\overline{x}}$.

Up to now the financial composition of the firm's capital was irrelevant. We next show that capital structure will be a strategic tool in order to implement the optimal labor contact with type-separation. We suppose that the bank does not renegotiate the debt contract with the firm: if the firm is unable to payback its debt, the bank will stop the project and obtain δI_0, the liquidation value. A justification of this assumption is, for example, the lack of coordination or the existence of renegotiation costs (see the discussion below).

As a benchmark let's consider the case where the financial structure of the firm does not affect the labor contract offered by the firm. In this situation, given believes about the worker's ability and the nil optimal salary of the first period, the financial contract solves:

$\overline{\overline{F}} = I_0$ and $\overline{\overline{D}}$ is solution to

$$\begin{aligned} I_0 &= \int_{\left[0,\overline{\overline{D}}\right]} \int_{[z^*,Z]} xf\left(x/z\right) \frac{p\left(z\right)}{\int_{[z^*,Z]} p\left(t\right) dt} dxdz \\ &+ \overline{\overline{D}} \int_{\left[\overline{\overline{D}},X\right]} \int_{[z^*,Z]} f\left(x/z\right) \frac{p\left(z\right)}{\int_{[z^*,Z]} p\left(t\right) dt} dxdz. \end{aligned} \tag{12}$$

Before studying how strategic considerations would affect the financial structure of the firm we compare $\overline{D}$ and $\overline{\overline{D}}$ respectively solutions of equations (8) and (12). We can prove the following proposition.

Proposition 7 $\overline{D} > \overline{\overline{D}}$

Proposition (7) shows how the quality of workers affects the debt face value and the corresponding probability of bankruptcy: if external investors know that the firm is hiring good type workers then the level of debt would be lower for the same amount borrowed for the investment. The reason is that better workers increase the probability of higher realizations and let the firm less vulnerable to bankruptcy. This proposition identifies another determinant of debt-equity ratio other than those mentioned in the literature[10].

We now study how the labor contract would affect the capital structure of the firm. We make the same analysis as in the previous section. We have two possible situations. We only discuss the case where $\overline{\overline{D}} < \overline{\overline{x}}$, the other case is similar to the analysis made in Section 3.1.

In this case the threat of liquidation is not credible and the firm cannot implement the optimal labor contract since there is a time inconsistency in the optimal labor contract with type-separation. The firm can however rise the face value of debt up to $\overline{\overline{x}}$ to make separation credible. We have then the next result:

Proposition 8 *When $\pi^{**} > \pi^{*}$, then the firm will offer the same labor contract as in Proposition 5.*

Besides, the financial contract negotiated by the firm is the following:
$\overline{\overline{D}} = \overline{\overline{x}}$
and

$$\begin{aligned}\overline{\overline{F}} = & \int_{[0,\overline{\overline{x}}]} \int_{[z^*,Z]} x f(x/z) \frac{p(z)}{\int_{[z^*,Z]} p(t)\,dt} dxdz \\ & + \overline{\overline{x}} \int_{[\overline{\overline{x}},X]} \int_{[z^*,Z]} f(x/z) \frac{p(z)}{\int_{[z^*,Z]} p(t)\,dt} dxdz \\ & > I_0. \end{aligned} \tag{13}$$

With Proposition (8) and equation (13) we find:

$$\frac{\partial}{\partial \delta} \overline{\overline{D}}(.) = -\frac{I_0 \int_{\left[\overline{\overline{D}},X\right]} f(u/z^*)\,du}{\left[y(z^*) - \delta I_0 - u_2\right] f\left(\overline{\overline{D}}/z^*\right)} \leq 0.$$

This shows that in a world with asymmetrical information the debt level is higher in firms whose assets are more specific (small δ). In the framework of this model, the fact that debt increases in relation to the degree of specificity stems from the low opportunity cost which makes the firm less likely to transfer funds to another type of investment. The firm can thus increase its debt and attract only the right type of workers without any large risk of liquidation. This result contrasts with that of Williamson

[10] See Harris and Raviv [1992] for a survey.

[1985] who conjectured that higher asset specificity would reduce the ability of the firm to take on debt financing. Dasgupta and Sengupta [1993] offer a model where they show that Williamson conjecture holds over a range for the specificity measure δ. Hart and Moore [1994] discussed the relation between asset specificity and the maturity structure of debt.

In our model and contrarily to Perotti and Spier [1993] , the financial structure of the firm in the second period is not important. However, after the signature of the financial contract and once the worker is hired, the firm would want to renegotiate with external investors before the realization of x. In fact once types are revealed, and since only high type worker is attracted, it would be beneficial to the firm to renegotiate the financial contact in order to avoid bankruptcy at the end of the first period and benefit from the positive net present value of the second period investment. If workers anticipate this renegotiation then type separation would not be feasible. In order to avoid this situation we suppose, in addition, that the firm is able to diversify its sources of financing leading to a harder coordination between external investors and preventing any kind of renegotiation. We then have that the implementation of optimal labor contract with separation over types dictates firm's behavior in two manners. First, the firm increases its debt beyond its real need for the investment, and second, it disperses its sources of financing generating high renegotiation transactions costs.

5 Discussion

By comparing the salary contracts in the two models previously discussed, we see that information structure can play an important role in setting salaries. In the model with adverse selection, the second-period salary is raised to compensate for the low first-period salary, so that the bad types will not be attracted by the contract. With equations (6) we see that the separation rate depends solely on the second-period best alternative salary. The implication arising from the model with adverse selection is, however, different. In this model the separation rate is, in fact, a function of the alternative salaries of the two periods. These results are discussed in more detail in the two following sections.

In the firm's maximization problem, it is supposed that the worker is capable of seeing the level of production. On balance, what is important for the worker is to know if the production level in the first period exceeds or falls below $\overline{\overline{x}}$, since this is the only statistic that can define the labor contract. On balance, we know that the financial contract will yield a liquidation if and only if the first-period production level falls below $\overline{\overline{x}}$, which will then serve as a signal to the worker.

5.1 Salary Profile and Debt Ratio

It is reasonable to think that information structure will differ from one industry to the next. In certain types of jobs, workers as well as firms share the same beliefs about job performance. In other types of jobs, workers may be better informed than the firm about their productivity. Variations in salary profiles can thus be explained by differences in information structure. We conclude that the variation in salary profiles based on seniority can be used as a measure of the degree of information asymmetry in the job market. As stated in Proposition 5, in the model with adverse selection, the second-period salary is a decreasing function of δ , which means that the salary-profile will be steeper in more specific firms. In the model without private information, the salary profile is independent of the specificity of fixed assets (δ).

We can in a similar manner explain the variation in debt ratio per firm.

5.2 Separation Rate

In the model with information symmetry, the separation rate is characterized by equation (6). In this equation we find

$$\frac{\partial}{\partial u_2}\overline{x}\,(.) = \frac{1}{\frac{d}{dx}E_x(y)} \geq 0. \tag{14}$$

This equation shows that the second-period separation rate is an increasing function of the second-period alternative salary. So, the higher the second-period salary, the greater the separation between firms and workers. Equation (6) also shows that the first-period alternative salary has no effect on the separation rate.

In the model with asymmetrical information, the separation rate is expressed by equation (10). This equation shows that, in contrast to the previous model, the separation rate depends on the alternative salaries of both periods. Differentiating (10), we obtain:

$$\frac{\partial}{\partial u_1}\overline{\overline{x}}\,(.) = -\frac{1}{\left[y\left(z^*\right) - \delta I_0 - u_2\right] f\left(\overline{\overline{x}}/z^*\right)} \leq 0 \tag{15}$$

and

$$\frac{\partial}{\partial u_2}\overline{\overline{x}}\,(.) = -\frac{\int_{\left[\overline{\overline{x}},X\right]} f\left(u/z^*\right) du}{\left[y\left(z^*\right) - \delta I_0 - u_2\right] f\left(\overline{\overline{x}}/z^*\right)} \leq 0. \tag{16}$$

Equation (15) shows that the first-period salary increases the separation rate in the second period. Contrary to the sign in equation (14), equation (16) shows that the second-period salary decreases with the second-period alternative salary.

6 Econometric Issues

The main conclusion from the previous analysis is that the level of debt is affected in two opposite ways by the work force. In fact, from one side and for strategic convenience firms may increase debt in order to attract only high skilled workers, and on the other side the high quality of workers makes this class of firms less riskier which under the assumption that debt is priced by the market competitive rate ensures a lower debt face value. The key implication from the previous analysis is that the quality of workers within a firm affects directly its capital structure. The analysis also explains variations in tenure-earnings profile across firms with different information structures besides the labor market and with different levels of capital specificity. This approach is confirmed empirically by Margolis [1996] and Abowd, Kramarz and Margolis [1999]. These two contributions use french data matching employer-employee information and show empirical evidences in favor of firm-specific seniority returns. In fact, from Propositions 1, 2 and 7 we can conclude that even if the same shock is allowed for all firms, we can explain variations in returns to seniority and intercepts across firms by allowing different firms to operate in different information environments.

One implication of this paper is that capital structure and contract wages are jointly determined. In Dachraoui and Dionne [1999] we account for this problem by using the next procedure:

Guided by the theory of financial capital structure, the determinants of firm's capital structure are first obtained by estimating the dynamic regression of debt-equity ratios over proxies for the different attributes that the theory suggests. In this regression we also include a measure for firms' needs in terms of ability. In a second step, the estimated debt-equity ratios are used to test the existence of a trade-off between wage contract components (starting wage and wage growth over the life contract). Abowd et *al*. [1999] found a negative correlation between these components. In Dachraoui and Dionne [1999] this analysis is extended by verifying how controlling for firm's capital structure affects this correlation.

7 Conclusion

In this work, we stressed the importance of information structure in analyzing interactions between financial decisions and job decisions. With the same model but different information structures, we reach dissimilar results. More specifically, the salary profile increases more with seniority when there is information asymmetry. This finding gives seniority another dimension aside from the conventional predictions of human-capital theory. This model thus answers the question as to whether seniority is profitable and gives an explanation for the variation in salary profiles from one industry to the next. In the same manner, we can explain the variation in the debt ratio by industry (Titman and Wessels, 1988). In this work, we also manage to determine the role of debt in establishing labor contracts. This finding which is proven in a framework with adverse selection can be generalized to cases where workers choose to perform and where this performance is not observable by the firm. The intuitive deduction is that a high debt level can be an incentive for workers to work harder. The incentive stems from the fear that the firm will go bankrupt and that workers will find themselves without a job. In this work we also show how debt can be affected by the quality of workers, as we reach the conclusion that firms with more able workers have less debt than do comparable firms with less skilled workers.

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Appendix

Proof of Proposition 3. For a non up-or-out labor contract $(w_1, w_2, l(.))$ we define A as the set of workers that would accept to work for the firm:

$$A = \{z/U_z(w_1, w_2, l(.)) \geq u_1 + u_2\}.$$

The profit of the firm at the second period is then given by:

$$\int_A \int_{[0,X]} (y(z) - \delta I_0 - w_2) f(x/z) p(z/z \in A) dxdz + \delta I_0.$$

We have two possible situations:

1: there exists z_1 such that $]z_1, Z[\subset A$, in this case we define a implicitly by

$$w_1 + w_2 \int_{[a,X]} f(x/z) dx + u_2 \int_{[0,a]} f(x/z) dx = u_1 + u_2. \tag{17}$$

With the new labor contract $(w_1, w_2, l_a(.))$, with

$$l_a(x) = \begin{cases} 1 \text{ if } x \geq a \\ 0 \text{ if } x < a, \end{cases}$$

only workers of type $z \geq z_1$ are going to accept to work for the firm. To make the proof we show that for all $a \leq b$ and for all x, we have that

$$K(x,z) = a \int_{[0,x]} f(u/z) du + b \int_{[x,X]} f(u/z) du$$

is increasing[11] in z.

In fact,

$$\frac{\partial}{\partial z} K(x,z) = a \int_{[0,x]} f_z(u/z) du + b \int_{[x,X]} f_z(u/z) du$$

and since $f(x/z)$ verifies the $MLRP$ condition then

$$\int_{[0,x]} f_z(u/z) du \leq 0 \text{ for all } x.$$

In addition $a \leq b$, then

$$\frac{\partial}{\partial z} K(x,z) \geq b \int_{[0,x]} f_z(u/z) du + b \int_{[x,X]} f_z(u/z) du = 0.$$

[11] We can also show that $K(.)$ is decreasing in x.

By the previous result we have

$$U_z(w_1, w_2, l_a(.)) < U_{z_1}(w_1, w_2, l_a(.)) = u_1 + u_2 \text{ for all } z < z_1.$$

Now, since $y(z) - \delta I_0 - w_2$ is increasing in z, we have

$$\int_A \int_{[0,X]} (y(z) - \delta I_0 - w_2) f(x/z) \, p(z/z \in A) \, dxdz$$
$$\leq \int_{]z_1,Z[} \int_{[0,X]} (y(z) - \delta I_0 - w_2) f(x/z) \, p(z/z > z_1) \, dxdz.$$

The last inequality shows that the firm makes more profit with the new contract $(w_1, w_2, l_a(.))$.

2: Suppose 1 is not true and define z_1 as

$$z_1 = \max\{z_2/\exists z_3 \text{ such that }]z_3, z_2[\subset A\}.$$

We define a as in equation (17) and make the analysis in the same way as before. ■

Proof of Proposition 5. For an *up-or-out* contact $(w_1, w_2, l_a(.))$, let z_a be the unique explicit solution to

$$U_{z_a}(w_1, w_2, l_a(.)) = u_1 + u_2.$$

z_a exists since there will be at least one type of workers who is paid his alternative wage, otherwise the firm will reduce w_1 without affecting workers decision to accept the labor contract. As we did in the proof of Proposition 3, we can proof that the firm would prefer the contact $\left(0, w_2', l_{a'}(.)\right)$, where w_2' and a' are given respectively by

$$w_2' = y(z_a) - \delta I_0$$

and

$$U_{z_a}\left(0, w_2', l_{a'}(.)\right) = u_1 + u_2.$$

The last expression can be rewritten as

$$[y(z_a) - \delta I_0 - u_2] \int_{[a',X]} f(x/z) \, dx - u_1 = 0. \quad (18)$$

Equation (18) is the participation constraint that we include in the maximization problem $(P2)$, where the objective function is obtained as follows:

$$\int_{[z,Z]}\int_{[0,X]} xf(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dxdt$$
$$+\int_{[z,Z]}\int_{[\overline{\overline{x}},X]}[y(t)-w_2]\,f(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dxdt$$
$$+\delta I_0\int_{[z,Z]}\int_{[0,\overline{\overline{x}}]} f(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dxdt.$$

Rearranging terms and substituting $y(z_a)-\delta I_0$ for w_2, the last expression can be written as:

$$\int_{[z,Z]}\int_{[0,X]} xf(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dxdt$$
$$+\int_{[z,Z]}\int_{[\overline{\overline{x}},X]}[y(t)-y(z_a)]\,f(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dxdt+\delta I_0.$$

Which ends the proof of Proposition 5. ■

Proof of Proposition 7. Let's define $V(D,z)$ as

$$\begin{aligned} V(D,z) &= \int_{[0,D]}\int_{[z,Z]} xf(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dxdt \\ &\quad +D\int_{[D,X]}\int_{[z,Z]} f(x/t)\frac{p(t)}{\int_{[z^*,Z]}p(m)\,dm}dxdt. \end{aligned}$$

We need to show that $V(D,z)$ is increasing in both D and z. If this is the case we will have

$V\left(\overline{D},0\right) = I_0+u_1 > I_0 = V\left(\overline{\overline{D}},z^*\right) > V\left(\overline{\overline{D}},0\right)$ which necessarily imply that $\overline{D}>\overline{\overline{D}}$.

The monotonicity of $V(.)$ in D is straightforward, now we prove that $V(D,.)$ is increasing in z for all D.

After simplification and using the fact that

$$\int_{[0,X]}\int_{[z,Z]} f(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dtdx=1,$$

we can show that the derivative of $V(.)$ with respect to z has the same sign as

$$\int_{[0,D]}[D-x]\left[f(x/z)-\int_{[z,Z]} f(x/t)\frac{p(t)}{\int_{[z,Z]}p(m)\,dm}dt\right]dx.$$

By integration by part the last expression can be written as

$$\int_{[0,D]}\left[\int_{[0,x]}\left[f\left(u/z\right)-\int_{[z,Z]}f\left(u/t\right)\frac{p\left(t\right)}{\int_{[z,Z]}p\left(m\right)dm}dt\right]du\right]dx,$$

which is equivalent to

$$\int_{[0,D]}\left[\int_{[0,x]}f\left(u/z\right)du-\int_{[z,Z]}\left[\int_{[0,x]}f\left(u/t\right)du\right]\frac{p\left(t\right)}{\int_{[z,Z]}p\left(m\right)dm}dt\right]dx.$$

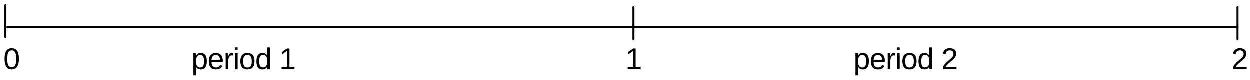
Since the $MLPR$ condition implies $FOSD$, then we have

$$\int_{[0,x]}f\left(u/z\right)du\geq\int_{[0,x]}f\left(u/t\right)du \text{ for all } t\geq z \text{ and } x.$$

The last inequality implies

$$\int_{[0,x]}f\left(u/z\right)du\geq\int_{[z,Z]}\left[\int_{[0,x]}f\left(u/t\right)du\right]\frac{p\left(t\right)}{\int_{[z,Z]}p\left(m\right)dm}dt,$$

which ends the proof of Proposition 7.■



At the beginning of period 1 :

- the firm sets the labor contracts (w_1, w_2, $l(x)$)
- the worker accepts or not the labor contract
- if he accepts, he gets w_1
- the firm negotiates a financial contract (F, min(x,D))

At the end of period 1 :

- x is realized
- the firm updates its beliefs about worker type
- decides whether or not to liquidate the project :
  - if liquidates, recuperates δI_0 and the game is over
  - if does not liquidate, decides either to keep the worker and pay w_2 or to hire a new worker and pay u_2
- and reimburses the bank according to the debt contract

At the end of period 2 :

- y is realized
- the firm is terminated

Figure 1
Sequence of Events