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Discussion Paper No. 662

IMPLICIT LABOR CONTRACTS TO EXPLAIN TURNOVER

BY

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* I am grateful for helpful comments by Dale Mortensen and George R. Neumann. I am responsible for any errors that remain.

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ABSTRACT

Aggregate data exhibit procyclical movement in the rate of turnover. However, existing models of turnover have been unable to explain this phenomenon. In this model I generate turnover as an outcome of a second best wage contract when there is asymmetry of information about workers' mobility costs. A wage contract that insures the "bad" ("unlucky") workers, results in "good" ("lucky") workers earning less than their marginal productivity. Therefore, good workers with low mobility costs leave the firm for the spot market wage. This, combined with an aggregate shock, results in a procyclical rate of turnover.

1. INTRODUCTION

Aggregate data exhibit procyclical movement in the rate of turnover. However, models of turnover leave this phenomenon unexplained. Traditional search models yield a counter-cyclical turnover behavior (see, for example, Mortensen 1984). The general equilibrium search model of Lucas and Prescott (1974) has no aggregate shock, so that no procyclical behavior can be explained. Other models of separation examine only the micro aspects of firm-worker relationship. Hall and Lazear (1984) explain excessive quits in "good times" by identifying "good times" as those that give the worker better opportunities outside the firm. This is not an adequate explanation for an "aggregate shock" where the relative productivity across firms remains constant (on average). The same criticism can be applied to Ito (1983), which characterizes an optimal wage contract permitting workers to search for alternative employments. Carmichael (1983) uses job dissatisfaction as a motive for quits. Clearly, this explanation has no obvious aggregate implications.

In this paper I use an implicit labor contract in the spirit of Holmstrom (1983) to generate a procyclical turnover behavior. The original labor contract literature - originated by Azariadis (1975), Baily (1974), and Gordon (1974) - does not deal with turnover. It tries to explain the widely claimed fact that wage payments are less variable than labor productivity (i.e., workers do not necessarily get their marginal product). In these models, workers face uncertainty with regard to the value of future productivity. The resulting equilibrium provides full insurance for workers, as long as information is symmetric, ex post mobility is disallowed (no quits), firms are risk neutral and workers are homogeneous in production and tests.

Another branch of literature (see, for example, Freeman 1977, Harris and Holmstrom 1982) analyzes implicit contracts when workers' productivity is not known but is learned through time. In this case, workers are facing uncertainty about their own productivity and want insurance against it. Maintaining the same assumptions as before, but with zero mobility cost, the resulting contract yields a non-decreasing wage structure, but no turnover.

The different assumption about mobility costs is the main difference between these two types of models (the different source of uncertainty creates only a change in interpretation and not in structure). Ironically, this difference leads to the same result as per turnover¹. Although the optimal contract implies temporary lay-offs when the value of leisure is sufficiently high, the firm retains all of its workers. Therefore, to generate turnover, I generalize the specification of mobility costs by allowing them to vary within some interval. The result is a synthesis of the two models described above. This new model enables us to explain turnover as a by-product of the optimal (second best) contract, when the firm does not know the workers' specific mobility costs. When combined with a macro shock, the turnover rate is shown to be procyclical as existing evidence suggests.

The model studied in the paper is a modified version of Freeman (1977). There are two types of workers, "good" and "bad", who live and work for two periods. A worker's type is not known in the first period but is fully revealed in the second. In addition, each worker has different level of mobility costs which are not known in the first period and are known only to the workers in the beginning of the second period. As a result, risk averse workers want to buy some wage insurance against the unfavorable realization in the second period. This wage insurance, which pays the good workers less than

their marginal product, causes the good workers with low mobility costs to leave the firm for the spot market wage. Hence, turnover in this model can be regarded as the price of wage-insurance. By increasing the amount the good workers "pay", the firm increases the proportion of good workers that quit and thus, decreases the number of workers that pay insurance. These "insurance payments" are shown to be increasing with good workers' productivity and, thus, create a procyclical rate of turnover.

By no means is this result restricted to turnover of good workers. The model can also fit a market with homogeneous workers, in which "good workers" are, in fact, "lucky workers", or workers in good realizations of the market. Under the interpretation of differences in abilities, however, the model seems more interesting. It can be compared, for example, to Lazear (1983), that also yields turnover of good workers. Since Lazear's model assumes asymmetry of information between the employer and a firm that wants to raid the employer for a worker, his model fits a goods market better (a relationship between a seller and a buyer of some goods). My model, describing an asymmetry of information between the firm and the worker, fits the labor market better.

The structure of the paper is as follows. In section 2, I present a model of implicit labor contracts in a two period world in which mobility costs and workers' abilities are random. Existence of a solution and of a positive turnover rate among the good workers in the second period is established. In section 3, I introduce a shock in some macro-related variable. I show that the turnover rate is positively correlated with productivity shocks.

2. THE BASIC MODEL

Consider an industry consisting of many identical firms producing an output with labor as the only input under constant returns to scale. There are two types of workers: type a with productivity y_a and type b with productivity y_b , where $y_a > y_b$. The value of productivity of both types is the same across firms. Workers live two periods in which they work and consume. In the beginning of the first period, no information is available to identify the type of each worker to the firm and to the worker himself. But, both of them know the proportion of type a workers in the population, q , and the value of y_a and y_b . Therefore, they know the expected productivity of an unidentified worker:

$$1) \quad y_0 = qy_a + (1-q)y_b$$

In the second period workers are fully identified and this information is available to any agent in the market. Each worker is an expected utility maximizer with an additively separable Von-Neumann Morgenstern utility function, and has no time preference. Let the rate of interest be equal to zero.

Our objective is to find the optimal wage strategy for the firm, where firms are assumed to be risk neutral and workers are risk averse. Before information about workers' types becomes available, each worker prefers the certain wage of $2y_0$ for his lifetime as opposed to any other wage scheme with expected value $2y_0$ (we ignore the problem of moral hazard). This certain-wage offer is feasible provided that one of the following conditions holds (see also Harris and Holmstrom 1982, Holmstrom 1983):

- i) Workers hold to their contract, i.e., do not move to another firm.
- ii) Mobility costs are very high, so it is never optimal to move (this condition implies condition i).
- iii) Workers face a perfect capital market.

In the case of a perfect capital market, consumption and earning decisions in each period are separable. Therefore, workers are willing to get the certain total wage of $2y_0$ in the form $(-y_a, 2y_0+y_a)$. No firm can match a wage of $2y_0+y_a$ in the second period market. Therefore, no worker is going to leave.

At this stage, in order to avoid the uninteresting case of full insurance, most writers (see Freeman 1977, Harris and Holmstrom 1982) assume that workers are not bound to their contracts, they have no mobility costs and an imperfect capital market exists.² The result is a downward rigid wage in which the good workers are paid their marginal productivity, the bad workers are paid above their marginal productivity and the first period workers are paying this wage-insurance.

Among the above three assumptions, the zero mobility cost seems to be the most restrictive. Therefore, we relax it by assuming that each worker has a different level of mobility costs c_i . These costs are not observable by the firm but have a known c.d.f. $F(c)$. The workers themselves know their particular c in the beginning of the second period. They do not know, however, their value of c in the first period, before the contract has been signed.³ The spot market wage for type a worker is y_a and, therefore, worker i of type a leaves the firm if his wage is lower than $y_a - c_i$. For simplicity we assume the support of the distribution of c is in $[0, \infty)$, i.e., no utility from moving. If we also assume that $F(c)$ is continuously differentiable with

d.f. $f(c)$, we can write the probability that type a worker quits, $P(s_a)$, as follows

$$2) \quad P(s_a) = \int_0^{y_a - s_a} f(c) dc$$

where s_a is the wage for the type a worker.

Given this environment, firms must choose an optimal wage strategy $s = (s_0, s_a, s_b)$, where s_j is the wage for worker of type j , $j = 0, a, b$. Competition among firms reduces the problem of optimal wage strategy to that of maximizing each worker's expected utility subject to zero profit for the firm. It can be seen that under the optimal contract, workers do not want to save, so that consumption in the first period equals the wage.⁴ In addition, type b workers do not want to leave the firm (because they are paid above their marginal productivity). Therefore, the optimal wage structure is given by the solution for the following problem:

$$3) \quad \max U(s, q) = u(s_0) + qE[\max[u(s_a), u(y_a - c)]] + (1-q)u(s_b)$$

subject to

$$4) \quad (s_0 - y_0) + q(1 - P(s_a))(s_a - y_a) + (1 - q)(s_b - y_b) = 0$$

$$4a) \quad s_j \geq 0 \quad j=0, a, b$$

Note that the objective function (3) is not necessarily differentiable.⁵ However, since the worker is risk averse, any contract with $s_a > y_a$ is strictly dominated by a contract in which $s_a \leq y_a$ with the same expected payment. Now, for every $s_a > y_a$, $s_a = y_a$ yields the same expected payoff for the worker, since $P(s_a) = 0$ for every $s_a > y_a$. By the same

argument, we know that constraint (4a) is never binding and, hence, we will not keep writing it. Therefore, the above problem yields the same solution as the following problem:

$$5) \max_s u(s_0) + q[1-P(s_a)]u(s_a) + q \int_0^{y_a - s_a} u(y_a - c)f(c)dc + (1-q)u(s_b)$$

subject to equation (4) and

$$6) s_a \leq y_a$$

Program (4)-(6) is now differentiable over a compact set. Therefore, a solution exists and the first order necessary conditions are:

$$7) u'(s_0) - \Psi_1 = 0$$

$$8) u'(s_b) - \Psi_1 = 0$$

$$9) [1-P(s_a)]u'(s_a) - \Psi_1 [1-P(s_a)+P'(s_a)(y_a-s_a)] - \frac{1}{q}\Psi_2 = 0$$

together with constraints (4) and (6), where Ψ_1 and Ψ_2 are the Lagrange multiplier for constraints (4) and (6) respectively.⁶

We can now establish the following result:

Proposition 1 Let (s_0^*, s_a^*, s_b^*) be a solution for program (4)-(6).

Then $s_0^* = s_b^*$ and $s_0^* < s_a^* < y_a$.

Proposition 1 means that the optimal contract implies a wage structure that is non decreasing over time as is often the case in this kind of models (Freeman 1977, Holmstrom 1983). Also, since $s_0^* < s_a^*$, full insurance is never optimal, although it is always optimal to pay the good workers less than their marginal product ($s_a^* < y_a$). This implies $P(s_a^*) > 0$, i.e., some of the good

workers are leaving the firm under the optimal contract.

Proof From conditions (7) and (8) it is easy to see that $s_0^* = s_b^*$. Now, to show that $s_0^* < s_a^*$, note that if $s_a^* \leq s_0^*$, then $s_a^* < y_a$ and, therefore, $\Psi_2 = 0$. Since $P'(s_a^*) = -f(y_a - s_a^*) < 0$, it follows from (9) that $u'(s_a^*) < \Psi_1 \implies s_a^* > s_0^*$, a contradiction. We can show $s_a^* < y_a$ in a similar way, but it is useful to do it as follows. From the zero profit constraint

(4) we can write s_0 and s_b as a function of s_a :

$$s_b = s_0(s_a) = [1/(2-q)][y_0 + (1-q)y_b + q(1-P(s_a))(y_a - s_a)].$$

Substituting into (9), using the fact that $u'(s_0^*) = \Psi_1$, we obtain

$$H(s_a) = (1-P)u'(s_a) - [1-P+P'(s_a)(y_a - s_a)]u'[s_0(s_a)].$$

H is continuous in s_a . Now, $y_a > s_0(y_a)$ implies

$$H(y_a) = u'(y_a) - u'[s_0(s_a)] < 0.$$

Also, let \bar{s}_a satisfy the following equation

$$\bar{s}_a = [1-(2-q)][y_0 + (1-q)y_b + q(1-P)(y_a - \bar{s}_a)].$$

Then, $\bar{s}_a = s_0(\bar{s}_a)$ and we have $H(\bar{s}_a) = -P'(y_a - \bar{s}_a)u'(\bar{s}_a) > 0$.

By the continuity of H it follows (Intermediate value theorem) that $H(s_a) = 0$ for some $s_a \in (\bar{s}_a, y_a)$. Clearly, the set of s_a which solve the problem is contained in the set $\{s_a \in (\bar{s}_a, y_a) : H(s_a) = 0\}$, Q.E.D.

Proposition 1 has some intuitive interpretations. The property that full insurance is not optimal is simply the fact that a risk averse individual will always take part in a "small" favorable gamble. By increasing s_a above s_0 , the firm creates some risk in favor of some positive expected gain. Also, the fact that $s_a < y_a$ regardless of factors like degree of risk aversion and rate of quitting looks surprising. It is due to the fact that small decreases in s_a from y_a cause only a small proportion of workers to leave, while increasing the utility of all "bad" workers.

We are now in a position to compare our model to the models with degenerate support for f (c is fixed at some level, possibly zero or infinite). Two cases are possible in this situation:

i) Mobility costs are high enough, so that $y_a - c$ is smaller than the wage under full insurance. In this case, the optimal contract is full insurance (constant wage over time and states) with no turnover.

ii) If c is not high enough, type a workers get $s_a = y_a - c$ and, again, they do not leave the firm. The reason for this is simple: an above $y_a - c$ wage is not optimal since, by lowering it, the firm can costlessly increase the level of insurance. On the other hand, any wage below $y_a - c$ causes all the good workers to leave. Hence, the optimal wage is equal to $y_a - c$ with no turnover. Thus, in both cases we can not obtain turnover, with contrast to our model.

Note also that the workers who quit are the good workers in a situation of full information about their productivity and no differences among firms. The model suggests that lack of information about the mobility of each worker makes it optimal to hold to some fixed wage. The firm knows that it is going to lose some of the good workers, but it can not know who, until the worker has quit. In the absence of some observable variable, the firm can not avoid this problem by designing a self selection mechanism. Hence, if the firm tries to increase the wage of workers who threaten to leave, every worker will do so. Therefore, the optimal procedure is to supply wage insurance and to pay the price, namely, lose some proportion of the good workers.

The results of proposition 1 do not depend on the specific type of distribution of mobility costs (although the uniqueness of these result may depend).⁷ Therefore, this model generalizes some of the results of the search models (with regard to turnover). It can be extended to include differences

among firms by allowing for some positive probability of quits in the case of $s_a = y_a$.

Our formulation of the mobility costs has another advantage. In most models of wage-contract the results are not sensitive to parameters like degree of risk aversion, changes in the riskiness of the distribution, etc. It suffices to have a concave utility function in order to achieve either full insurance or a non decreasing wage.⁸ In our model, however, these parameters have an impact on the contract due to their effect on the cost of insurance and its payoff.⁹

It is interesting to compare this explanation for turnover to the explanation based on "search while employed" (Burdett 1978, Mortensen 1978). There, the reason for turnover is some exogenous differences among firms. Workers, therefore, are looking for better jobs while employed. With some probability they will find such jobs and will quit. On the other hand, the only difference among firms in our model is the type of contract they offer: a multi-period contract versus a single period contract. Therefore, it is the contract which creates turnover, and not some exogenous variables.

This difference does not mean that search is excluded from our analysis. In fact, search is a reasonable way to justify the existence of mobility costs (although not the only one). We may either assume that each worker has different costs of search, or that workers increase their intensity of search as the difference between their wage and the wage outside increases, in order to obtain a distribution of mobility costs according to our assumption.

3. EXOGENOUS SHOCK IN THE VALUE OF OUTPUT

In the previous section we described a wage-insurance based on uncertainty about the workers' ability. It is easy to see that the same structure applies, by different interpretation of the variables, to a model in which the uncertainty is the consequence of some macro-related parameters. For example, we can assume that the level of production is fixed, but prices are changing stochastically. Therefore, $y_i > y_j$ means that the price for output in state i is higher than the price in state j . The mathematical structure of the model remains the same in this case. The only difference is the ability of the firm to reduce its risk. By hiring many workers, the firm can have virtually no risk in the case of unknown workers' ability because each workers' performance is independent of the other. On the other hand, the firm can not avoid the shock in macro-related parameters and must bear the loss if the state is "bad". The only difference between these two interpretations is, therefore, the appeal of the assumptions that firms are risk neutral with zero probability of bankruptcy.

This discussion suggests that there is no problem in combining these kind of shocks together. Indeed, let us assume that with probability π_1 , the value of output in the second period is high, and with probability π_2 , $\pi_2 = 1 - \pi_1$, the value is low. In particular, with probability π_1 the output is (y_a^1, y_b^1) and with probability π_2 it is (y_a^2, y_b^2) , where $y_a^1 > y_a^2$ and $y_b^1 > y_b^2$.

At this level of generality we do not specify what is the reason for this change or what is its magnitude. It appears we do not need to be more specific in order to obtain the main results. However, to keep the exposition simple, we make the following assumptions (later these assumptions will be relaxed).

$$i) y_b^1 \leq [1/(2-q)][y_0 + (1-q)(y_b^1 + y_b^2)]$$

$$ii) y_a^2 \geq qy_a^1 + (1-q)y_b^1$$

These two assumptions mean that the exogenous shock is not "too strong". Note that (i) implies $y_0 > y_b^1$, but no further assumptions about y_0 have been made. In the previous section we assume y_0 is the average of the output in the second period. It seems to be too restrictive to assume this here, in the presence of an exogenous shock.

An additional assumption we make is that the distribution of mobility costs is the same across states, i.e.,

$$P(s_a^i) = \int_0^{y_a^i - s_a^i} f(c) dc \quad i=1,2.$$

This assumption is made in order to show that it is the existence of a wage contract, and not just changes in mobility costs, that causes a pro-cyclical turnover rate.

The firms' problem is to choose a wage vector s , $s = (s_0, s_a^i, s_b^i)$ to maximize workers' utility subject to zero profits. Assumptions (i) and (ii) guarantee that the optimal solution satisfies, as before, the conditions $s_a^i \leq y_a^i$ and that $s_b^i \geq y_b^i$, so that the problem can now be written as follows

$$10) \max_s u(s_0) + q \sum_{i=1}^2 \pi_i E[u(s_a^i)] + (1-q) \sum_{i=1}^2 \pi_i u(s_b^i)$$

s.t.

$$11) (s_0 - y_0) + q \sum_{i=1}^2 (1 - P_i)(s_a^i - y_a^i) + (1-q) \sum_{i=1}^2 \pi_i (s_b^i - y_b^i) = 0$$

$$12) s_a^i \leq y_a^i \quad i=1,2$$

where $P_i = P(s_a^i)$ and $Eu(s_a^i) = (1-P_i)u(s_a^i) + \int_0^{y_a^i - s_a^i} u(y_a^i - c)f(c)dc$

Program (10)-(12) is differentiable over a compact set. Therefore, solution exists and the first order necessary conditions are

$$13) \quad u'(s_0) = \Psi$$

$$14) \quad u'(s_b^i) = \Psi \quad i=1,2$$

$$15) \quad (1-P_i)u'(s_a^i) - \Psi[1 - P_i + P_i'(y_a^i - s_a^i)] - \frac{1}{q} \lambda_i = 0 \quad i=1,2$$

And conditions (11) and (12), where Ψ is the Lagrange multiplier for (11) and λ_i for (12).

It can be seen that these conditions imply $s_0 = s_b^1 = s_b^2$, i.e., a non decreasing wage structure again. We can obtain a similar result to proposition 1 for s_a^i and P_i .

Proposition 2 Let s^* be a solution to program (10)-(12). Then

$$s_0^* < s_a^{*i} < y_a^i.$$

The proof of proposition 2 is very similar to the proof of proposition 1 and is, thus, omitted. It is possible to see that if we relax assumption (i), the resulting contract can yield a wage which is lower than the productivity in state (b,1), i.e., there will be some quitting in this state. If we relax assumption (ii), the resulting contract can yield an above-productivity wage for state (a,2) workers (i.e., no quitting in this state). Clearly, we can get situations like these if we analyze an economy with many possible states. The main results, however, stay the same, namely

i) A downward rigid wage.

ii) In the "best" state workers get paid less than their productivity.

Therefore, some of them are quitting.

In this respect, the model is general in nature. No special assumptions about the exogenous shock are required to obtain the above results or the results which follow. In particular, we do not have to assume that the shock has the same effect on both good and bad workers, or that it is more powerful than the "ability" shock. Moreover, the model can be easily extended to include more than one shock.

It is interesting to compare the rate of turnover, P_i , between the states. Empirical studies (see Parson 1977 for a survey of the literature) show that the turnover rate is procyclical, so we want to see if $P_1 > P_2$. Clearly, any meaningful comparison must be done between unique solutions. Therefore, I now assume that the bordered-Hessian determinant is negative definite. Under this condition we can show the following

proposition 3 $P(s_a^1) > P(s_a^2)$ i.e., the turnover rate is higher in the "good" state of the economy.

Proof Let $G_i(s_a^i, \Psi) = (1-P_i)u'(s_a^i) - \Psi(1-P_i + P_i'(y_a^i - s_a^i))$.

By our assumption on P , if $P(s_a^1) = P(s_a^2)$, then $y_a^1 - s_a^1 = y_a^2 - s_a^2$ and

$P'(s_a^1) = P'(s_a^2)$. Now, $y_a^1 > y_a^2$ and, hence, $s_a^1 > s_a^2$. Thus, it is easy to see

the following

$$16) \quad P(s_a^1) = P(s_a^2) \implies G_2(s_a^2, \Psi) > G_1(s_a^1, \Psi).$$

Let $s_a^{*1}, s_a^{*2}, \Psi^*$ be the values which solve the problem, i.e.,

$G_2(s_a^{*2}, \Psi^*) = G_1(s_a^{*1}, \Psi^*) = 0$, and assume, by contradiction, that

$P(s_a^{*1}) < P(s_a^{*2})$. Now, $P(s_a^{*1}) \neq P(s_a^{*2})$. Indeed, if $P(s_a^{*1}) = P(s_a^{*2})$ then

$s_a^{*1} > s_a^{*2}$. But, from condition (15) we obtain $u'(s_a^{*1}) = u'(s_a^{*2}) \implies s_a^{*1} = s_a^{*2}$

a contradiction. Let s_a^{-1} be the value for which $P(s_a^{-1}) = P(s_a^{*2})$, i.e.,

\bar{s}_a^{-1} solves $y_a^1 - \bar{s}_a^{-1} = y_a^2 - s_a^{*2}$. Clearly, $\bar{s}_a^{-1} < s_a^{*1}$. By the assumption that the bordered-Hessian determinant is negative definite, $\partial G_1 / \partial s_a < 0$ and, therefore, $G_1(\bar{s}_a^{-1}, \Psi^*) > G_1(s_a^{*1}, \Psi) = G_2(s_a^{*2}, \Psi)$ which contradicts condition (16), Q.E.D.

The intuition for this result can be explained as follows. Suppose both type of "good" workers, (a,1) and (a,2), pay an equal premium, i.e., $y_a^1 - s_a^1 = y_a^2 - s_a^2$. By our assumption on mobility costs, this means that the proportion of each type that stay in the firm is the same, and both types react the same to changes in wage. Since, in addition, they pay the same premium, the firm has the same change in total wage-insurance-premium if it lowers the wage of workers of type (a,1) instead of type (a,2). By doing so, however, it increases the expected utility of the workers since, by the concavity of the utility function, and by the fact that $s_a^1 > s_a^2$, workers of type (a,2) have higher marginal utility from income.

It thus follows, from propositions 2 and 3, that the combined model yields the same results as before and, in addition, yields a procyclical turnover rate.

Up to now we have focused our attention on the good workers' mobility, assuming that the firm retains all of its "bad" workers. It is useful to note, however, that the model is flexible enough to permit a more sophisticated analysis; it can allow for bad workers' mobility. To see this, assume the bad workers have some alternative wage (possibly the value of leisure), with some fixed mobility cost. The firm can now offer a wage contract which specifies, for each state, a wage and a retaining probability r_i (see Holmstrom 1983). In order to solve this kind of contract, we have to do the following

i) Replace the term $\sum_{i=1}^2 \pi_i u(s_b^i)$ in (10) by $\sum_{i=1}^2 \pi_i r_i u(s_b^i) + \sum_{i=1}^2 \pi_i (1-r_i) u(w_i)$

where w_i is the alternative wage (or the value from leisure) less the mobility costs.

ii) Replace the term $\sum_{i=1}^2 \pi_i (s_b^i - y_b^i)$ in (11) by $\sum_{i=1}^2 \pi_i r_i (s_b^i - y_b^i)$.

iii) Add the constraints $0 \leq r_i \leq 1$.

Because of the additively separable nature of the utility function, this additional sophistication does not create much of a difficulty. Therefore, with this modification we may get some bad workers' layoffs (or turnover). Layoff is obtained when the value of leisure is sufficiently high (as is the case in the traditional contracts literature). Turnover of bad workers is obtained when they have alternatives in the job market. It is important to see, however, that this layoff (turnover) of bad workers is not explained by the existence of a wage contract. It is the result of the existence of value from leisure (or alternative wage). The wage contract only reduces the number of layoff workers compared to a non-contract world. On the other hand, as our model suggests, it is the existence of a wage insurance that causes some of the good workers to quit. In this respect, implicit labor contracts can explain turnover.

With the existence of an alternative wage, what happens in other industries has an impact on our industry through this wage. It does not change, however, the results with respect to the good workers quit. Indeed, consider a worker who has to choose a job from a number of alternative industries (occupations). At the current time he only knows the distribution of his productivity for each alternative. But, once he choose a job in a

particular industry and starts working, he is continually gathering information about his true aptitude for this kind of industry. If he find himself "good" in this occupation, he will not consider any transfer to an alternative occupation, because this alternative was inferior to the current one even before the worker was sure about his ability. Therefore, good workers look for an alternative job in the same industry, as our model suggests. On the other hand, if the worker finds himself not fit for this industry, he may want to change occupation. This decision is affected by the alternative wage, as many models suggest (see, for example, Ito 1984).

4. CONCLUDING REMARKS

The purpose of the paper has been to explore the implication of variable mobility costs on implicit labor contracts with heterogeneous workers. I find that with variable mobility costs across workers, contracts guarantee workers a downward rigid wage, and, for the good workers, a wage below productivity. This contract leads to some turnover of good workers, the proportion of which is pro-cyclical.

These results rely on a rather weak set of assumptions, which are the same as used by other authors, but generalize the specification of mobility costs. The exogenous shock we analyzed is of a very general nature, and no special assumptions about it are required to derive the results.

In addition, the model can be easily extended to a large number of states of the world, multiple periods, etc. Therefore, I believe the results represent fundamental properties of implicit contracts, that will prove to hold in different kind of environments.

FOOTNOTES

- 1) See Weiss(1984) for a discussion on the role of mobility costs on the optimal contract.
- 2) Alternatively, we can assume that mobility costs equal some known constant. The results remain the same, but the good workers get their marginal productivity less mobility costs.
- 3) If they know c in the beginning of the first period, the optimal contract may include self selection aspects which are beyond the scope of this paper.
- 4) Therefore, the imperfection of the capital market only means that workers can not be net borrowers (see Freeman 1977).
- 5) It is not differentiable at the point $s_a = y_a$ if $P(y_a) \neq 0$.
- 6) Although we did not mention sufficiency, note that this set of first order conditions can not yield a minimum solution. For such a solution, condition (4a) is binding, and we can not omit it. Moreover, the inclusion of condition (6) causes program (4)-(6) to yield a different minimum than that of program (3)-(4).
- 7) Note that program (4)-(6) is not necessarily concave and, hence, the solution may not be unique. However, it can be seen (Berkovitch 1983) that, by and large, this problem yields a unique solution. For example, it is sufficient that the function H in the proof of proposition 1 is increasing to obtain a unique solution. This happens under rather mild assumptions.
- 8) The only case in which these elements do have some effects is when some probability of layoff exists.
- 9) For a comparative statics analysis of this kind, see Berkovitch (1983).

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