ANNALES D'ÉCONOMIE ET DE STATISTIQUE. – N° 41/42 — 1996

Worker's Limited Liability, Turnover and Employment Contracts

Jonathan S. LEONARD, Marc Van AUDENRODE*

ABSTRACT. – We develop a model of turnover and wages based on the legal limits on workers' liability. A simple two-period model generates differences among firms in entry level wages, and in returns to age and tenure. It predicts that both quits and discharges are negatively correlated with the steepness of the age-earning profile. The discharge prediction is contrary to a job matching or pure human capital model. The predictions of the model are tested on a sample of firms from the Belgian manufacturing sector. We find that 1) the dispersion of pay policy across firms is similar in Belgium and the U.S., 2) this dispersion does not reflect simple rent-sharing or omitted variables, 3) about 8% of workers separate annually with discharges concentrated in the first years, and 4) steeper seniority profiles are associated with lower quit and discharge rates.

Responsabilité limitée des travailleurs, rotation et contrats de salaire

RÉSUMÉ. – Nous développons un modèle expliquant la formation des salaires et les mouvements de travailleurs basé sur l'engagement limité des travailleurs. Notre modèle simple à deux périodes peut expliquer les différences existant entre les firmes en ce qui concerne les salaires d'embauche, et les rendements liés à l'âge et l'ancienneté. Il prédit également que les séparations volontaires et involontaires de travailleurs seront inversement reliées avec la pente du profil de salaire. Nous testons ces prédictions sur un échantillon de grandes firmes du secteur manufacturier belge. Nous montrons que : 1. La dispersion des politiques de salaires en Belgique est comparable à celle existant aux États-Unis ; 2. Cette dispersion ne reflète pas une simple situation de partage de rente ou encore un cas de variable omise ; 3. Environ 8% des travailleurs se séparent chaque année de leur employeur, les licenciements ayant principalement lieu aux cours des premières années ; 4. Les entreprises offrant un profil de salaire avec pente plus forte connaissent moins de séparations volontaires et involontaires.

* J. S. LEONARD: University of California; M. Van AUDENRODE: Université Laval. We thank George Akerlof, Bill Dickens and participants at seminars at Columbia, Montréal, Rochester, Seattle and UCLA for helpful comments on a previous version of this manuscript. We also benefited from the comments of participants at the ADRES Paris Conference.

1 Introduction

Two major sets of economic theories compete with one another to explain observed wage differentials between industries and establishments, and more generally to explain the functioning of the labor market. The first set, the job matching theories, is of market clearing inspiration, and relates the wage to the quality of the match between the worker and the job he is assigned to. Low quality matches will result in low wages and a high probability of rupture by quit or discharge, while high quality matches will result in high wages and will likely last longer. The second set, which includes the rent sharing and the efficiency wage theories, links wage differentials to differences across firms in available rents and workers' bargaining power in the rent sharing models, or to the inability of the firm to perfectly enforce its employment contracts in the efficiency wage theories. While the implications of these non-market clearing theories on wages have begun to be scrutinized, their effect on job turnover is less studied.

In this paper the reasons for the existence of both voluntary and involuntary separations are studied within the framework of the efficiency wage theory. Efficiency wage theory provides a fruitful initial framework for the study of turnover as it naturally accommodates wage differentials across employers that make some jobs more desirable for the workers and so induces quits. In estimating the importance of these differentials, the expected stream of future lifetime earnings is a crucial element in the decision. When a worker is indifferent between all the non-wage aspects of two jobs, the element that will determine his decision to stay or quit will be the expected value of the future earnings in both jobs. This question is of particular importance because the slope of the age-earning profile can be unrelated to the marginal productivity of the worker (LAZEAR [1979]). The particular policies of each employer in that matter will be of prime importance in estimating the quit risk facing the firm.

In the model developed here, we show that the higher the wage premium paid by the employer, the lower the level of discharge and quits. Conversely, firms paying low wage premia will suffer many quits and will have to fire more workers. The model's prediction on quits is similar to the job matching theory's predictions. The major difference between the model developed here and the job matching model comes from the predicted relationship between wages and separations initiated by the employer. Job matching models have always been uneasy with the explanation of the existence of separations initiated by the employer, and consequently do not develop these questions deeply.

Two reasons can, *a priori*, be found to explain why firms drawing their workers from the same population might end up having different age-earning profiles, on average. The simplest way to justify these differences is to assume that the return to tenure differs between firms. As the rent obtained by the employer is a share of the rent created by the worker, there would be an accrued incentive for the employer to terminate the unsuccessful matches when productivity returns to tenure are high. In this framework, high wages would be associated with a high level of firings.

However, even when assuming that all firms are identical, differences in profiles can still be found. Higher wages and steeper age-earning profiles, on average at the firm level, would simply be associated with more successful matches, and hence with a higher level of selectivity by the employer in deciding which employment relationship to continue and which to terminate. In either case, a clear positive correlation between the wages and the steepness of the age-earning profile and the rate of firings would be predicted. Finally, the predictions on firings found in rent sharing models are relatively unclear. Traditionally, these models discuss the implications of wages on layoffs rather than on firings. In LINDBECK and SNOWER [1988], as an example, none of the models of insider behavior require firing for cause. It is however, fair to say that pure models of union behavior would also tend to predict a negative correlation between firings and wages: steep age earning profiles and high wages are signs of a strong union. When a strong union is present, a higher level of job protection might be expected to exist, resulting in fewer firings.

This paper develops an efficiency wage model with the distinctive prediction that steep earnings profiles are associated with both fewer quits and fewer firings. To our knowledge no previous paper models this question formally, or tests it empirically. We test our model's clear turnover predictions using data on Belgian manufacturing firms, and find results that give some credit to the efficiency wage interpretation of turnover.

Section 2 will present a model of job turnover when efficiency wages are paid in a situation of heterogeneous firms and workers. Empirical evidence from the Belgian manufacturing sector is presented on wage policy (section 3), turnover (section 4), and the impact of the former on the latter (section 5). The chief empirical innovation in this paper is using matched employer-employee data to first estimate firm specific pay functions, and second to estimate the impact of pay policy on turnover at the firm level, a relationship of paramount interest.

2 Efficiency Wages and Turnover

Among the numerous reasons considered in explaining labor turnover, job matching is undoubtedly the most popular. The theory of job matching bases turnover, quits and firings, on the need for both employers and workers to find the correct match, i.e., the most productive-between the worker's skills and the job's characteristics (MORTENSEN [1978], JOVANOVIC [1979], and ANTEL [1985]).

A second class of turnover models links quits and layoffs to unexpected shocks in firm demand. These shocks, together with stickiness in the design of the employment contract, might cause quits during the firm's good times and layoff during downturns (HALL and LAZEAR [1984], ARNOTT, HOSIOS and STIGLITZ [1988]).

Finally, the third class of models of turnover puts forward problems of adverse selection and signaling. The wage paid by an employer affects the quality of the applicant pool (WEISS [1980], GREENWALD [1986] and WALDMAN [1985]).

Efficiency wage models present an attractive ground for explaining turnover. Firms that imperfectly enforce their employment contracts have to pay an efficiency premium to their workers in order to induce faithful behavior from them. This premium will be larger the worse the employer's ability to enforce the contract. Hence, jobs with high efficiency premiums will be in high demand among workers. At any point of their career, workers will be willing to quit their jobs to accept an offer where the expected value of their future earning is larger. In this case, the labor market will never clear. There will be an excess supply of labor to high wage premium jobs but this will not create downward pressure on the wages.

2.1. **Overview of the Model**

In this model, we single out an institutional feature of the labor market, common to most of the industrialized economies that illustrates how industrialized countries treat employment contracts differently than other contracts. We claim that the legal limits on workers' liability, which exist in most countries, are a possible foundation for a model of efficiency wages that is not subject to the bonding critique and which is able to describe several regularities of the labor market, among which the question of turnover.

Many developed countries have designed laws that, in contrast to their common law, limit workers' liability for the possible damages they can cause during the execution of their work and place the burden of this liability upon the employer.

Situations where workers can make mistakes harmful to the firm or to third parties are frequent in employment relationships: a driver having a traffic accident, a worker ruining a production batch, and so on. Sometimes damages are huge, as they may be for airline pilots, oil tanker captains or anybody working with dangerous substances and products. When an accident occurs on the job in the U.S., the employer is responsible to third parties for a worker's torts committed within the scope of the worker's employment, even though the worker's conduct was wanton and malicious (PROSSER et al. [1988]). Some courts also limit an employer's ability to recover against its own employees, when the employer is injured because of employees' negligence. (AMERICAN LAW INSTITUTE [1964]).

In Canada similar reasoning allows courts to hold employers responsible for the damages caused by his employees. Courts are however less clear than in the U.S. on the question of knowing whether the employer will be held responsible when the employee's conduct is intentional, malicious or out of the scope of his work. (BLANPAIN et al. [1976]. In Germany, workers are not responsible for any damage – either toward third parties, or towards the employer – caused during the course of work performance.

They will however be responsible in cases of particularly gross negligence or intentional conduct (BLANPAIN et al. [1976]). Finally, Belgium's Act concerning individual Labor Contracts [1978] and Sweden's Employment Act of 1972 both contain a rule similar to the German one. (BLANPAIN et al. [1976]).

This free insurance system for the workers can induce a suboptimal level of care or effort among them. Optimal behavior can therefore only be induced through payment of a wage premium to the workers who correctly perform their duties – *i.e.*, who do not make any costly mistakes – as the employer is not allowed to protect himself legally against having to assume the financial risk of such occurrences. Of course, the employer will be able to insure himself against some of these risks. However, such insurance is commonly experience rated and limited to the employer's liability toward third parties. In addition, these insurance contracts are not complete and do not cover some losses – most importantly the negative reputation effects that some of these accidents can have for the firm.

The model developed here is able to explain several regularities of the labor market: inter-firm and inter-industry wage differentials, observed differences in returns to age and to tenure, the movements of workers between jobs as well as why firms and workers do not sign lifetime contracts.

2.2. **The Model**

In our model, workers can be employed either in firms paying efficiency wages, or in the spot market. Firms paying efficiency wages will pay a wage premium to compensate for their inability to hold their workers liable for their mistakes. In the spot market, workers are paid a lower wage and earn a zero rent.

Workers differ in ability. Some workers have a lower probability of making mistakes. These differences among them hold regardless of the firm in which they are employed (among the firms paying efficiency wages). Firms differ by the magnitude of the cost of a worker's mistake. Some firms suffer large costs if a worker fails. For others, this cost is close to negligible. Obviously, as long as the probability of an accident is reduced by paying an efficiency premium to the worker, firms with potentially high costs of mistakes will pay higher wages to their workers to reduce the risk. Workers will want to work for these high paying employers and will try to signal themselves as highly reliable workers in order to obtain a job in one of these firms. Workers in this model know their own type. However, they cannot truthfully reveal it to their employer. Because of the legally mandated limits on workers' responsibility, the employer cannot make any payment conditional upon the cost of a mistake, nor can he sell or auction these contracts, as this would be considered as forcing workers to surrender an unalienable right.

The basic assumptions underlying the model are:

Assumption 1:

There are two types of firms. Firms of type 1 pay efficiency wages according to the cost to them of a worker's mistake. Type 2 firms pay the spot market wage, here normalized to zero, for simplicity.

Assumption 2:

Jobs in type 1 firms are in short supply, while type 2 firms will absorb all the remaining labor supply at the current wage.

Assumption 3:

Type 1 firms earn rents that make them always better off by hiring workers at the efficient wage than when not hiring.

Assumption 4:

There is exactly one position in each type I firm.

Assumption 5:

Both firms and workers face a zero interest rate.

Assumption 6:

Workers differ only by their probability of making a costly mistake [1]. Each worker will be characterized by a probability of mistake $P = 1 - \alpha C$, where C is the level of effort (or "carefulness") produced by the worker. The α's will be distributed uniformly between α_* and α^*, $\alpha^* < 1$. Workers have the utility function $U = W - C^2$ where W is the wage premium promised to the worker. Individual α's are not observed, but firms know all the relevant parameters of their distribution. Specifically, we assume that firms know $E(\alpha)$, $E(\alpha^2), \ldots$

Assumption 7:

Firms receive the value of the worker's production, but pay the promised wages and potentially have to pay for the worker's mistakes. The cost of a mistake will vary across firms and will be identified by V_j.

Assumption 8:

At equal salaries, workers are indifferent between jobs. This implies that the expected value of the lifetime earnings associated with a job will be the only element they will consider when choosing their jobs.

Assumption 9:

Workers live for two periods. Firms are immortal.

Assumption 10:

Both firms and workers are risk neutral.

Assumption 11 :

If a worker makes a mistake, he does not receive the wage premium and he is fired.

1. This assumption allows us to disregard the possibility of having the employer try to induce workers to self-select, by tying the conditions of the contract to other characteristics of the workers (productivity, for example).

2.2.1. ***Short Term Contracts***

Assume first that firms cannot commit to long term contracts and that, at the end of the period, the employment record of the workers will remain private information for the worker and his current employer.

Assumption 12:

Employment records are private information.

In this case, each worker will maximize, each period:

$$\max \alpha\, C\, (W - C^2) + (1 - \alpha\, C)\, (-C^2) \tag{1}$$

The optimum level of effort for the worker, for a given wage will be:

$$C = \frac{\alpha\, W}{2} \tag{2}$$

Which will generate a probability of failure equal to:

$$P = 1 - \frac{\alpha^2\, W}{2} \tag{3}$$

Given this, each firm will minimize its expected cost, which is given by:

$$\frac{a^2\, W}{2}\, W + V \left(1 - \frac{a^2\, W}{2}\right) \tag{4}$$

where W is the wage and $a^2 = E\,(\alpha^2)$.

The optimal wage for maximum profit is, assuming an interior solution, $W = \frac{V}{2}$.

It is interesting to note that, in equilibrium, the optimal wage is completely independent of the distribution of worker's quality. This particular result is due to the special linear form of the function describing the probability of mistake. Nothing however implies that for other functional forms the optimal wage would be increasing function of the quality of the worker. The contrary could also be true, and all form of self-selection would naturally be precluded. We can easily see that, at the equilibrium, the probability of an error will decline both with the cost of the mistake for the firm and with the quality of the worker and that a worker will earn a higher rent the higher his quality and the higher the cost of his mistakes for the firm that hired him.

2.2.2. ***Long Term Contract***

When a worker has not committed a mistake during the first period, the employer will revise his judgment and assume that the worker is more reliable than the simple average worker. The employer will therefore prefer to offer long term contracts to the workers–under the condition that they did not make mistakes during the first year, both because of the revision of the ability of the workers they are able to perform at the end of the first period and because, in addition, the wage premium promised for the second period will also have some spillover effects and serve as an incentive during the first period. As we keep our assumption of private information of the quality of the worker, and as type 1 jobs are relatively scarce, the worker cannot signal himself as a high quality worker outside the firm, and he will accept the long term contract. In addition, since workers cannot signal their true quality, type I firms always prefer to hire young workers.

During the second period, the problem will be the same for the worker as in the previous case. Hence, the level of effort he will produce will still be given by equation (2). During the first period, the problem will change for the worker, as he will have to consider that defaulting at that time will jeopardize his future rents.

The first problem for the worker will be:

(5) $$\max P_1 (-C_1^2)+(1-P_1)\,[(W_1-C_1^2)+P_2\,(-C_2^2)+(1-P_2)\,(W_2-C_2^2)]$$

Where the subscripts refer to the period of the worker's productive life.

Solving the first order conditions, we find:

(6) $$C_1 = \frac{\alpha}{2}\,(W_1 + \Delta\,\text{Expected Surplus})$$

Where the expected surplus is given by:

(7) $$\frac{\alpha^2\,W_2^2}{4}$$

In steady state, a firm will have a young worker employed with probability $\dfrac{1}{(2-P_1)}$, where P_1 is the probability for a young worker to make a mistake, and the probability of employing an old worker will be $\dfrac{(1-P_1)}{(2-P_1)}$. (Appendix A).

Therefore, a firm will, in steady state solve the following problem, representing its expected cost:

(8) $$\min E\left(\frac{1}{2-P_1}\,(P_1\,V+(1-P_1)\,W_1)+\frac{1-P_1}{2-P_1}\,(P_2\,V+(1-P_2)\,W_2)\right)$$

In order to make the problem more tractable, a first order Taylor approximation around $P_1 = 0$ was performed. (8) becomes:

(8b) $$\min E\left(\left(\frac{P_2}{2}+\frac{2-P_2}{4}\,P_1\right)V+\left(\frac{1}{2}-\frac{1}{4}\,P_1\right)W_1 + \left(\frac{1-P_2}{2}-\frac{1-P_2}{4}\,P_1\right)W_2\right)$$

The solution for a global minimum is given by (Appendix B):

$$W_1 = \left(\frac{1}{2} - \frac{a^2 V}{8}\right) V - \frac{1}{a^2}, \quad \text{and} \quad W_2 = V \tag{9}$$

Firms with high costs of mistakes will now be characterized by high entry wages and steep are earning profiles. The first period wage will be lower than the one-period contract wage derived before. Actually, it will always be negative, but the second period's will be much higher, as it will have some spillover incentive effects during the first period of work.

It can easily be shown that within the range of an interior solution, both the entry wage and the second period wage increase with *V*. The steepness of the age earning profile, measured by $W_2 - W_1$ is also a positive function of *V*.

It also follows immediately that firms with high costs of mistakes will have a lower probability of suffering from these mistakes and that this probability will decrease with the average quality of the workforce. This fact, in turn, implies that within the range of interior solutions, the expected cost of operation of the firm will decrease when the average quality of the population increases.

Turning now toward the workers, in equilibrium, their expected benefit will always be positive, as they will adapt their level of effort to the wage they are offered and to their true quality. Type I firms will not be able to deter workers from applying for their jobs, and no self-selection mechanism will take place. It can also be shown that the expected surplus of a worker will increase with his own quality and with V.

2.2.3. ***Contract with Public Information***

Assume now that, after the first period, the exact employment record of any worker will be available to any potential employer.

Assumption 12b:

Employment records are public information.

Because workers can signal themselves as reliable to other firms, and because firms with high costs of mistakes value reliability much more than do firms with low costs of mistakes, it will be beneficial for the employer to hire older workers who have signaled themselves as particularly reliable, and trade the reliability of the worker for an increase in the wage bill. Firms with low costs do not value workers' reliability as much, so they will not try to retain these workers.

The first implication of this assumption is that now firms and workers will not bind themselves to long term contracts. As it happens most often in reality, they will just sign contracts of indefinite duration. Good workers do not want to be bound into long term contracts, as they want to be allowed to cash in on their valuable signal at the end of the first period. To ask for a long-term contract is to signal your undesirability. Firms will not need to sign long term contracts either, as the second period surplus that the worker can earn by exploiting the signal will serve as an incentive during the first period.

The content of the contract that firms with very high costs of mistakes will offer to the young workers is not basically changed–as they are paying the highest wages on the market. They will offer them a W_1 wage, as given by (9), and offer te worker the option to work for them during the second period at a wage also given by (9). However, the situation of the firms with low costs of mistakes is no longer the same. At the end of the period now, if one of their workers has not defaulted, he will be allowed to apply to a higher paying firm. Therefore, the incentive effect during the first period will not come anymore from the wages promised by the initial employer for the first and second periods, but from the first period wage and the expected surplus that the worker can earn during the second period by exploiting the signal and being hired by a high wage firm.

In this framework, only the workers with very high α will not default during the first period. Firms with high cost of mistakes will value this piece of information very much, and the increase in worker's reliability will offset the increase in wage bill for the firm.

Finally, note that an older worker recently hired will be paid $V/2$, while an older worker who is spending his second year with the same firm will be paid V. Therefore, the difference between these two wages ($V/2$) will be interpreted as return to tenure, while the difference $V/2$ and W_1 will be interpreted as return to age. These obviously differ from firm to firm and will be positively correlated with the cost of potential worker's mistakes for the firm.

2.3. **Testable Implications of the Model**

This model has shown that the legal limitations on worker's liability can generate the payment of non-market clearing wages. The predictions of the model on the wage structure are consistent with several empirical regularities.

We have also shown that, even in an efficiency wage framework that provides a strong incentive for long-term employment relationships, quits and discharges can be explained. Firings arise from the employer's need to enforce efficiency requirements. Quits are the result of the willingness of the worker to cash in on the signal their employment record sends to the market and to potential employers. By holding a job in a company that requires a certain level of risk of mistake, the worker signals himself as a worker with higher ability and reduces the uncertainty about his performance. This positive signal often offsets the cost to the employer of paying an efficiency premium at the end of the worklife even if the employee has spent less time with the company.

Quits will occur less often when the efficiency premium to be paid at the end of the working life is higher, as workers will find fewer lucrative opportunities to quit. This implies that firms with steeper age-earning-profiles should suffer less quits than those firms with flatter profiles. In this model, return to age, return to tenure and entry level wages are positively correlated – all three being positive functions of the cost of mistake – we can extend this conclusion to return to tenure and entry level wages. Discharges or firings will also occur less often in firms paying higher wages, as these higher wages reflect the need for the firm to reduce farther the risk of mistake by their employees. When longer employment relationships take place, this need for the employer to reduce the risk of failure will be reflected in the premium to be paid at the end of the contract, which can be approximated by the steepness of the age earning profile. Here too, firms with steeper age earning profiles will fire fewer workers than firms with flatter profiles.

3 Empirical Evidence on Wages and Turnover

The presumption in this paper and in much of compensation literature is that firms differ in their compensation policy. Obviously with homogeneous workers, homogeneous firms, and perfect competition there would be no differences in pay or pay policy to analyze. So our first goal is to compare observed wage distributions with those predicted by the most parsimonious and simple model of a competitive labor market. Labor economists however, have long known that wage uniformity is more likely to reflect controlled than competitive labor markets. Europe in general, and Belgium in particular, are then especially interesting because of 1) high levels of government intervention in industry to set wage growth rates and minimum wage levels; 2) high rates of unionization (all the firms we study are unionized), and 3) and a centralized industry bargaining system (compared to the U.S.). In addition Belgium is a geographically compact country with a dense transportation network that brings most jobs and most workers within less than an hour of each other. The geographic barriers are linguistic more than temporal.

While they recognize that the system has frayed around the edges in the last decade, experts on the Belgian labor market routinely describe it as a system in which wages are set in industry wide bargaining, with little if any deviation at the firm or worker level. Indeed, this type of wage uniformity and rigidity has commonly been alleged to contribute to high unemployment in Europe. However, most of the evidence presented on this issue has been based on macroeconomic aggregates, and these can easily be spectacularly misleading concerning the underlying microeconomic behavior. Our second goal is then is to compare wage setting, in the U.S. and in a European country, not on the basis of commonly asserted folktales or aggregate patterns, but on the basis of observed microeconomic behavior. Finally, we will show how worker turnover differs between Belgium and the U.S., and show how differences in pay policies affect turnover.

In a matched employer-employee data-set, the previous hypotheses can now be empirically tested. 312 companies from the Belgian manufacturing industry will be used [2]. This dataset, built using data from the Belgian

2. The choice of these firms has been dictated only by the availability of non-wage related data for the firm (sales, assets, liabilities,...). The sample may not be representative of the Belgian manufacturing sector, which includes many smaller firms.

retirement funds for private workers, contains annual individual information on every person who has been working for these companies between 1983 and 1985. Although we only consider here the work experience of workers in one of these 312 firms, we can observe the result of a worker separation from one of them and infer from this result whether the separation was initiated by the employer or by the employee, or whether the separation resulted in unemployment, or dropping out of the labor force [3].

In this application, we will explain the quit and discharge rates during 1984 in terms of firm pay policy. The 312 study firms have in 1984 an average of 814 employees, ranging in size from 7 to 20,801 with a standard-deviation of 1844. They employ 175,570 blue collar workers and 69,125 white collar workers. Given the structural differences between blue- and white-collars labor markets, we estimate separate equations for each class of worker. These are population–not sample–data on employees within these firms. One could then treat the results that follow as calculations based on the population of workers in these firms, rather than as the usual estimates based on a sample. From that perspective, the standard-errors cannot reflect sampling error (of which there can be none in the population), but rather must reflect true dispersion of behavior in the population, or equivalently specification error. This reflects the inability of this or any other model to perfect capture reality. The firms themselves are those for which financial information is available. Most of them represent the largest industrial employers in Belgium. In total, they account for almost 30% of Belgian manufacturing employment. To place what follow in macroeconomic context, in 1984 the Belgian unemployment rate was 14%, after almost 10 years of stagnant overall macro growth.

3.1. **Wage Dispersion Across Workers, Industries and Firms**

The first surprising finding is that wages in a compact European country with a reputation for centralized industry-wide wage setting are in fact widely dispersed across firms within each industry, and across workers within each firm. The second surprising finding is that wages in Belgium are only slightly more compressed than in the U.S. Table 1 presents population statistics and Table 2 presents a standard log wage equation for the pooled 175,570 population of Bue-Collar workers in 1984 in 312 Belgium manufacturing firms.

The first two equations of Table 2 control only for worker characteristics (age, sex, tenure with the current firm), and so are directly comparable with similar estimates from microdata on individual workers. The amount of wage variation explained by this simple equation in Belgium is similar to that typically observed in the U.S. In both cases, there is substantial individual

3. A small minority of Belgian workers are not covered by the pension system from which the data are built. The largest of these uncovered groups are the tenured employees of the federal government. When a worker under the normal age of retirement disappears from the data, he is said to have dropped out of the labor force. A small fraction of them might have actually gone to work for the federal government. Since only a very small number of these workers are hired with tenure, this problem is likely to be of limited magnitude.

TABLE 1

Means and Standard-Deviations

	Blue-Collar		White-Collar	
	Mean	Standard-deviation	Mean	Standard-deviation
Across Workers				
(*N* = 244, 695)				
Ln Wage	7.68	0.24	7.96	0.41
Age	36.1	10.4	32.0	7.9
Tenure	5.6	2.1	5.7	2.1
Tenure > 6	63%	48	67%	47
Male	86%	35	77%	42
Across Firms				
(*N* = 312)				
Quit Rate	0.80%	1.2	1.8%	2.3
Discharge Rate	2.8%	3.6	1.2%	1.6
Employees	571	1382	243	543

Measures across firms represent averages and standard deviation of different measures at firm level.
Note : Tenure is truncated at 7.

heterogeneity, only about a third of which may be accounted for by observed individual characteristics. Given that a relatively high minimum wage in Belgium truncates the bottom tail of the wage distribution, and Belgium's more centralized bargaining structure and egalitarian norms, one might have expected greater wage uniformity.

Our data allows us to move beyond these standard estimates based on individual workers to ask how wage patterns differ across industries (eqs. 3 and 4) and firms (eqs. 5 and 6). In Belgium firms differ systematically, substantially, and significantly in the wages paid- despite high unionization, despite centralized industry wage bargaining, despite minimum wages and raises extended throughout an industry by force of law, and despite generous welfare, unemployment and minimum wage policies that all tend to truncate the lower tail of the wage distribution.

Membership in one of 18 industries is controlled for in equations 3 and 4 of Table 2. Not surprisingly, there are clearly important industry patterns–with an additional 19% of wage variation accounted for by industry. To put the same result of equations 3 and 4 another way, 49% (1-.51) of individual wage variation occurs within industry, after controlling for age, sex, and tenure.

The firm plays an important role in determining wages. Individual firm dummies are added in equations 5 and 6. Knowing which firm employs a person is nearly as important as the person's age, tenure, and sex in predicting wages. While the latter alone account for at most 32% of individual wage variation, the employer accounts for a minimum (in the terminology of ANOVA) of 30% (.62-.32) of individual wage variation.

The firm dummies span the industry dummies, so equations 5 and 6 implicitly control for industry. Comparing equation 6 with equation 4,

Table 2

Pooled Blue-Collar Wage Equations, 1984

Log Daily Wage (N = 175,570)	(1)	(2)	(3)	(4)	(5)	(6)
Cons.	6.743	6.191	6.653	6.164	6.824	6.413
	(1073)	(327)	(888)	(888)	(361)	(277)
Sex (a)	.305	.304	.219	.218	.205	.204
	(223.7)	(227.5)	(175.5)	(175.5)	(173.3)	(173.0)
Age	.0247	.0696	.0181	.0601	.0143	.0520
	(73.0)	(44.2)	(62.3)	(62.3)	(54.7)	(43.4)
Age^2	–.0002	–.00152	–.0002	–.00130	–.0001	–.00119
	(66.8)	(35.9)	(56.4)	(38.0)	(49.8)	(37.2)
Age^3	N.A.	.00001	N.A.	.000010	N.A.	.000009
		(29.3)		(32.4)		(32.2)
Tenure	.0717	.135	.582	.0709	.0548	.04175
	(31.9)	(17.4)	(30.4)	(10.7)	(31.4)	(6.9)
$Tenure^2$	–.00600	–.0290	–.00481	–0.106	–.00424	–.00121
	(19.4)	(11.5)	(18.1)	(4.9)	(17.5)	(0.6)
$Tenure^3$	N.A.	.00226	N.A.	.000595	N.A.	–.0002
		(9.3)		(2.9)		(1.4)
Perm (b)	.00955	–.0468	.00759	–.00640	.00888	.0160
	(2.7)	(6.5)	(2.5)	(1.1)	(3.3)	(1.4)
18 Industry Dummies	No	No	Yes	Yes	No	No
311 Firm Dummies	No	No	No	No	Yes	Yes
Adj. R^2	.3168	.3205	.5072	.5101	.6213	.6234

( ): *t*-statistics
N.A. = Not Added
(a): Male = 1
(b): Perm = 0 when Tenure < 7; Perm = 1 when Tenure = 7.

about 2/3 (.19/.30) of the firm effects are common industry effects, and at least 11% (.62-.51) of individual wage variation is firm-specific. Firm specific compensation policy plays a substantial rule in Belgian (and we assume European) wage determination.

A number of traditional econometric results also hold for Belgium. The returns to both age and tenure are positive, but declining [4]. Older workers earn higher wages until about age 43. Wages increase more dramatically with tenure, but also tail off more rapidly, with little change after the sixth year. Because of the large number of observations, a significant cubic relationship is found for both age and tenure, but this has modest economic substance (eq. 2). Wages increase (in the cubic) by about 20 percent between

4. These cross-section estimates of the returns to age and tenure probably understate returns as a given cohort ages because the wage profiles of recent cohorts have shifted up.

ages 20 and 31, increase an additional 2 percent to the peak at age 39, and decline 2 percent until age 56 with a slight rise thereafter. In the case of both tenure and age, the returns are concentrated in the first third or less of work life.

3.2. Sorting and the Returns to Age and Tenure

Even if no firm increased wages with age, typical wage estimates (without firm data) would show such a relationship if older workers sort into higher wage firms. Similarly, even if wages did not increase with tenure, such a relationship might commonly be estimated if workers in good job matches were rewarded with higher wages and so tended to stay to develop high tenure (ABRAHAM and FARBER). In the first case, the interesting question is how much of the returns to age occur within as opposed to across firms. In other words, do the observed returns to age reflect common seniority wage policies within each firm, or are they driven by the sorting of older workers into high wage firms. In the second case, the question is how much of the observed returns to tenure reflect successful sorting and match specific premiums.

The returns to both age and tenure observed in Belgian microdata on individual workers overstates the returns within the average firm. Compare equations 5 and 6 of Table 2 with equations 1 and 2. Controlling for firm, the returns to age and tenure are reduced, dramatically in the case of age. The average worker earns 20% more by age 31 than at age 20. Controlling for firm, however, the average worker's earnings increase by only half as much, 10% [5]. Half of the observed returns to age among these firms is then accounted for by the movement of older workers to higher wage firms [6]. Movers among these firms apparently earn a premium. This strong result is surprising in the Belgian context because few have thought of it as a fluid labor market with job shopping (turnover) sufficient to produce such a result. U.S. microdata usually does not permit estimation of firm effects but the greater turnover of U.S. workers suggests that the estimated returns to age in the U.S. may overstate even more what happens within the average firm.

Table 3 limits the sample to a group of stayers–here those with more than 7 years tenure at the same firm. The results in equation 6 show that among these stayers, the returns to age are muted and practically negligible. Because 7 years of tenure are required to be in this sample, it is practical to compare wages starting at age 27 (the estimates imply a 2 to 3 percent wage gain before this age, but these must be largely extrapolations beyond the observed range). Between age 27 and their peak at age 41, earnings increase by only 2.6 percent. For seasoned workers, wages are remarkably flat within the firm.

The contrast between strong returns to age in Table 2 and negligible returns in Table 3 indicates bigger returns to age among low tenure workers. Old workers with low tenure are unusual. Among these firms, they are also

5. This estimate includes both movers and stayers, but conditions on employer in 1984.
6. We will show that the bulk of these movements happens during the first few years of employment.

TABLE 3

Pooled Blue-Collar Wage Equations, 1984, High Tenure

Log Daily Wage
(Workers with more than 7 years seniority)
($N = 111{,}994$)

	(1)	(2)	(3)	(4)	(5)	(6)
Cons.	7.064	6.705	7.003	6.777	7.141	6.979
	(691)	(177)	(624)	(204)	(91)	(84)
Sex (a)	.296	.296	.223	.222	.209	.209
	(183)	(183)	(151)	(151)	(150)	(150)
Age	.0193	.0474	.0114	.0289	.0079	.0206
	(38)	(16)	(6)	(12)	(20)	(10)
Age^2	–.000280	–.000927	–.000126	–.00057	–.000108	–.00041
	(33)	(13)	(24)	(9)	(19)	(8)
Age^3	N.A.	.0000057	.N.A.	.00001306	N.A.	.00000259
		(10)		(7)		(6)
18 Industry Dummies	No	No	Yes	Yes	No	No
311 Firm Dummies	No	No	No	No	Yes	Yes
Adj. R^2	.2501	.2507	.4648	.4650	.5963	.5965

( ): *t*-statistics
N.A. = Not added
(a): Male = 1.

unusually well paid–again consistent with firms paying a wage premium to attract experienced workers.

The returns to tenure are also lower once firms are controlled for. Comparing equations 6 and 2 of Table 2 indicates that workers are more likely to build up high tenure in high wage firms, so estimates such as those in equation 2 overstate the true return to tenure within firms. Similar conclusions are drawn for the U.S. by ABRAHAM and FARBER [1987].

Previous work in the U.S. (LEONARD [1988]) developed models in which the wage distribution within a firm becomes truncated as wage outliers leave the firm to find better matches. In this model, wages also become less predictable on the basis of characteristics observable to the econometrician–as the firm uncovers true variations in productivity unobservable to an outsider. These models predict that as a group of workers increase their tenure within firms, the firm effects become stronger (as selection across firms proceeds), but the R^2 of wage equations decreases as wages are determined more by factors observed by the firm but not by the econometrician. Comparing the high tenure workers in Table 3 with the entire work force in Table 2, we see that publicly observed personal characteristics such as age and sex explain less wage variation among seasoned workers than among entrants. This result for Belgium is consistent with earlier work for the U.S. (LEONARD [1988]). In both countries wages depend less on publicly observed characteristics, and relatively more on private information as tenure increases.

A putty-clay view holds that the equalizing forces of labor market competition are strongest for new hires (the active margin). Wages can vary more among high tenure workers because of larger fixed costs that limit their mobility. This predicts less wage variation across workers and firms at low tenure who are more directly exposed to competition. In contrast, a rent-sharing model (or any firm-wide firm-specific effect) predicts constant firm effects across tenure groups. A final, competitive model allows workers to be forward-looking, and equalize present-values of career earnings. The variance of wages across firms with different returns to tenure will then fall as they reach the cross-over point some years after hiring.

Competition does not force more compressed firm effects among new hires than among tenured workers, contrary to the active margin theory. Nor is the variance of firm effects constant across tenure groups, contrary to simple omitted common factor models such as rent-sharing or compensating differentials. Separately for workers with one and seven years of tenure, we estimate pooled (across firm) log wage equations as a function of age and its square, sex, and firm dummies. The standard-deviation of the firm effects among newly hired blue-collars is .44, falling to .38 among workers with 7 years of tenure. Among White-Collar workers, the new hire standard-deviation of firm effects is .47, falling to .39 at seven years of tenure. The firm effects we observe are not due simply to the lock-in of tenured works, nor to a common omitted firm factor. Nor are differences across firms in skill requirements or occupational distribution likely to account for these wage patterns, for if that were the case we would have expected much greater dispersion for white than for Blue-Collar workers. These results are congruent with forces that tend to level the present-value of earnings over the career. We shall reinforce this point later in examining the relationship between starting pay and returns to tenure.

Note also that the wage penalty for being a woman has been remarkably persistent and stable. Among workers hired into their firm more than 7 years ago, women earn 30% less than men, controlling for age, and 20% less controlling for age and firm. The penalty is nearly identical in the full population which includes more recent entrants. One-third of the wage penalty occurs because Belgian women are more likely to work in low wage firms. Pay equity proposals that end at each firm's walls cannot touch this.

3.3. **Differences in Firm Compensation Policy**

Previous work in the U.S. has shown that the standard deviation of firm wage effects within industry, typically lies in the range of 7 to 21%, even within industries and labor markets thought of as competitive, even within narrowly focused industries and geographic regions, and even after controlling for narrow occupations (GROSHEN [1991]; LEONARD [1989], [1990]). In Europe, we expect less variation across firms–not because the markets are more competitive (although they are shifted toward smaller establishments), but because they are more unionized, more subject to centralized bargaining, and more constrained by government wage regulation directly through the minimum wage as well as indirectly through wage floors created by generous social welfare programs.

Previous work has estimated a one parameter model of wage policy–allowing firms to differ only in their average pay. Here we estimate 6 or more parameter models, that allow a much richer characterization of firm's pay policies. We allow firms to differ in average pay, returns to age, returns to tenure, and in policies for blue- and White-Collar workers.

For each firm with 100 or more blue collar workers, and for each with 100 or more White-Collar workers we estimate individual firm wage equations of the form:

$$(10) \qquad W_{84\,i,\,j} = \alpha_{1j} + \alpha_{2j}\,\mathrm{Age}_i + \alpha_{3j}\,\mathrm{Age}_i^2 + \alpha_{4j}\,\mathrm{Tenure}_i + \alpha_{5j}\,\mathrm{Tenure}_i^2 + \alpha_{7j}\,\mathrm{Perm}_i + \alpha_{8j}\,\mathrm{Sex}_i + \nu_i$$

These are regressions of the log of the daily 1984 wage for each worker on age and its square, tenure and its square and sex. These regressions are run separately for each company and for blue and white collar workers within each company. This results in 239 Blue-Collar equations and 145 White-Collar equations. Table 4 presents the results.

TABLE 4

The Distribution of Estimated Age Earning Profiles

Across Firms
(Summary Statistics From Firm Specific Quadratic Wage Equations)

	Empirical Distribution of Estimated Coefficients			
	Intercept	Age	Tenure	Starting Pay
Blue-Collar *n* = 239 Firms				
Mean estimated Coefficient	6.87	.017	.062	7.13
Standard deviation	0.42	.016	.091	.29
% variance within Industry	35	88	95	
Mean estimated Std. dev.	.139	.006	.051	
White-Collar *n* = 145 Firms				
Mean estimated Coefficient	6.03	.066	.054	7.11
Standard deviation	0.59	.032	.165	.26
% variance within Industry	89	22	86	
Mean estimated Std. dev.	.326	.016	.120	

Note: Starting pay is the fitted value at age 20, tenure 0.

Simply put, common depictions of Belgian (and perhaps European) pay policy as rigidly uniform across firms are wrong. Belgian manufacturing firms exhibit large differences from each other in starting pay, as well as in the returns to tenure and age. Moreover, most of this variation take place within, not across, industry lines.

The dispersion in pay across Belgian firms is not only large–it is comparable in magnitude to that observed in the U.S. Again the evidence is contrary to common assertions. The standard deviation of blue collar starting pay across large Belgian manufacturing firms is .289 (Table 4). None of this can be accounted for by differences in age (held fixed at 20), tenure (held fixed at 0), sex (controlled for), broad occupation (the population is limited to blue collars), macroeconomic conditions (year is held fixed), region (Belgium is too compact), or broad industry (controlled for). In other words, to encompass 95% of these firms requires a range of firm daily wages from 2190 BF to 705BF, a 3:1 ratio. One standard deviation above and below the mean would range from 1659BF to 931BF, a 1.8:1 ratio. Pay dispersion across Belgian manufacturing firms is substantial.

It contributes little to compare these results to the theoretical construct of a perfectly informed and perfectly competitive market with no wage dispersion because as an empirical matter, wages are rarely identical across workers, establishments or firms, even within what are often thought of as competitive markets. For example, a survey of 2087 workers in U.S. fast-food restaurants in 1982 showed that for the proverbial hamburger-flippers and their managers, the standard-deviation of wages are respectively 10 percent and 22 percent of average wage (KRUEGER [1991], p. 88).

A distinct empirical question is whether there are systematic differences across firms or establishments in the level of pay in the relatively unregulated US markets. Even within unregulated industries, substantial differences have typically been found. GROSHEN [1991] presents such evidence for six different US manufacturing industries [7]. Controlling for occupation, sex, region, and incentive pay, she finds that the standard-deviation of pay across establishments within industry is about 14 percent of the average wage. In a study of compensation at some 200 plants in the California electronics industry between 1980 and 1985, LEONARD [1989] finds, controlling for occupation, that the standard-deviation of plant effects averages 7.3 percent in what is usually thought of as a competitive industry. Even greater dispersion is found among managers and executives across firms and industries. LEONARD [1990] examined executive and managerial pay for executives at 439 of the largest U.S. corporations between 1981 and 1985. The standard-deviation of estimated firm wage effects is .21 for the logarithm of base salary plus bonus, controlling for occupation, education, position in the corporate hierarchy and unit sales.

7. Groshen uses data from U.S. Bureau of Labor Statistics Industry Occupational Wage Surveys between 1974 and 1978 for production workers. Wages reported are straight-time hourly wages for hourly workers, and average hourly earnings for workers under incentive pay schemes. Groshen statistically controls for sex, region (where available), incentive pay, and detailed occupation. She finds significant establishment wage differentials in all six industries, averaging .14 log points. The standard-deviation of establishment wage differentials in each industry are plastics (0.15), industrial chemicals (0.15), wool textiles (0.15), men's and boy's shirts and nightwear (0.13), cotton and man-made textiles (0.09), and fabricated structural steel (0.18).

All of these studies are of employers in unregulated industries. All find substantial wage variation across employees and across employers. The standard-deviation of establishment or firm wage differentials in these studies range from 7 percent to 21 percent. The roughly comparable figures for starting pay in Belgium are 26 percent for white-collars and 29 percent for blue-collars. The wage differentials observed among large Belgian manufacturing firms exceeds that observed in US industries.

It is not possible to perform a perfectly identical analysis of US wages across firms. Some part of the larger pay dispersion observed here for Belgium is probably due to the finer occupational categories used in the US studies. Part of what we label here as firm differences in pay may reflect different skill distributions across Belgian firms, although it may also be that US firms hide some pay differentials for identical workers behind different job titles. The definition of industry, and its administration to firms may also result in broader and more heterogeneous firms within industry in Belgium than in some of the US studies. US firms are also more likely to differ in benefits, more of which are privately provided in the US than in Belgium. Counterbalancing this, the US studies tend to include firms that are more widely dispersed across regions and across firm size. Education is not directly controlled for here, nor in most of the US studies. In the one US study that does control for education (LEONARD [1990]), it has little impact on wages once detailed occupation is controlled for.

The US results that follow most closely the methods we apply here to Belgium come from an analysis of wages for workers divided into two job classes (production and non-production) analogous to the blue and white collar classifications we use, and into 2-digit industries within manufacturing, a similar level of industry classification. DAVIS and HALTIWANGER [1991] report the standard-deviations of plant means (Table 2) and the overall means (Table 6) of hourly wages. From this data, we calculate the coefficient of variation to be .37 for Blue-Collar and .35 for White-Collar. Using similar broad occupational classes and 2-digit industry classes, Davis and Haltiwanger's data indicates that the standard-deviation of firm effects is 35% for White-Collar and 37% for Blue-Collar within US manufacturing industries in 1984. They also report that 26% of the Blue-Collar between plant variation is accounted for by differences in plant size (p. 151). The dispersion of size in our Belgian firms is roughly one-third that observed across U.S. plants. To isolate our comparison from differences due to differing size dispersions, we eliminate two-thirds of the 26% of U.S. between plant variation. If U.S. plants varied as little in size as our Belgian firms do, we would expect to see roughly a 30 percent standard-deviation of Blue-Collar firm effects. This is quite close to what we actually observe in Belgium. The point of this exercise is not to claim that this technique is without flaw, but rather to show that the observed differences in wage dispersion across employers in Belgium compared to the U.S. are well within the range of uncertainty created by differences in populations studied, in industrial and occupational classification, and in measurement and classification techniques. Differences in the size distribution alone are sufficient to account for most of the differences observed across countries in cross-employer wage dispersion.

Nor is Belgium alone among European countries in its wage dispersion. The only similar analysis for Europe of which we are aware is the remarkable work by ABOWD, KRAMARZ [1992] and ABOWD, KRAMARZ, and MARGOLIS [1994]. The former paper reports (Table 1) that in the French economy, the standard-deviation of enterprise effects on annual compensation is 34 percent of mean pay, rising slightly to 35 percent among unskilled workers. This includes both within and across industry components, but, like our study, shows substantial differences in pay across firms.

On this evidence, it appears mistaken to claim that Belgian (European?) wage structures across employers within manufacturing are too compressed and too uniform compared to the supposedly more competitive US. Indeed, Belgian manufacturing firms appear to be roughly comparable in wage dispersion to their US counterparts. Belgian wage dispersion may vary in degree, but certainly not in type from that observed in the U.S.

A significant advantage of the richer parameterization of pay policy employed here is that it allows us to see that Belgian firms differ not only in terms of starting (or average) pay, but also in terms of the returns to age and tenure. The latter differences are exceedingly large. As one would expect, given greater differences in ability, observability, and responsibility, there are greater variations in the returns to age and tenure for white collar than for blue collar workers.

The magnitude of the slope differences across firms is such that it is natural to suspect measurement or specification error. Again, sampling error is precluded because there is no sampling of employees. An example of the type of error we suspect is as follows. Suppose the true age earnings profile were quadratic and identical over firms, A linear function fit to firms with different age distributions of workers will yield steeper slopes in firms with younger workers. Indeed, among blue collar workers the estimated return to age within a firm is negatively correlated with average age. We attempt to guard against this type of error by limiting the calculation to firms with more than 100 workers in the particular collar color, and by fitting cubic equations. If the differences in pay policy found here across firms are all spurious statistical artifacts despite our precautions, then by definition, they can have no real effects. The best evidence that at least part of these differences are real is to show that they have a real impact on workers or firms. We present such results in the last section.

Both economic and institutional explanations of pay policy would usually predict differences across industry. Such differences could arise in theory if industries differ in production functions, shirking costs, monitoring costs, observability of output, specific human capital investments and investment shares, and default risk. In institutional accounts industries differ by history or by tautology.

Most of the variation in Belgian pay policy occurs within–not across–industries (Table 4). Pay policy is more heterogeneous across firms than can be accounted for by any of the simple models that predict differences across but not within industries.

Comparing returns to age and tenure shows that the average worker (Table 2, eq. 1) is in a firm that is less steeply sloped than the average firm

(Table 4) (slopes are steeper in smaller firms). Clearly, the returns to tenure during the first six years are dramatic within these firms.

In theory, competition within labor markets equalizes the present value of compensation for homogeneous employees among otherwise comparable employers. This implies that employers with steeper returns to age and tenure must also have lower starting wages. In contrast, a rent-sharing model easily accommodates employers whose entire wage-age or wage-tenure profile is above average.

TABLE 5

Correlation Matrix of Estimated Coefficients

	White Collars			Blue Collars		
	Intercept	Age	Tenure	Intercept	Age	Tenure
White Collars:						
Intercept		–.90	–.21	.16*	–.13*	–.02*
Age			–.13	–.09*	.10*	–.05*
Tenure				.04*	.01*	.19
Blue Collars						
Intercept					–.73	–.19
Age						–.16
Tenure						

* Not significant at 5% error level.

Table 5 shows the correlations of pay parameters across firms for blue and white collar workers. Among both blue and white collar workers, firms with higher returns to age or tenure tend to pay less initially. These correlations are significant, and in the case of returns to age, large. This is consistent with specific human capital models, some [8] deferred compensation or bonding models and with on the job sorting models. Note also, also that the negative correlation between the returns to age and tenure probably reflect the collinearity of the variables.

We employ a "brothers" (GRILICHES [1979]) test to difference out unobserved firm-specific factors that might affect both white-collar and blue-collar pay. For example, if high wages or returns to age and tenure were due to rent sharing (and different groups of workers could equally extract rents), to a firm-wide compensating differential, or to firm-wide fringe benefits, then we would expect to see strong positive correlations between pay parameters for blue-collar and white-collar workers.

Even within firm, within class of worker, the correlations of firm effects between low and high tenure workers are moderate. The firm effect for blue-collar workers with one year of tenure is correlated .69 with that of same firm same collar workers with seven years tenure. Among white-collar

8. Deferred compensation that solved moral hazard or adverse selection problems might increase productivity over the working life. In this case, slopes and intercepts might be positively correlated. However, competing firms would be driven to adopt the same policy–eliminating variance and the positive correlation.

workers, the correlation across tenure groups is only .43. These correlations restate the fact that firms with steeper returns to tenure pay less initially. These results are consistent with labor market competition that tends to equalize not starting wages but rather the present-value of career earnings.

Table 5 shows that with the exception of returns to tenure, pay policies toward blue- and white-collar workers are not significantly correlated. In other words, pay policy does not reflect a common firm-wide force or condition. This rules out widely shared rents; compensating differentials for firm-wide risks, amenities, working conditions or fringe benefits; growth booms; or locale specific differences. The observed heterogeneity *within* firms across classes of workers is a simple but powerful result because it makes a firm-wide, firm-specific force an unlikely cause of observed pay differences. Because efficiency wages depends on monitoring or observability problems that might easily differ across classes of workers within a firm, the absence of common firm effects leaves open an efficiency wage interpretation of the data.

An efficiency wage model appears more relevant than a rent-sharing interpretation. Even in a strongly unionized [9] country, no significant correlation (with the exception of the return to tenure) can be found between the wage schedule of blue- and white-collar workers. A rent sharing interpretation would imply strong positive correlation between them. On the other hand, an efficiency wage interpretation, grounded in monitoring and the uncertainty existing on workers' performances does not make the same prediction. This distinction arises because, while blue and white collar workers in a same firm face the same rents they do not face the same costs of monitoring, shirking, or the same costs of potential mistakes.

4 Employee Turnover

Before examining the impact of pay policy on turnover, we first describe the nature of flows out of firms. Employee turnover is low in Belgium compared to the U.S., but it is still substantial. Firms in this sample have had a relatively high level of turnover between 1984 and 1985. Turnover figures are calculated from individual data. A worker who was present in 1984 and disappears from the firm's payroll in 1985 is classified as having left the firm. The reasons for the separation are inferred from the employment history of the worker. If he spends some time unemployed after he leaves the firm, he will be assumed to have been laid-off. Temporary layoffs do not exist in Belgium. The discharges reported here are permanent separations. If he goes directly to another employer, he will be assumed to have quit the firm. Finally, if he disappears from the records of the private sector social security system, he will be classified as having left the labor force.

9. All companies in the study are unionized.

These definitions are of course subject to some criticisms. Some workers willing to leave the labor force might ask their employer to fire them in order to be allowed to collect some unemployment compensation. Some workers laid off might find a new job between the day when they are notified of their discharge and the day their employment effectively ends, as Belgian law requires in most cases short advance notice of the lay off. These discrepancies, however, are likely to be minor [10]. However, the longer notice typically required for white- than for blue-collar workers may result in a higher ratio of quits to discharges among white-collars.

When a separation is initiated by an employer, the data do not allow us to retrieve the cause of the separation. The data on layoffs include indistinguishably layoffs in response to a fall in product demand, and firings that would occur even with fixed demand. Our theory concerns firings for cause, so the regressions that follow count as discharges only those separations resulting in unemployment that are in excess of the decline in positions at the firm.

Table 6 shows the distribution of 1984 labor stocks and outflows between 1984 and 1985 by tenure and by job class. 8.3% of blue-collar and 8.8% of white-collar workers had left their 1984 employer by 1985. Neither restrictive labor regulations nor union nor insider power eliminate the firm's ability to reduce its work force. Leaving aside discharges, the annual outflow rates are 4.5% for blue collar and 7.1% for white-collar. These attrition rates are sufficient to adjust to most macroeconomic shocks. (Even in the "unregulated" U.S., aggregate employment rarely declines by more then 4% per year).

Quite clearly, Belgian firms can and do fire workers, at an annual rate of 3.8% for blue collar and 1.7% for white-collar, despite more restrictive labor law and wider union representation. Much of the turnover of employees can be accounted for by the turnover of jobs. Our previous work (LEONARD and VAN AUDENRODE [1993]) demonstrated that about 3% of Belgian manufacturing jobs were destroyed annually. A large part of the relatively low rate of Belgian employee turnover can be accounted for by the relatively low rate of Belgian job turnover.

Directly comparable U.S. data on employee turnover at the firm or establishment level is no longer available. The most recent Federal government survey of turnover indicates a separation rate of 4.1 percent per month [11]. Multiplying by 12, separations equal to 49% of employment could be expected to occur annually. These separation rates are similar to those reported in another survey published by the U.S. Bureau of Labor Statistics. For 1980, the last full year for which statistics are available, the average monthly separation rate was 4.1% per month (U.S. Bureau of Labor Statistics, *Employment and Earning, Revised Establishment Data*, August 1981, p. 315). The average quit rate was 1.5% per month. Multiplying by 12, separations equal to 49% and quits equal to 18% of the work force would

10. The Belgian social security system requires workers to be continuously in the labor force to retain their social rights. Therefore, unless a laid-off workers finds a job starting the day after his previous contract has been terminated, he has to register as unemployed, even for a few days.

TABLE 6

Turnover and Tenure

Blue Collars:							
% of Workers	Stay	Quit	OLF	Retire	Discharge	Disability	Ambiguous
	91.7	.7	1.0	1.9	3.8	.6	.3
Distrib. by Tenure							
1	5.9	23.7	24.6	1.6	16.8	8.9	100
2	5.6	17.9	17.4	.9	24.1	7.4	0
3	8.2	10.7	10.8	1.0	9.6	9.8	0
4	4.0	5.4	3.6	.7	4.7	3.3	0
5	4.8	5.2	4.2	1.4	5.9	3.6	0
6	6.3	3.7	4.3	1.4	4.9	4.0	0
7 (more)	65.7	33.4	3.2	92.9	33.9	63.1	0

White Collars:							
% of Workers	Stay	Quit	OLF	Retire	Discharge	Disability	Ambiguous
	91.2	1.7	2.5	2.3	1.7	.3	.2
Distrib. by Tenure							
1	6.3	19.5	10.6	1.9	18.4	9.4	100
2	5.0	18.5	18.2	1.6	42.1	7.6	0
3	5.5	10.6	13.4	1.0	13.8	8.5	0
4	3.6	6.4	7.6	1.1	3.0	1.3	0
5	4.2	8.7	6.5	1.2	3.7	.9	0
6	4.0	6.4	5.1	.1	2.3	1.3	0
7 (more)	71.3	29.9	38.5	89.7	16.6	71.0	0

be expected each year. These are far larger than the Belgian blue-collar separation rate of 8.3% and quit rate of 0.7%.

White-collar workers in Belgian firms are not clearly more stable than blue-collars. While 63.7% of blue collar workers have 7 or more years tenure with their firm, 69.1% of white-collar workers have. Recall that the annual separation rate is higher for white-collar than for blue collars. These separation rates hide deeper differences in the types of outflows. 46% of blue-collar, but only 19% of white-collar separations are discharges into unemployment. In contrast, white-collar separations are far more likely to take the form of moving directly to a new employer (19% of separations) or dropping out of the labor force (28% of separations–OLF here includes self-employment and public sector employment). The firms included here

11. Separations include quits, discharges for cause, retirements, deaths, and layoff exceeding 30 days. Workers on temporary layoff, on strike, or on assignment from temporary help agencies are not counted as separations. Data were collected between November 1990 and April 1991 in eight industries nationwide, including non-manufacturing industries (SIC codes 13, 17, 36, 42, 508, 58, 60 and 806). As reported by the U.S. Bureau of Labor Statistics in *Employee Turnover and Job Opening Survey*, 789,000 separations occurred in an average month. Base employment in these industries is 19,506,000 so the monthly separation rate is 4.1%.

offer most of the best and most stable jobs available for blue collar workers. White-collar workers have broader opportunities in the service, finance and the public sectors.

New job matches have high infant mortality rates. Firms that have recently hired the most also layoff the most. The correlation of new hire rates and layoff rates across firms is .30 for blue-collars and .32 for white-collars. Firms do sort on-the-job during the first year's tenure, although as we shall show in the next section, this does not itself account for the variation in seniority profiles. It is also worth noting that we see no evidence of the negative correlation between quits and layoffs predicted by theories in which the two are different names for the same thing, and so perfect substitutes (McLaughlin [1991]).

TABLE 7

Turnover and Age

Blue Collars:							
% of Workers	Stay	Quit	OLF	Retire	Discharge	Disability	Ambiguous
	91.7	.7	1.0	1.9	3.8	.6	.3
Distrib. by Age							
< 25	14.4	36.5	39.6	0	40.1	6.0	51.8
25-30	15.4	18.0	15.6	0	15.6	5.2	18.5
30-40	30.6	21.9	20.6	0	17.4	18.3	18.6
40-50	24.3	13.7	15.8	0	9.2	25.4	7.7
50-60	15.0	8.0	8.4	81.2	16.9	39.2	3.2
>60	.3	1.8	0	18.8	.7	6.1	.2
White Collars:							
% of Workers	Stay	Quit	OLF	Retire	Discharge	Disability	Ambiguous
	91.2	1.7	2.5	2.3	1.7	.3	.2
Distrib. by Age							
< 25	6.4	18.8	16.8	0	51.5	4.0	56.3
25-30	11.4	25.1	21.3	0	19.6	5.8	16.3
30-40	30.8	32.1	31.1	0	14.5	12.0	19.2
40-50	28.7	15.1	22.7	0	6.0	12.5	8.2
50-60	20.7	7.1	8.1	62.7	8.2	43.8	0
>60	2.0	1.7	0	37.3	.1	21.9	0

The time path of separations also differs between blue and white-collars. Tables 6 and 7 clearly show that discharges are a disease of the young and the recently hired, as one would expect from a matching process with imperfect information. 41% of blue collar discharges occur within the first two calendar years of employment (representing 13.3% of employed) and 40% occur among those under 25 years of age (representing 15.6% of employment). Surprisingly, discharges are even more front-loaded among white-collar workers. 61% of white-collar discharges occur in the first

Table 8

The Ratio of Tenure Group Turnover Rate to Total Turnover Rate, by Tenure Group

Tenure	1	2	3	4	5	6	7
Blue Collars:							
Quits	3.45	2.78	1.32	1.36	1.08	0.06	0.52
O.L.F.	3.58	2.70	1.32	0.91	0.88	0.70	0.55
Layoffs	2.46	3.75	1.18	1.19	1.22	0.81	0.53
White Collars:							
Quits	2.81	3.00	1.80	1.76	2.03	1.61	0.43
OLF	1.53	2.95	2.28	2.08	1.53	1.29	0.56
Layoffs	2.66	6.81	2.34	0.83	0.86	0.59	0.24

The ratio for quits for tenure group i, for example, is computed as:

$$\text{Ratio} = \frac{\frac{\text{Number of Quitters with Tenure } i}{\text{Total Number of Quitters}}}{\frac{\text{Number of Workers with Tenure } i}{\text{Total Number of Workers}}}$$

two calendar years of employment (12.9% of employment) and 52% occur among those under age 25 (7.6% of employment). Employers discover and eliminate white-collar mismatches earlier than blue-collar, despite the presumption that white-collar productivity and effort are less observable.

In theory, one might have expected a lower quit rate among white-collars because of greater investments in firm-specific human capital. However, we see the opposite here. Also surprising is that blue-collar quits are more concentrated than are white-collar in the early years with a firm. Table 8 shows for each year of tenure the share of all quits in the tenure group divided by the share of all employment in the tenure group. Identically, it shows each group's quit rate divided by the overall quit rate. The blue collar quit rate in the first year of tenure is 3.45 times average, but falls to 0.60 of average by the sixth year. In contrast, the white-collar quit rate falls more slowly with tenure, remaining 1.61 times average after 6 years. White-collar workers in these firms are more transient and exhibit weaker attachment. If it takes the white-collar employees longer to discern a mismatch, the same cannot be said of their employers. Discharges are more front-loaded for white-collar, but quits are less front-loaded. Employers appear to discover bad matches more quickly than do employees.

5 The Effect of Pay Policy on Turnover

While a number of theories imply that pay policies will affect employee turnover, these are rarely tested. Pay policies differ at the firm level, but firm level data on human resource practices and outcomes are usually not publicly available. Here we take pay parameters estimated from the relatively rich firm and class specific quadratic wage equations and ask whether these affect the firm's quit and discharge rates as economic theory predicts.

5.1. **Competing Predictions**

The first theory is that competition among homogeneous firms and workers forces homogeneous pay policies. The differences we observe across firms in pay policy are then statistical artifacts due to measurement or specification error. This theory carries a strong prediction: differences in estimated parameters that do not reflect true differences cannot have real effects. Only true differences in pay policy should covary with human resource outputs. The theory of compensating differentials makes the same unambiguous prediction for quits. Pay differences that are compensating differentials unambiguously predict no correlation with quit rates.

A variant of this statistical theory combines error with differing age distributions across firms. Again suppose all firm' pay follows the same quadratic function of age, with error. Firms with younger workers will tend to yield steeper slope estimates even with the correct specification. This predicts that steeper slopes will be associated with younger work forces (which tend to have higher turnover).

If causation is reversed, and firms adopt steeper profiles when troubled by high turnover, the correlation of steepness and turnover is again predicted to be positive. On-the-job sorting also predicts a positive correlation between steepness and the discharge rate. Firms draw new hires with random unobserved productivity. Over time low productivity workers become apparent and are fired, and the pay of survivors is increased to reflect the expected productivity of the truncated distribution. Higher discharge rates produce steeper wage profiles.

Wage profiles that reflect general human capital predict no differences in turnover. If human capital is firm specific, slopes may increase either because worker's share of investment (and returns) is greater or because the level of investment is greater. The first case reduces quits but may increase discharges. The second case reduces both quits and discharges.

Compensation policies may also be designed to induce self-selection among workers. Suppose that productivity is only slowly revealed over time. Firms with deferred compensation (that in effect require workers to post a performance bond) will induce low productivity (or poorly matched) workers to self-select out. Steeper profiles are associated with lower turnover.

The efficiency wage model developed here predicts that steeper wage profiles will be associated with lower rates of both quits and discharges. As we described before, we expect firms whose difference in observed wages can be interpreted as either differences in the efficiency premium they have to pay or difference in their policy concerning the temporal distribution of the lifetime earnings to face different turnover behavior. From the estimation of the age earning profile in each company, we obtained 239 sets of coefficients for the blue collars and 145 for the white. These coefficients were then used to estimate the effect of the wage policy by the firms on their turnover. To do that, we will assume that the workers perceive the current existing age earning profile as being what they can expect as the evolution of their own wage.

The following regression was performed separately on the 239 observations for the blue collars and the 145 observations for the white-collars:

$$(11) \qquad Q_j = \beta_1 + \beta_2\,\alpha_{1j} + \beta_3\,\alpha_{2j} + \beta_4\,\alpha_{4j} + \beta_2\,\alpha_{8j} + \beta_6\,\mathrm{size}_j + \beta_7\,\mathrm{growth}_j + \beta_8\,\mathrm{age}_j + \beta_9\,\mathrm{sex}_j + \mu_j$$

Where α_1, α_2, α_4, and α_8 are respectively the intercept, coefficient on age, tenure and sex for the estimated age earning profile for company j estimated in (10), SIZE represents the size of the company measured by the total employment in the considered group, GROWTH measures the employment growth in the company between 84 and 85, AGE and SEX represent, respectively, the average age and proportion of men in the company. Finally, Q is a logit transformation of either the quit rate or the discharge rate [12] in the company between 1984 and 1985 [13].

5.2. The Impact of Pay Policy on Turnover

The relationship between pay policy and quits and discharges is shown in Table 9 for blue collars, and in Table 10 for white-collars. In all cases, higher wage levels (intercepts) significantly reduce both quits and layoffs. The quit result is unremarkable, that for discharges is not so readily explained. Theories of pay differences as measurement error or as compensating differentials can both be dismissed. These pay differentials have real effects, reducing both quits and discharges. These effects are both significant and substantial. A one standard-deviation increase in the return to age will cut the quit rate in half, and the discharge rate by 39% for blue-collars. For white-collars, quits and discharges would be driven to zero. A one standard deviation increase in the returns for tenure has somewhat similar effects: reducing blue collar quits by 38% and discharges by 32%, and reducing white-collar quits by 47% and discharges by 43%. The behavioral effect on quits is stronger among white-collars. That steeper slopes reduce quits and discharges is consistent with a number of theories, including specific human capital, induced prior self-selection, and the efficiency wage model developed here.

These results stand in clear conflict with on-the-job sorting models. In these models, firms are uncertain about individual productivities, so pay mean expected productivity. As firms uncover low productivity workers, they fire them, truncating the bottom tail of the productivity distribution, and

12. As our theory deals essentially with discharges for cause, as opposed to layoffs for economic reasons, we used as an approximation for discharges the variable: $D_j = \mathrm{Min}$ ($\mathrm{LAYOFFS}_j$, $\mathrm{LAYOFFS}_j + \mathrm{GROWTH}_j$). The results are not fundamentally different from the ones obtained by using the total layoffs as the left hand side variable.

13. To avoid losing observations with zero quits or discharges, we used Haldane's transformation (Gart & Zweifel [1967]).

TABLE 9

Earnings Profiles and Turnover. Blue Collar Workers (1)

Effect on	Minimum Chi-Square Estimate	
	Quits	Discharges (2)
Const.	11.977	5.968
	(2.24)	(1.94)
α_1 (Intercept) (3)	–1.860	–.840
	(2.82)	(2.05)
β_2 (Age)	–33.498	–17.256
	(2.52)	(1.91)
β_4 (Tenure)	–4.279	–2.778
	(3.03)	(3.41)
β_7 (Sex)	–1.829	–.969
	(2.70)	(2.13)
Size	–.0001	–.0001
	(0.30)	(2.04)
Growth	1.221	–.608
	(1.60)	(1.24)
Age	–.078	–.072
	(2.48)	(4.43)
Sex	1.036	.003
	(2.45)	(0.01)
Adj. R^2	.359	.398

( ) = *t*-statistic.
(1) All equations include 17 industry and 8 regional dummy variable. The industry variables are jointly significant at the 1% error level, while the regional variables are significant only in the quit equation.
(2) Discharges = Min (Total Layoffs, Total Layoffs + Growth).
(3) The α's and β's used as independent variables here are firm specific coefficients estimated from equations.

raising the pay of the survivors to reflect the new higher mean productivity of the truncated distribution. More intensive sorting on the job causes both more discharges and a steeper seniority profile. We observe that steeper slopes are associated with a lower rate of discharge, which rejects the on-the-job sorting model.

Attempts to explain differences in human resource outcomes have almost always been limited to publicly observable gross firm characteristics such as size, industry, unionization or growth. Modern theories call attention to the importance of differences in compensation policy, but these are rarely observable by outsiders, and are often asserted to vary little within industry or size class (For exceptions that test the effects of internal compensation policies see ABOWD [1989], LEONARD [1989], ABOWD, KRAMARZ & MARGOLIS [1994], KRUSE [1993]). Table 11 presents an ANOVA of the relative importance of public firm characteristics and of firm compensation policy in accounting for turnover behavior in Tables 9 and 10. We find that both sets of effects are highly correlated (especially in the case of white collars), and that compensation policy is only slightly

TABLE 10

Earnings Profiles and Turnover. White Collar Workers (1)

Effect on	Minimum Chi-Square Estimate Quits	Discharges (2)
Const.	20.319	16.915
	(2.65)	(4.85)
α (Intercept) (3)	–2.712	–2.404
	(2.60)	(5.44)
β_2 (Age)	–42.696	–39.300
	(2.50)	(5.10)
β_4 (Tenure)	–3.676	–2.564
	(2.78)	(4.09)
β_7 (Sex)	–4.109	–1.607
	(3.13)	(2.09)
Size	–.0001	–.0001
	(.66)	(0.70)
Growth	–1.519	–.694
	(1.48)	(.75)
Age	–.061	–.054
	(1.49)	(2.22)
Sex	–.624	–1.206
	(.58)	(2.29)
Adj. R^2	.427	.530

( ) = *t*-statistic.
(1) All equations include 17 industry and 8 regional dummy variable. The industry variables are jointly significant at the 1% error level, while the regional variables are significant only in the quit equation.
(2) Discharges = Min (Total Layoffs, Total Layoffs + Growth).
(3) The α's and β's used as independent variables here are firm specific coefficients estimated from equations.

less important than commonly measured public characteristics in explaining why turnover varies across firms.

The other variables introduced have more surprising effects. The size of the company reduces the probability of layoffs for blue collars, but has no effect on quits. Growth of employment does not significantly affect either layoff or quits. The most surprising result is that the gender wage differential has a strong negative effect on quits. Firms with higher wage gaps between men and women suffer less quits and layoffs. On the other hand, the sex composition of the work force, which could be expected to be strongly negatively correlated with quits and layoffs is rarely significant and has conflicting predictions.

The major difference between this work, and previous studies of turnover lies in the fact that not the current wage, but the complete future stream of earnings is taken into account to explain turnover. Such a distinction is of major importance when wages vary over the lifetime. This study differs from MINCER and HIGUCHI's [1988] because we use firm data as opposed to industry data and because we consider not only quits, but discharges and consider intra-industry movements. This study differs from the handful of

TABLE 11

ANOVA of Pay Policy and Firm Characteristics in Accounting for Turnover

		Quits	Discharges
Percentage of variation accounted for by:			
Blue-Collar			
	Pay Policy	8	17
	Firm Characteristics	27	37
	Both	36	40
White-Collar			
	Pay Policy	19	21
	Firm Characteristics	38	44
	Both	43	53

Pay policy represents the following four variables: the intercept, return to age, return to tenure, and gender differential in the quadratic semi-log wage equation.
Firm characteristics are the Firm's size, growth rate, percent male, and mean employee age.

previous firm-level studies of turnover (LEONARD [1989]) by allowing a much richer characterization of pay policy. The major result which differentiates this study concerns the discharge equations. Most theories would expect a positive relationship between age earning profiles and discharges. Our model predicts the opposite relation and the prediction is empirically verified.

Some econometric comments on the model are worthwhile at this point. There are at least two technical problems linked to the proposed specification. The first one concerns the random nature of the α's variables in equation (11) and the second one is linked to the use of group average data. As the α's are estimated from equation (10), a problem of stochastic explanatory variables exists in the estimation of equation (11). The treatment of the problem depends on the type of assumption made concerning the relations between the independent random variables and the error term (KMENTA [1986]).

If we assume that the α's and the μ's are independent, the O.L.S. estimates retain their properties of efficiency and unbiasedness. When they are assumed to be uncorrelated only, the desirable properties of the estimator still hold asymptotically. If they are correlated, then the estimators are biased and inconsistent. In our case, the stochastic nature of the explanatory variables comes from the error term in the individual equation (10). These random variables can be different from company to company. They are however all assumed to be normal, with expectation zero and a given variance. The interaction of the n's error term and the $X' X$ matrix of independent variables–all individual characteristics of the workers in the company–generate the randomness of the coefficient. In our case however, as firms with larger dispersion in the wages are likely to have less quits, the random variable are likely to be correlated and the estimators would be biased towards zero. The absence of any reasonable instrument, however, prevents us from performing any test of the magnitude of the problem.

Finally, to accommodate the random nature of the α's in the estimation of the standard errors, we use White's robust estimation technique.

The second econometric problem in performing the estimation of (11) is linked to the use of group-average data. As we know, group average data never performs as well as a direct regression on the individual observations. In our case, however, two difficulties in implementing an estimation on the individual data made us prefer the simpler technique. The first difficulty is purely computational. Performing logit estimations on more than one hundred and fifty thousand observations is difficult and extremely costly. The second difficulty comes from the interpretation of the coefficient of the age earning profile. We only dispose of as many estimations of the age earning profile as there are firms in the sample–less than 300 for more than 150,000 observations. Econometric problems arising when merging aggregate data with micro observations have now been extensively been documented (see GREENWALD [1983] or MOULTON [1986], among others). The difficulties and cost of implementing an efficient estimation in this context, and the fact that we had a consistent estimator available, made us choose to prefer grouped averaged estimation.

6 Conclusions

In this paper, we estimated the impact of the age earning profile on quits and layoffs. The question is of major importance because in efficiency wage models, the payments made at the end of an employee's working life can be unrelated to spot productivity, but linked to efficiency considerations.

A theoretical model has been developed showing that firms with steeper age earning profiles–or forced to pay higher efficiency premiums–would suffer less quits than firms with flatter or spot wage payments. Our model also yields layoffs that decrease with the steepness of the age earning profile. This surprising result occurs because, in our framework, a steep age-earning profile is a sign that the employer cannot easily monitor workers or detect them shirking. The empirical evidence clearly sustain these results. Quits and layoffs are shown to decrease with steepness in both return to age and return to seniority, even after controlling for other factors such as the growth of employment, the general level of wages and the structural composition of the work force of the company. The use of a single year of observations of quits implicitly controls for the general macroeconomic conditions prevailing at the time.

The introduction of a heterogeneous labor force in a model of efficiency wages seems to explain relatively well the turnover movements between companies. The power of this model arises because it allows for a job-matching process among a heterogeneous workforce, as well as recognizing that efficiency wage premiums create incentives for turnover.

APPENDIX A

Steady State in the Two-Period Model

We know that, at any time t, the probability of employing a young worker (Y) conditional on the fact that a young worker was employed during the previous period is $P(Y_t|Y_{t-1}) = P_1$, the probability for a young worker t fail during period t–1 and be replaced by another young worker during period t. The probability for a young worker t remain employed and become an old worker is, of course $P(O_t|Y_{t-1}) = 1 - P_1$.

Similarly, when an old worker was employed in $t-1$, a young worker will be employed in t, no matter what. We have $P(Y_t|O_{t-1}) = 1$, and $1 - P_1$.

Using the definition of conditional probability, we can write:

(A1) $$P(Y_T) = P_1\, P(Y_{T-1}) + 1.P(O_{T-1})$$

and

(A2) $$P(O_T) = (1 - P_1)\, P(Y_{T-1})$$

Remembering that, by construction, $P(Y) + P(O) = 1$, and substituting (A2) into (A1), we find:

$$P(Y_T) = \frac{1}{2 - P_1}$$

APPENDIX B

Solution of the Long-Term Contract

The first order conditions for an extremum are given by the following of equations:

$$\text{(A3)} \qquad 1 - \frac{a^2}{2} V + a^2 W_1 + a^4 W_2 \left(\frac{3}{8} W_2 - \frac{1}{4} V \right) = 0$$

and

$$\text{(A4)} \qquad \frac{a^6}{4} W_2^3 - \frac{3}{16} a^6 V W_2^2 + \left(a^2 + \frac{3}{4} a^4 W_1 - \frac{a^4}{4} V \right) W_2 - \frac{a^2}{2} V - \frac{a^4}{4} W_1 V = 0$$

Inverting (A3), we get:

$$W_1 = \left(\frac{1}{2} + \frac{a^4 W_2}{4} \right) V - \frac{1}{a^2} - \frac{3}{8} a^2 W_2^2$$

Substituting into (A4), we obtain the three following roots for W_2:

$$\text{(A5a)} \qquad W_2 = V$$

$$\text{(A5b)} \qquad W_2 = \frac{-\frac{a}{4} V \pm \sqrt{\frac{a^{16}}{16} V^2 + \frac{a^6}{4} V + \frac{a^4}{2}}}{-\frac{a^4}{4}}$$

where (A5a) corresponds to a global minimum.

• References

Abraham, K., Farber, H. (1987). – "Job Duration, Seniority, and Earnings", *American Economic Review*, 77, pp. 278-297.

Abowd, J. (1990). – "Does Performance-Based Managerial Compensation Affect Corporate Performance?", *Industrial and Labor Relations Review*, 43, pp. S52-S53.

Abowd, J., Kramarz, F. (1992). – "A Test of Negotiation and Incentive Compensation Models using Longitudinal French Enterprise Data", *mimeo*, National Bureau of Economic Research.

Abowd, J., Kramarz, F., Margolis, D. (1994). – "High Wage Workers and High Wage Firms: Compensation Policies and Firm Performance in France", *mimeo*, National Bureau of Economic Research.

AKERLOF, G., KATZ, L. (1989). – “Do Deferred Wages Eliminate the Need for Involuntary Unemployment as a Worker Discipline Device?”, *Quarterly Journal of Economics.*

AMERICAN LAW INSTITUTE (1964). – “Restatement of the Law of Torts”, 2nd edition.

ANTEL, J. (1985). – “Costly Employment Contract Renegotiation and the Labor Mobility of the Young Men”, *American Economic Review,* 75, No. 5, pp. 976-991.

ARNOTT, R., HOSIOS, A., STIGLITZ, J. (1988). – “Implicit Contracts, Labor Mobility and Unemoployment”, *American Economic Review*, 78, No. 5, pp. 1046-1066.

BLANPAIN, R. (1976). – “International Encyclopedia of Industrial Relations”, Deventer, The Netherlands; Kluwer.

DAVIS, S. J., HALTIWANGER, J. (1991). – “Wage Dispersion between and Within U.S. Manufacturing Plants, 1963-1986”, *Brookings Papers: Microeconomics,* pp. 115-200.

DICKENS, W. T. (1986). – “Error Components in Grouped Data: Is it Ever Worth Weighting?”, *mimeo,* University of California, Berkeley.

GART, J., ZWEIFEL, J. (1967). – “On the Bias of Various Estimator of the Logit and its Variance with Application to Quantal Bioessay”, *Biometrika*, 54, No. 1, pp. 181-187.

GREENWALD, B. (1986). – “Adverse Selection in the Labor Market”, *Review of Economic Studies*, 53, pp. 325-347.

GRILICHES, Z. (1979). – “Sibling Models and Data in Economics: Beginnings of a Survey”, *Journal of Political Economy,* 87, No. 5, Part 2, pp. S37-S64.

GROSHEN, E. (1991). – “Sources of Intra-Industry Wage Dispersion: How Much Do Employers Matter?”, *Quarterly Journal of Economics,* 106, Issue 3, pp. 869-884.

HALL, R., LAZEAR, E. (1984). – “The Excess Sensitivity of Layoff and Quits to Demand”, *Journal of Labor Economics,* 2, No. 2, pp. 233-257.

JOVANOVIC, B. (1979). – “Job Matching and the Theory of Turnover”, *Journal of Political Economy,* 87, No. 5, pp. 972-990.

KMENTA, J. (1986). – “*Elements of Econometrics*”, 2nd Ed., McMillan, New York.

KRUEGER, A. (1991). – “Ownership, Agency, and Wages: An Examination of Franchising in the Fast Food Industry”, *Quarterly Journal of Economics,* 106, Issue 1, pp. 75-102.

KRUSE, D. (1993). – *Profit Sharing: Does It Make a Difference? The Productivity and Stability Effects of Employee Profit Sharing Plans,* W. E. Upjohn Institute for Employment Research, Kalamazoo, MI.

LAZEAR, E. P. (1979). – “Why is There Mandatory Retirement?”, *Journal of Political Economy*, 87, pp. 1261-1284.

LEONARD, J. (1990). – “Executive Pay and Firm Performance”, *Industrial and Labor Relations Review,* 43, pp. S13-S29.

LEONARD, J. (1989). – “Wage Structure and Dynamics in the Electronics Industry”, *Industrial Relations,* 28, No. 2, pp. 251-275.

LEONARD, J. (1988). – “Career Paths of Managers and Executives”, *mimeo*.

LEONARD, J., Van AUDENRODE, M. (1993). – “Corporatism Run Amok: Job Stability and Industrial Policy in Belgium and the United States”, *Economic Policy,* No. 17, pp. 355-389.

LINDBECK, A., SNOWER, D. J. (1988). – “*The Insider Outsider Theory of Employment and Unemployment”,* M.I.T. Press, Cambridge.

MCLAUGHLIN, K. J. (1991). – “A Theory of Quits and Layoffs with Efficient Turnover”, *Journal of Political Economy,* 99, No. 1, pp. 1-29.

MINCER, J., HIGUCHI, Y. (1988). – “Wage Structures and Labor Turnover in the United States and Japan”, *Journal of the Japanese and International Economy,* 2, pp. 97-133.

Mortensen, D. (1978). – "Specific Capital and Labor Turnover", *Bell Journal of Economics*, 9, pp. 572-586.

Moulton, B. (1988). – "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units", *mimeo,* working paper of the Bureau of Labor Statistics, No 181.

Prosser, W., Wade, J. W., Shwartz, V. E. (1988). – "*Torts: Cases and Material*", Wilsbury, New York: Foundation Press.

Waldman, M. (1984). – "Jobs Assignments, Signaling and Efficiency", *Rand Journal of Economics,* 15, No. 2, pp. 255-267.

Weiss, A. (1980). – "Job Queues and Layoffs in Labor Markets with Flexible Wages", *Journal of Political Economy,* 88, No. 3, pp. 526-438.