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Piece-Rates, On-the-Job Training and the Wage-Tenure Profile

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**PIECE-RATES, ON-THE-JOB TRAINING
AND THE WAGE-TENURE PROFILE**

by

Anders Björklund and Jeannette Åkerman

Paper prepared for IUI's 50th Anniversary Symposium, November
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AND THE WAGE-TENURE PROFILE

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Paper prepared for the IUI-conference in Stockholm, November 1989

1. Introduction

A consistent finding in micro data studies is that years of tenure at the present employer has a positive effect on the level of wages. This pattern holds even when controlling for age, schooling, general labor market experience and personal characteristics.

New theories of personnel management suggest that a rising wage–tenure profile (or "end–weighted" wage schedules) can be an optimal policy for an employer. Two theories have received most attention in the literature; the human capital model, originating from Becker (1975) and extended by Hashimoto (1981) and Carmichael (1983) and others, and the "shirking" model developed by Lazear (1979, 1981).

The human capital model focuses on firm–specific education and knowledge. In order to invest in firm–specific competence, the employer must expect the employee to stay with the firm for some time. To minimize employee separation, the firm must establish a compensation policy which creates incentives to remain with the firm. End–weighted wage schedules is a means of achieving this objective. Thus, the theory predicts steeper wage tenure profiles for jobs with large amount of firm specific training.

The essence of Lazear's model is that to discourage workers from shirking, an employer will provide a lifetime earnings profile that pays workers less than their marginal product when they are young, and more than their marginal product when they are older. If the worker shirks he will be laid off and loses the good "higher than marginal productivity" years. The theory is relevant for jobs which are difficult to monitor. Without monitoring costs a piece–rate compensation is, of course, optimal. Hence, the theory predicts flatter wage–tenure profiles for jobs which are paid by piece–rates.

The purpose of this study is to test these predictions on Swedish data. Information about piece rate remuneration is used as an indication of monitoring costs. As a measure of firm–specific training we use the question "On a job like yours, how long would it take the average new person to become fully trained and qualified?" This question was asked in the 1984 wave of the HUS project.

The plan of the paper is as follows. In section 2 we offer a presentation of the theories and their predictions about the wage–tenure profiles. Previous empirical studies are also presented. Our own empirical methodology and data are presented in section 3 which is followed by the results from the estimations in section 4. Finally, we conclude with a discussion about possible future extensions of our analysis.

2. Presentation of the theories

The human capital model

The human capital theory focuses on the workers accumulation of skills and the sharing of workers and employers of the cost and returns to specific training. Skills are not only acquired through formal education, more important is training in the production process. On–the–job training is more than work related courses, it is also the worker's own training of his task when working, as well as getting acquainted with the company, routines and fellow–workers.¹ The human capital accumulation is a continuous process. It implies that productivity will raise with training and to a certain amount during the course of the occupational life. A more trained worker will be more productive and will thus have a higher wage. The worker will, when deciding how much training to invest, balance a future higher wage to lower wage during training to maximize lifetime–income.

The firm will provide training if the receipts due to trained personnel's higher productivity is greater than the outlays in teaching, forgone production and materials use. A trained worker posses a firm–specific competence after training, and if he quits the firm it is a great loss. The firm must pay a wage higher than the wage the worker can receive outside the firm to decrease the likelihood of turnover. The employee must also pay a part of the firm–specific training in receiving wage lower than marginal productivity during training.

The human capital model implies certain characteristics of wage tenure profiles and of turnover patterns. A job with a large extent of training will

¹ Becker (1975) makes a distinction between general and specific training. We do not consider this, since all on–the–job training contains a certain amount of firm–specific training.

have a lower starting wage than a job with less training, since the worker will pay part of the training cost. The worker will engage in training since it implies greater earnings in the future. The employer will provide training to the employees since productivity will rise. In other words, the human capital approach will predict a greater wage tenure effect in a job with more training than a job with less. It is important to notice that the theory implies that all wages can increase with tenure to a certain amount, since on-the-job training is continuous, the worker is perfecting his skills and his knowledge of the work place, the boss and fellow-workers.

Human capital theory have implications for turnover patterns. Younger workers have higher probability to quit, since they have more time to devote to training in a new company and thus increase lifetime-income. Further, the younger has not accumulated as much firm-specific competence than an older worker who receives a higher wage then he would elsewhere. A firm in decline will not lay-off employees with firm-specific training since when trade conditions will be better the laid-off workers might have find other jobs and the company will have to employ non-trained workers and train these. The same analysis can be made concerning wage rigidity. The employer is reluctant to lower the wage for trained workers in recession since these possess a certain amount of firm-specific training, and thus market wages do not decrease.

Lazear's shirking model

The shirking theory focus on the employer's need to monitor the workers effort.² The employer want their workers to be hard-working and honest, and the employee want to receive a high wage. Lazear argues that the employer and the employees engage in implicit contracts. They enter into long-term wage-employment contracts which include upward-sloping age-earning profiles. The contract implies a wage lower than marginal productivity at the beginning of the contract and greater than marginal productivity in the end. The efficiency of an end-weighted wage profile arise from it being an incentive device for the firm and thus induces less shirking by the worker. If the worker shirks he will be dismissed and lose his wage during the high paid

² Other used names in the literature are wage-work effort model and theory of delayed payment contracts.

years in the end of the working life. If capital markets are perfect and there is complete information, a worker will be indifferent between receiving a wage path equal to marginal product each period and one which pays less than marginal product initially and more than marginal product during his last year in the work force, as long as the present value of the two wage paths are the same. Other things equal, a firm would be indifferent between paying the two wage streams. But other things are not equal, the end-weighted wage schedule allow the worker and the firm to behave in such a way as to rise the present value of marginal product over the lifetime.

Pensions and mandatory retirement are, according to Lazear, essential in the end-weighted long-term contract. The worker does not want to stop working at the optimal retirement date (when the present value of the lifetime marginal product equals the present value of the lifetime wage payment) since his current wage are then higher than marginal productivity and the labor supply would be distorted. Mandatory retirement must be included in the contracts to be efficient.

The shirking theory implies that the wage tenure profile will be upward sloping even in the absence of any on-the-job training. The theory implies further that piece-rate workers and self employed will have flatter wage profiles. Workers on piece-rate are easy to monitor, and therefore the employer does not have to provide them with incentives not to shirk. The self-employed works for himself and does not need neither monitoring or non-shirking incentives. A young worker have a higher probability to quit since his wage is lower than marginal productivity. The older worker have a lower probability to quit, since if he would he would forego the higher payments in the end of the working life.

Testable implications of the shirking and human capital models

This passage will discuss what the two theories indicate for wages and other terms of employment. Both models indicate an upward-sloping wage profile over time. According to the human capital theory this arise because the firm wants to establish incentives to stay with the firm. In the Lazear model both the employer and employee prefer an end-weighted wage path since it reduces shirking. Further, a job switch is often followed by a wage drop

followed by an increase in wage growth. Human capital theory explains this with the reinvestment in new firm-specific capital, but the shirking model suggests that this is the period when the worker is putting up collateral. Both models imply hours constraints and other restrictions to regulate labor supply. Lazear puts emphasize on the existence of mandatory retirement in the shirking model, but even the human capital model requires labor supply restrictions.

There are implications which differ across the two models. The shirking model predict that workers on piece-rate will have flatter wage profile since piece-rate is a control on the worker and the employer do not need a non-shirking incentives, but the human capital model does not indicate this. Lazear (1981) identifies this as one of the major points in his analysis. Another important difference between the two models is that in the human capital model, earnings and productivity are correlated over the whole working cycle. In the shirking model wage grows with tenure, even if productivity does not. Senior workers receive higher wages as an incentive for the younger worker not to shirk. According to human capital theory wage will grow faster but starting at a lower level if the job offers more on-the-job training.

The two models have several different features and different implications but there are, to our opinion, no reason why not both models can offer valid explanation to observed behaviour. The theories are complements rather than substitutes.

Previous empirical studies

The two different models have been tested empirically in various studies. Various kinds of empirical evidence which are consistent with one or the other of the models are brought forth. Some of these studies are presented in this section.

Barron et al (1989) use records of on-the-job training in five different training activities, provided to workers in entry level positions. The training is measured in hours. Their estimation shows that productivity and wage growth are positively related to on-the-job training. This finding is

consistent with the conventional human capital model. Duncan and Hoffman (1979) show similar results with data from the ninth wave of the Panel Study of Income Dynamics. Their study indicates that time spent in training increases earnings. The on-the-job training variable in this case is more or less identical with the one used in our study.

Other studies, on the other hand, are inconsistent with the human capital theory. Medoff and Abraham (1980 and 1981) investigated earnings and performances by managers and professionals in several big companies. They found a strong positive association between experience and earnings, but no or a negative association between experience and performance. They conclude that the human capital model could not explain the observed return on labor market experience.

Evidence supporting Lazear's shirking theory is found in Hutchens (1987). He tests how repetitive tasks in jobs influence wage and other working conditions related to the shirking theory. The repetitive task is a proxy for piece-rate jobs, which are easy to monitor. His conclusion is that repetition of task reduces the probability of pensions and mandatory retirement and reduces work tenure and older workers wages. His conclusion is that Lazear's theory yields valid predictions, even though he is not totally convinced that the shirking theory is the only possible explanation of these phenomena. He points for example at Carmichel's reformulated theory of employer-financed specific training.

Leigh (1984) scrutinizes what influence whether a worker has a date of mandatory retirement or not. He focus on the relationship between mandatory retirement and 1. specific on-the-job training, 2. presence of vested pension plant and 3. transactions costs associated with monitoring worker performance. He concludes that the empirical evidence suggests that a comprehensive explanation of mandatory retirement requires the consideration of monitoring costs as well as of specific human capital. In other words he indicates that both the shirking model and the human capital model have explanatory power concerning the wage profile.

The empirical studies which we have presented show clearly that there are interesting relations between wage tenure profiles and both theories. These

relations are interesting and should be elucidated further to be able to understand the underlying structure. All studies on this topic are executed on U.S. data. To be able to scrutinize the theories' universality, studies have to be performed on data from other countries in addition to the studies performed in the United States. There are to our knowledge no Swedish wage profile studies testing the validity of the shirking theory or the human capital theory. It is of great interest to investigate how the Swedish labor market works in this respect.

3. Empirical methodology and data

We will in this paper apply a simple and straightforward empirical methodology to test our hypotheses. Our work on this problem is under progress and the methodology will be further developed and refined in subsequent analyses.

The hypotheses will be tested with a conventional log wage equation extended with variables motivated by the shirking and the human capital models as follows:

$$(1) \quad \begin{aligned} \text{Ln}W_i = & \alpha_1 + \alpha_2 \text{Age}_i + \alpha_3 \text{Age}_i^2 + \alpha_4 E_i + \alpha_5 E_i^2 + \alpha_6 S_i + \alpha_7 \text{Wom}_i \\ & + \alpha_8 \text{Ten}_i + \alpha_9 \text{PR}_i + \alpha_{10} (\text{PR} \times \text{Ten})_i + \alpha_{11} \text{OJT}_i + \alpha_{12} (\text{OJT} \times \text{Ten})_i \\ & + \epsilon_i \end{aligned}$$

where $\text{Ln}W_i$ equals log wage for individual i ; E_i denotes work experience; S_i denotes years of schooling; Wom_i equals one for women and zero for men; Ten_i is years with the present employer; PR_i equals one for workers with piece rate and zero otherwise; OJT_i is a measure of the amount of firm specific training; and ϵ_i is a stochastic error term.

Lazear's shirking theory predicts that α_9 will be positive and α_{10} negative. A positive α_9 indicates that a worker on piece-rate will have a higher starting wage than an identical fellow-worker without piece-rate. The worker with piece-rate does not need non-shirking incentives and thus he receives wage equal to marginal productivity. The coefficient α_{10} captures the specific tenure effect for piece-rate work. A negative α_{10} will, for piece-rate workers,

neutralize the positive tenure effect for all workers and their wage profile will be flatter. The human capital theory predicts α_{11} to be negative and α_{12} to be positive. Firm specific training indicates a lower starting wage since the employer and employee share the cost of training, and thus α_{11} will be negative. A positive α_{12} arise from training on the job which will raise the workers firm-specific productivity and the tenure effect will thus be greater.

We will use data from two sources. The micro data base from the Level of Living Survey – LNU-data – (see Eriksson and Åberg (1986)) contains information about piece-rates. Data exist for 1968, 1974 and 1981. The basic sample from 1968 was reinterviewed in the later surveys with additions of youth and immigrants to make it a representative sample of the Swedish population.

We will also use the HUS-wave from 1984 (see Klevmarken (1984)). It contains the same information about type of wage remuneration as the LNU-data, but in addition to that there is a question which can serve as a proxy for firm-specific training. The question is: "On a job like yours, how long would it take the average new person to become fully trained and qualified?"

Sample means of the data to be used are reported in Table 1. Piece-rate remuneration has declined since 1968; from 16.5 to 6.5 per cent in 1984. The mean of our on-the-job training variable is 1.46 years, i.e. the respondents reported that it takes about one and a half year to become fully trained and qualified at their jobs. This is quite close to what Duncan and Hoffman (1978) reported for the U.S., namely 1.66 years.

4 Results

In this section we will investigate the results of the statistical estimations of the wage equation. We start by examining the estimations in Table 2 which uses the LNU-data. This data set includes only information about piece-rates which can be used to test the shirking theory. Whereas the coefficients for age, experience, schooling and sex have changed markedly during the period 1968 to 1981, there is a notable consistent pattern of the coefficients for tenure and piece-rates. In the equations without the piece-rate variables the coefficients for tenure are .0045, .0061 and .0053 for

1968, 1975 and 1981 respectively. The implication of this is that the wage premium for ten years in the same firm is approximately five per cent.

The wage equations in Table 2, with the variables for piece-rates, a dummy for piece-rate and piece-rate/tenure interaction added, show that there is practically no tenure effect for workers with piece-rate compensation. The general tenure coefficient and the interaction coefficient more or less counteract each other to make the tenure effect close to zero for workers with piece-rate. The piece-rate dummies have coefficients between .100 (1968) and .142 (1981). These estimations imply that those who take a piece-rate job start with a higher level of wage than others but after 10–20 years their wage will fall short of workers with other types of compensation.

To sum up the LNU-estimations, we see that the results are in conformity with Lazear's theory. The coefficients of the piece-rates variables are strongly significantly different from zero which strengthen the conclusion. In addition we also found that the pattern holds for both sexes when we estimated separate equations for men and women.

The wage equations using HUS-data are presented in Table 3. The first two columns reports estimations of wage equations with the same specification as in Table 2. The estimated coefficients for tenure, piece-rate and the piece-rate/tenure interaction variables reveal basically the same pattern as the one found in LNU-data. Piece-rate workers start with a higher wage but receive only a very low tenure premium. There is a slight difference in the magnitude of the estimates though; the coefficients of both the piece-rate dummy and the piece-rate/tenure interaction are slightly smaller (absolutely) compared to those obtained from LNU-data. The individual coefficients are not significant either (at conventional levels) but in combination they raise the explanatory value of the equation.

The HUS-data contains the interesting proxy variable for firm-specific training which will be used to test the human capital theory. In the equation presented in the fifth column in Table 3 we have added to the ordinary wage equation the OJT variable and the OJT/tenure interaction variable. The estimation results support the human capital theory. The interaction term is positive with a t-value around 2.0 and the OJT coefficient is negative even

though small and insignificant. The magnitude of the interaction coefficient might seem small but taking into account that the variation of the OJT variable is rather high (standard deviation=2.5 years), the estimate implies rather large differences in tenure effects for different jobs. The wage premium for ten years with the same employer is approximately five per cent for a job which take no time to learn, whereas the premium is approximately eight per cent for a job which takes five years to master.

Finally, in the last column in Table 3 we have simultaneously added all four variables from the HUS-data of interest in this paper; a piece-rate dummy, piece-rate/tenure interaction variable, the OJT variable and the OJT/tenure variable. The inclusion of both types of variables, both the variables testing Lazear's shirking theory and the human capital theory, does not change any inference regarding the theories. The equation shows that both theories have explanatory power for the wage profile. We see also that the estimated coefficients in this equation have not changed much which indicate that multicollinearity between piece-rate and OJT is not much of a problem.

Noticeable is that when running separate equations for men and women, we found in general more significant results for men then for the combined sample. For women the coefficients were estimated with very low precision and the explanatory power of the equations was low.

5 Conclusions and directions for future work

We have examined whether the implications from Lazear's theory and the human capital theory for the wage tenure profile hold on the Swedish data. Our results support both theories. We do not consider this a contradiction. In our opinion, the theories are complements rather than substitutes.

We note, however, that our methodology is simple and there are at least two sources of potential bias which must be considered in our subsequent work. The first is ordinary omitted variable bias resulting from possible correlation between unobserved ability and propensity to change employer. The second stems from matching theory which is based on the notion that there is an (in general) unobserved productivity component associated with each employee/employer match. In that case good matches are most likely to

survive and a positive, but spurious tenure effect on wages will appear in cross-section data. By using the panel of the HUS-data along the lines suggested by Abraham and Faber (1987 and 1988), Altonji and Shakotko (1987), Topel (1986) and Kletzer (1989) we hope to be able to improve the analysis.

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Table 1 Sample means

	LNU 1968	LNU 1974	LNU 1981	HUS 1984
Age	38.5	38.5	38.7	40.8
Experience	19.0	18.0	17.9	19.9
Years of schooling	8.7	9.8	10.5	11.0
Women	0.391	0.435	0.478	0.498
Tenure	8.2	8.2	8.8	10.6
Piece-rate	0.165	0.139	0.066	0.065
Tenure/piece-rate	?	?	?	11.4
OJT ^a (years)	-	-	-	1.46
OJT/piece-rate	-	-	-	1.52

^a Defined by the question "On a job like yours, how long would it take the average new person to become fully trained and qualified?".

Table 2 **Wage equations using LNU-data**
(Standard errors in paranthesis)

Independent variable	Dependent variable					
	Ln wage 1968	Ln wage 1968	Ln wage 1974	Ln wage 1974	Ln wage 1981	Ln wage 1981
Age	0.0473 (0.0052)	0.0486 (0.0052)	0.0518 (0.0041)	0.0531 (0.0041)	0.0186 (0.0038)	0.0204 (0.0038)
Age squared/ 100	-0.0531 (0.0065)	-0.0547 (0.0065)	-0.0581 (0.0050)	-0.0596 (0.0049)	-0.0197 (0.0045)	-0.0215 (0.0045)
Experience	0.0208 (0.0029)	0.0194 (0.0030)	0.0063 (0.0023)	0.0053 (0.0022)	0.0118 (0.0022)	0.0109 (0.0022)
Experience sq./100	-0.0361 (0.0059)	-0.0334 (0.0059)	-0.0108 (0.0045)	-0.0086 (0.0045)	-0.0187 (0.0042)	-0.0169 (0.0042)
Years of schooling	0.079 (0.002)	0.079 (0.002)	0.042 (0.002)	0.044 (0.002)	0.036 (0.001)	0.037 (0.001)
Women	-0.269 (0.015)	-0.261 (0.015)	-0.226 (0.012)	-0.215 (0.012)	-0.146 (0.009)	-0.140 (0.009)
Tenure	0.0045 (0.0008)	0.0061 (0.0009)	0.0061 (0.0007)	0.0074 (0.0007)	0.0053 (0.0006)	0.0057 (0.0006)
Piece-rate	-	0.100 (0.024)	-	0.139 (0.020)	-	0.142 (0.024)
Piece-rate x Tenure	-	-0.0076 (0.0017)	-	-0.0088 (0.0016)	-	-0.0060 (0.0019)
\bar{R}^2	0.449	0.453	0.397	0.406	0.340	0.347
n	2994	2994	3135	3135	3445	3445

Note: The intercept is not presented.

Table 3 **Wage equations using HUS-data**
(Standard errors in paranthesis)

Independent variable	Dependent variable					
	Ln wage ^a 1984	Ln wage ^a 1984	Ln wage 1984	Ln wage 1984	Ln wage 1984	Ln wage 1984
Age	0.0075 (0.0059)	0.0076 (0.0059)	0.0088 (0.0066)	0.0090 (0.0066)	0.0096 (0.0066)	0.0098 (0.0066)
Age squared/ 100	-0.0039 (0.0068)	-0.0040 (0.0068)	-0.0039 (0.0076)	-0.0042 (0.0076)	-0.0050 (0.0076)	-0.0051 (0.0076)
Experience	0.0137 (0.0035)	0.0137 (0.0035)	0.0118 (0.0039)	0.0118 (0.0039)	0.0112 (0.0039)	0.0112 (0.0039)
Experience sq./100	-0.0235 (0.0068)	-0.0235 (0.0068)	-0.0231 (0.0075)	-0.0231 (0.0075)	-0.0217 (0.0074)	-0.0217 (0.0074)
Years of schooling	0.039 (0.002)	0.040 (0.002)	0.038 (0.002)	0.039 (0.002)	0.038 (0.002)	0.039 (0.002)
Women	-0.148 (0.014)	-0.145 (0.014)	-0.158 (0.014)	-0.156 (0.014)	-0.159 (0.014)	-0.157 (0.014)
Tenure	0.0052 (0.0009)	0.0054 (0.0009)	0.0057 (0.0010)	0.0058 (0.0010)	0.0049 (0.0010)	0.0050 (0.0010)
Piece-rate	-	0.079 (0.044)	-	0.064 (0.049)	-	0.061 (0.049)
Piece-rate x Tenure	-	-0.0036 (0.0032)	-	-0.0036 (0.0036)	-	-0.0033 (0.0036)
OJT	-	-	-	-	-0.0023 (0.0044)	-0.0025 (0.0044)
OJT x Tenure	-	-	-	-	0.0006 (0.0003)	0.0006 (0.0003)
\bar{R}^2	0.357	0.358	0.353	0.352	0.356	0.356
n	1623	1623	1448	1448	1448	1448

Note: The intercept is not presented.

^a These equations were run on the maximum number of observations. Internal non-response on the OJT question is responsible for the lower sample in the other estimations.