ETLA The Research Institute of the Finnish Economy

Juha Kettunen

Essays on Wages, Job Tenure and Unemployment Duration in the Finnish Labour Market

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Helsinki 1997

ETLA ELINKEINOELÄMÄN TUTKIMUSLAITOS
The Research Institute of the Finnish Economy
Lönnrotinkatu 4 B 00120 Helsinki Finland

Sarja A 25 Series

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ETLA, The Research Institute of the Finnish Economy
Publisher: Taloustieto Oy

Helsinki 1997

ISBN 951-628-249-0
ISSN 0356-7435

Printed in: Tummavuoren Kirjapaino Oy,
Vantaa 1997

KETTUNEN, Juha, **ESSAYS ON WAGES, JOB TENURE AND UNEMPLOYMENT DURATION IN THE FINNISH LABOUR MARKET**. Helsinki: ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1997, 214 p. (A, ISSN 0356-7435, No 25). ISBN 951-628-249-0.

ABSTRACT: In this thesis the dynamics of the Finnish labour market are studied. The study on the method of pay develops a dynamic economic model which is used as the basis for an econometric study. The microeconomic data have been compiled for this study from the administrative files of the Confederation of Finnish Industry and Employers. Logit models are used in the estimations. A small variance approximation is derived in order to take into account the unobserved heterogeneity across workers. In the second stage the wage equations by the methods of pay with selectivity into different groups are estimated.

The study on the job tenure based on microeconomic data is an application of the competing risk approach. The data cover the years 1980 - 1990 and contain information on workers, jobs and plants. According to the results the wage groups of the workers and relative wage within a firm is positively related to the job tenure. Also the duration-dependent effects were estimated. The effect of wages is more important for the persons who have been working for a long time. An approach based on the discrete mixing distribution is followed in order to correct the models for unobserved heterogeneity.

The study on the mover-stayer models of labour mobility uses Finnish microeconomic data on unemployed durations. The data have been compiled from the administrative files of the Finnish Ministry of Labour. The probabilities of becoming employed, moving to other regions and changing occupations are estimated. The models are based on a Gompertz distribution. They yield estimates of the proportion of unemployed persons who will never become employed, move or change occupations. Allowance for neglected heterogeneity is made assuming that the effect of omitted variables has a gamma distribution across persons.

Acknowledgements

This Ph.D. thesis is based on my studies at the University of Bristol. I am deeply grateful to Professor Andrew Chesher for his advice and encouragement. Without his direction this study would not have been completed. I wish also to acknowledge the constructive comments from Dr. Simon Burgess and Professor Gostas Meghir. I have also benefited from discussions with numerous students and members of the staff at the University of Bristol.

This thesis is also a report on the research programme of labour economics at The Research Institute of the Finnish Economy (ETLA). Chapters II and III are based on a project on the wage structure of Finnish industry. Chapter IV is based on a research project on unemployment duration.

The empirical study is based on microeconomic data on wages, job tenure and unemployment duration. I am grateful to a large number of colleagues and friends for their advice in collecting the data sets.

I wish to thank the Yrjö Jahnsson Foundation for financial aid which enabled my studies at the University of Bristol.

I wish to thank also the Finnish Work Environment Fund and the Ministry of Labour for financing the collection of data used in the study. Thanks are also due to my colleague Mr John Rogers who carefully checked the language of the study.

Helsinki, October 1996 *Juha Kettunen*

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Chapter I

INTRODUCTION

This study analyses the determination of wages, job tenure and unemployment duration in the Finnish labour market using microeconomic data. Rich and reliable data and appropriate econometric methods have a great importance in applied econometric research. During the study a microeconomic data set was compiled for each chapter of this thesis.

High unemployment is at the moment the most serious economic problem in Finland. The unemployment rate was about 18.5 per cent in 1994. The growth of unemployment and consequent unemployment-related expenditures of the central government has led to a sharp increase in the state debt. Nevertheless in Finland there have been relatively few basic studies on the functioning of the labour market based on rich and relevant microeconomic data. Therefore this study seeks to make a contribution to a more general body of knowledge about labour market processes from a microeconomic perspective.

In Chapter II a dynamic model is derived in order to describe and analyse the selection of a method of pay. The incentive wage is an important issue in the flexibility in the labour market. The wage mechanism can be a way of adjustment to the needed changes in the labour market. For an empirical analysis a cross-section data set on blue-collar workers has been compiled from the files of the Confederation of Finnish Industry and Employers.

Logit models are used to analyse the factors affecting the choice of incentive wages. According to the results many factors affect the choice of the incentive wage. For example, the incrementals of the time-based wage are negatively related to the probability of working on the incentive wage basis. It supports the prediction of a theoretical model that a high time-based wage could motivate the persons to stay in the time-based work. In the second stage the wage equations by the methods of pay with selectivity into different groups are estimated. According to the results incentive wages compress the wage differentials based on the required levels of skill. The wage groups which have agreed to the collective wage agreements are too wide to reflect the differences in the productivity of the workers.

In Chapter III the job tenure in Finnish metal and forest industry is studied using microeconomic data on blue-collar workers. The longitudinal data were compiled from administrative files of the Confederation of Finnish Industry and Employers. The data cover a period of 11 years starting from the first quarter of 1980.

During the 1980's there was a remarkable decrease in the number of workers. This study seeks to shed some light on the process of leaving the firm and industry. The wage structure in Finnish industry has been more extensively analysed in other studies (Kettunen and Marjanen, 1992, Kettunen, 1993b,f, Kettunen and Vartiainen, 1993 and Kettunen, 1994c,d).

Special emphasis is devoted in Chapter III to the effects of wages on the probability of exiting from employment. Among other things it is analysed whether the workers having lower wages differ from those having higher wages. The empirical analysis is carried out in the competing risk framework. This makes it possible to take into account the phenomenon that employment spells may be terminated by different outcomes. The data allow one to make a distinction between the workers who change their jobs within the Finnish industry or leave it.

According to the results the workers who have long spells of employment usually have higher wages than others. Also the starting wages of these workers are higher than the average. An increasing wage profile is related to the low starting wage, short employment and faster turnover of labour. A high wage group or a relative wage in the plant reduces the turnover. The low wage has the largest effect for the persons who do not change their employer within industry but leave industry. Also it turns out that the effect of the wage on the exit rate is more important for the persons who have long spells of employment.

In Chapter IV the mover-stayer models of transition intensities from unemployment are studied. The probabilities of becoming employed, moving to another region and changing occupations are estimated. Often econometric models of unemployment duration neglect the fact that some of the persons will not return to work, move to another region or change occupation. The models of this study are based on a Gompertz distribution. They yield estimates of the proportion of unemployed person who will not become employed, move or change occupations.

Also the duration-dependent changes of the unemployment insurance were examined. In Finland the eligibility rules of unemployment benefits become stricter during the unemployment duration. These changes in the system were studied using the semiparametric models with piece-wise linear hazards.

During the rapid and stable economic growth of the last decade wide-ranging unemployment insurance reforms were carried out. At the moment the main structural problem of our economy is the stubborn unemployment, which has focused the interest on the effects of unemployment insurance. Despite the well intentioned aims, the improvement of the unemployment insurance in 1985 increased unemployment appreciably. The coverage of unemployment insurance was also improved. The ability of the system to function was put to the test, since it has had the effect of lengthening the duration of unemployment. The study shows a negative effect of the replacement ratio of unemployment benefits. The problem has been explored more extensively in other studies (Kettunen, 1989, 1990, 1991a-i, 1992a-d, 1993a,c-e,g, 1994a,b,e,f, 1996 and Asplund, Kettunen and Torsti, 1993).

Special attention in the technical sense is paid in the thesis on the unobserved heterogeneity across workers, which bias the parameter estimates of the models. In Chapter II a new model based on a small variance approximation is derived in the context of a logit model in order to rectify the effect of unobserved explanatory variables. Chapter III follows an approach of estimating a discrete mixing distribution in the context of a parametric model of duration. In Chapter IV a parametric distribution is assumed for the unobserved heterogeneity across the workers. Usually unobserved heterogeneity is neglected in microeconometric work. Therefore there is the possibility to make a contribution to methodology related to the unobserved heterogeneity of the different models. The results of estimations support the reasoning that taking the unobserved heterogeneity into account has a great importance in the microeconomic models.

References

Asplund, R., Kettunen, J. and Torsti, E. (1993), Työmarkkinoiden joustavuudesta, The Research Institute of the Finnish Economy, Suhdanne 1993/4, 26-33.

Kettunen, J. (1989), Työttömyysturvan vaikutukset työnetsintään, The Research Institute of the Finnish Economy, C 49, Helsinki.

Kettunen, J. (1990), Työllistyminen, työvoiman liikkuvuus ja työttömän taloudellinen asema, The Research Institute of the Finnish Economy, B 67, Helsinki.

Kettunen, J. (1991a), The Effects of Unemployment Insurance: Description of the Finnish System and Data, Suomen Tilastoseuran vuosikirja 1990 (The Yearbook of the Finnish Statistical Society 1990), Helsinki, 85-108.

Kettunen, J. (1991b), Heterogeneity in Unemployment Duration Models, The Research Institute of the Finnish Economy, Discussion papers, No. 352.

Kettunen, J. (1991c), Occupational Mobility of Unemployed Workers, The Research Institute of the Finnish Economy, Discussion papers, No. 359.

Kettunen, J. (1991d), A Programme for Estimating Nonlinear Maximum Likelihood Models with an Application to Duration Models of Unemployment, The Research Institute of the Finnish Economy, Discussion papers, No. 387.

Kettunen, J. (1991e), Regional Mobility of Unemployed Workers, The Research Institute of the Finnish Economy, Discussion papers, No. 375.

Kettunen, J. (1991f), Transition Intensities from Unemployment, The Research Institute of the Finnish Economy, Discussion papers, No. 355.

Kettunen, J. (1991g), Työttömyyspäivärahojen vaikutukset työttömyyden pitkittyessä, In Leskinen, E., Markkula, J. and Oinonen, M. (eds.), Pitkittäisaineistojen analyysi -seminaari 23.5.-24.5.1991 Jyväskylässä, The University of Jyväskylä, Reports from the Department of Statistics, 15/1991, 56-61.

Kettunen, J. (1991h), Työttömyysturvajärjestelmän muutospaineet (Reform of the Unemployment Insurance System), Kansantaloudellinen aikakauskirja (The Finnish Economic Journal) 2/1991, 201-207.

Kettunen, J. (1991i), Työttömyysturvajärjestelmän vaikutukset työmarkkinoiden toimintaan: Tutkimusaineistokuvaus, The Research Institute of the Finnish Economy, No. 376.

Kettunen, J. (1992a), A Search Theoretical Analysis of the Finnish Unemployment Insurance System, Finnish Economic Papers 5, 129-138.

Kettunen, J. (1992b), Time-Dependence in Semi-Parametric Models of Unemployment Duration, The Research Institute of the Finnish Economy, Discussion papers, No. 394.

Kettunen, J. (1992c), Työttömien työllistyminen sekä alueellinen ja ammatillinen liikkuvuus (Re-employment and Labour Mobility of Unemployed Workers), Kansantaloudellinen aikakauskirja (The Finnish Economic Journal), 1992:2, 212-217.

Kettunen, J. (1992d), Työttömyyden tukemisesta työllistymisen kannustamiseen, In Vartia, P. and Ylä-Anttila, P. (eds.), Kansantalous 2017, The Research Institute of the Finnish Economy, B 80, 268-269.

Kettunen, J. (1993a), Comment on Lilja (Unemployment Benefit System and Unemployment Duration in Finland), Finnish Economic Papers 6, 38-40.

Kettunen, J. (1993b), Förändringar i lönestrukturen inom den finska industrin under 1980-talet (Changes in Earnings Structure in Finland during the 1980s), Ekonomiska Samfundets Tidskrift (The Journal of the Economic Society of Finland), nr 3, 153-158.

Kettunen, J. (1993c), Increasing Incentives for Reemployment, Finnish Economic Papers 6, 51-60.

Kettunen, J. (1993d), Kalenterimallit: Coxin mallin variaatioita sovellettuna työllistymisen analysointiin, Suomen Tilastoseuran vuosikirja 1992 (The Yearbook of the Finnish Statistical Society 1992), 85-107.

Kettunen, J. (1993e), Re-employment of Finnish Unemployed Workers, The Research Institute of the Finnish Economy, A 17, Helsinki.

Kettunen, J. (1993f), Suomen teollisuuden palkkarakenne, The Research

Institute of the Finnish Economy, B 83, Helsinki.

Kettunen, J. (1993g), Työttömyysvakuutuksen rahoituksen työllisyysvaikutukset (The Effects of Financing Unemployment Insurance on Unemployment), Kansantaloudellinen aikakauskirja (The Finnish Economic Journal) 3/1993, 348-356.

Kettunen, J. and Marjanen, R. (1992), Suomen Työnantajain Keskusliiton palkkatilastot, The Research Institute of the Finnish Economy, Discussion papers, No. 425.

Kettunen, J. and Vartiainen, J. (1993), Suomen teollisuuden työntekijöiden palkkarakenne, The Research Institute of the Finnish Economy, Discussion papers, No. 431.

Kettunen, J. (1994a), The Effects of Education on the Duration of Unemployment, Labour: Review of Economics and Industrial Relations 8, 331-352.

Kettunen, J. (1994b), Järjestelmä ohjaa työllistymistä, Kansantaloudellinen aikakauskirja (The Finnish Economic Journal), 1/1994, 51-52.

Kettunen, J. (1994c), Suomen teollisuuden palkkarakenteen muutos 1980-luvulla, The Research Institute of the Finnish Economy, Discussion papers, No. 463.

Kettunen, J. (1994d), Suorituspalkkaus teollisuusyritysten paikallisen sopimisen muotona, The Research Institute of the Finnish Economy, B 90, Helsinki.

Kettunen, J. (1994e), Time-dependent Effects of Unemployment Benefits, Finnish Economic Papers 7, 120-129.

Kettunen, J. (1994f), Työllistymistä kannustettava, ihmiset vaarassa passivoitua, Sosiaalinen aikakauskirja (Social Review), 2/1994, 15-17.

Kettunen, J. (1996), Duration-dependent Features of Unemployment Insurance, Economics Letters 51, 115-121.

Chapter II

METHOD OF PAY IN FINNISH INDUSTRY

Abstract

In this chapter a dynamic model is derived to describe and analyse the decision of the method of pay. Empirical evidence is presented using microeconomic data on the blue-collar workers in Finnish industry. Logit models are used to analyse the factors affecting the choice of incentive wages. Special attention is paid to unobserved heterogeneity across workers. A new estimator based on a small variance approximation of unobserved heterogeneity is derived for this purpose. In the second stage wage equations by the methods of pay with selectivity into different groups are estimated. The empirical results give support to the results of the economic model.

1. Introduction

The choice of the method of pay has many explanations. They centre not only around the monitoring costs but also around all the factors affecting the time-based and incentive-based wages. The payment plans of incentive wages are designed to induce additional efforts by workers, which increase production and compensation. In this chapter a dynamic model of the method of pay is derived in order to predict the choice of the method of pay and to present empirical evidence on the theoretical results.

Imperfect information on the wages has been a crucial element of the theories of job search since the pioneering microeconomic studies in the 1960's (see Phelps, 1970). Stiglitz (1985) assumes that there are two kinds of imperfect information in the labour market. First, individuals do not know the wage paid before the wage contract. Secondly there are other characteristics associated with a job which are acquired only gradually in a new job. Our study makes a similar kind of assumption about the imperfect information. There is imperfect information of matching individuals to jobs so long as workers and jobs differ. It implies uncertainty in the productivity of workers. Firms are searching for qualified workers for incentive work. Our model to be presented is essentially an analogue to models of search.

The model is an extension of Lazear's (1986) static model, where he assumes symmetric information between workers and firms. Both of them are equally uninformed of the productivity of the workers, but know the distribution of the productivity. Workers with low expected productivity are more likely to prefer time-payment. Hard-working individuals are better off under an incentive scheme. Therefore the firm is more likely to pay them on an incentive-wage basis.

The dynamic model gives predictions for the effects of many explanatory variables. The probability of working at a particular piece rate is decreased by the time-based wage, monitoring costs and increased by the piece-rate, subjective rate of time preference and distribution and uncertainty of offers. The dynamic nature of the economic model predicts, for example, that women and students are more amenable to working on a piece-rate basis, because they usually have a limited spell of employment in a firm.

The empirical significance of individual self-selection is examined. Hard-working individuals will seek out industries, firms, occupations and finally specific tasks which reward their excess effort and adjust their efforts accordingly. It is assumed that both the self- selection of workers and effectiveness in incentive work occur simultaneously.

The microeconomic data on the wages of the Finnish industrial workers give support to the theoretical findings. The data are classified by the method of pay. The samples of the study have been made from the large files collected for bargaining purposes by the Confederation of Finnish Industry and Employers. The data have been obtained directly from the accounting figures of the member firms of the confederation. The characteristics of the workers, jobs and plants are rather detailed in the data.

The econometric study analyses the choice of the method of pay and the wage structure by the different methods of pay in the wood, paper and metal industries. The purpose of the choice models is to determine whether the use of different methods of pay is related in a predictable way to monitoring costs and other factors. Special attention is paid to the variables of the theoretical model which are not observed in the data. In the second part of the econometric study the wage formation is studied conditional on the method of pay.

This chapter is organized as follows. In the next section the dynamic model of the method of pay is derived. It serves as a background to the empirical study. The data of this study are presented in section 3. The logit models allowing for unobserved heterogeneity are derived in section 4. The results of the estimations of the wage equations by the method of pay are presented in section 5. Finally the results of the study are summarized and discussed in the concluding section.

2. A Dynamic Model of Method of Pay

2.1. Lazear's Static Model

A standard goal in the economic studies of the method of pay is to maximize worker's expected wealth subject to a zero profit constraint. An essential characteristic of the piece-rate pay is that it is an incentive device for increased effort. The wage level is determined by the effort E and the cost of effort function c(E). The worker increases his effort in incentive work as long as the cost of effort per unit of output q is less than the piece-rate p. Hence the efficient effort level is given by $E^* = \arg_E \max [pq(E) - c(E)]$.[2] There are, however, a number of other important factors which explain why some workers are paid by the piece for their output while the others are paid by the hours worked for their input of working hours.

The time-based wage $\bar{w}$ depends strictly on the working hours. The earnings of time workers are independent of their own output and effort, but the promotion decisions with long-term salary decisions may depend on individual performance. For simplicity the promotion decision is neglected in our study, because the promotion probably depends on the productivity of the worker regardless of the method of pay. In the firms there are usually minimum requirements for the effort of time work. A dismissal results only if the required minimum tasks are not fulfilled or serious mistakes are made.

While the time-based wage is usually known in advance, an essential feature of the piece-rate wage is that there is uncertainty about the output. It is assumed that workers and firms are equally uninformed of q, but both of them know the distribution of q. The density and distribution functions are denoted as f(q) and F(q), respectively.

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2 Because the form of the production function q(E) is free, any cost function can always be reduced to c with an appropriate redefinition of q (see Lazear, 1986). Alternatively the production function can be given the interpretations of quality or effort.

Incentive workers have variation in their effort and output. Therefore they have also greater variation in earnings than time workers. According to the results of Seiler (1984) the earnings of incentive workers are more diverse than the earnings of identical time workers within both firms and occupations. Greater dispersion in the income of incentive worker is a result of the individual output. In addition the earnings of time workers are insensitive to the fluctuations of the production process and demand of the products. These factors are beyond the worker's control. In Pencavel's (1977) study the standard deviation of the natural log of hourly earnings was 0.188 while the corresponding deviation of the earnings of time workers was 0.107.

Where does imperfect information come from and why does the information not accumulate? Stiglitz (1985) explains that there is a continual flow of ignorance through a continual flow of new entrants into the labour force and flow out of it. The dynamics of the labour market sustain the imperfect information.

It is assumed in Lazear's (1986) static model that workers have an alternative wage $\bar{w}$ which is independent of q. In a simple form the piece rate is determined by an expected output as follows

$$(1) \qquad w = \int_{\bar{w}}^{\infty} qf(q)dq - c,$$

where $\bar{w}$ can be interpreted as the time-based wage. Consequently, the expected lifetime wealth can be written as follows

$$(2) \qquad W = \bar{w}F(\bar{w}) + w.$$

The lifetime wealth is determined by the time-based wage with probability $F(\bar{w})$ if the output does not exceed the threshold value of wage $\bar{w}$. Otherwise the wealth is determined by the expected piece-rate wage. This is only a simplified form of Lazear's static model, which is in this study extended to a dynamic model. Lazear has extended his model introducing the initial monitoring period in order to test the output of each worker and to select the workers for the piece-rate work.

2.2. Dynamic Model

In this section the predictions of the effects of the various factors are derived from a dynamic model of the method of pay. The applicant function $a = a(p)$ is assumed to depend positively on the firm's piece rate p. The applicants are assumed to enter the piece work with probability $a\Delta t$, which weights the alternative choices of time-based and incentive wages during the interval Δt. This is in line with the previous analysis by Seiler (1984), who assumes that prospective employees can choose either compensation system. Also Lazear (1986) assumes that workers are sorted across firms and jobs by the choice of the worker. Workers are assumed to know their productivity. Therefore they choose the firm where their utility is highest. Workers with great productivity choose piece-rate firms and those with low productivity choose the firms paying time rates.

The firm may hire new workers only if it has enough willing applicants. Obviously the workers' behaviour depends on the employers' choice to offer both methods of pay. The collective wage agreements, which are made on the union level, bind the firms to maximize the earnings of the workers by offering piece work whenever it is available. As in the previous studies it is assumed also in our study that workers choose the firms and the firm maximizes workers' earnings by determining the method of pay.

In the following the expected discounted worker's time-based wage during an interval of length Δt is evaluated against the prospective new offers of incentive wage. The value function of the prospective new offer of piece-rate work is denoted by $V'(t)$. The value function for an individual who is paid by the time-based wage can be written as follows

$$(3) \qquad V(t+\Delta t) = \frac{1}{1+r\Delta t}\{\bar{w}\Delta t + a\Delta t\, E_F \max[V'(t), V(t)]$$

$$+ (1 - a\Delta t)V(t)\},$$

where r is the subjective rate of time preference and $\bar{w}$ is the time-based wage. The time concept in the value functions is reversed indicating the worker's remaining time in the labour force. The expectation is taken with respect to the distribution of the quality (or effort) of workers.

The interpretation of (3) is as follows. The workers' compensation for being employed at a time-based wage is proportional to the length of the time interval Δt. With probability $a\Delta t$ a piece-rate offer is received. The acceptance rule is presumed to maximize the workers value in the labour market. With probability $(1 - a\Delta t)$ the worker will not receive an offer. This alternative leads to a value function of the time-based wage V(t).

The decision on the method of pay can be treated in continuous time. Forming the difference quotient $[V(t+\Delta t) - V(t)]/\Delta t$, taking the limit as Δt approaches zero and rearranging terms gives

$$(4) \qquad \dot{V}(t) = \bar{w} + a\, E_F \max[V'(t), V(t)] - (a + r)V(t).$$

In the case of an infinite horizon equation (4) is equal to zero.

On the piece-rate basis the worker's compensation depends on the piece rate p for producing a unit of output q. The cost of increasing the incentives for a more productive work is that the firm has to establish a monitoring system. The workers' compensation can be written as follows

$$(5) \qquad w = pq - c,$$

where c denotes the monitoring costs.

A constant amount of the monitoring costs c has to be allocated for each worker. Alternatively one could define the costs to depend on the output, but the conclusions of the analysis would be similar. In the previous literature it has been noted that if the cost of determining how much each worker has produced is excessive, the firms avoid piece rates (Beach, 1975, 681). The firms that have standardized production where workers perform the same tasks repetitively are amenable to piece work. On the other hand, in jobs where the workers perform a wide range of duties the time work is a reasonable alternative.

The monitoring costs c depend on how difficult it is to measure the worker's output. If the performance is accurately and inexpensively observed, the link between pay and performance is strong. The salary paying firms save on monitoring costs and pay lower wages, but on the other hand they have less productive workers. The costs c can be given also other interpretations such as the cost of effort.

The efficient separation of workers is determined by an acceptance rule. According to the acceptance rule only the workers with $q \geq q'$ are paid at the piece rate. Similar rules regarding the method of pay that depends on the productivity of workers can be found in Lazear (1986) and Brown (1990). The others are paid at the time rate. The q' is assumed to be the endogenous choice variable of the firm. An implication of the selection rule is that for a given occupation piece-rate firms have higher quality workers than time rate firms.

For simplicity it is reasonable to assume an infinite horizon. Hence, the discount factor $B = 1/r$ and the discounted earnings are $w/r = (pq - c)/r$. An infinite horizon leads to a stationary solution implying a constant value function. Then the differential equation can be written as follows

$$(6) \qquad \dot{V} = \bar{w} - rV + a \int_{q'}^{\infty} [(pq - c)/r - V]dF(q).$$

The infinite horizon may not always, however, be reasonable. At least this is true when looking from the standpoint of the workers. A worker's time in the labour force may vary with the time set aside for planned education, maternity, house work or age. Assuming a finite horizon of length t the differential equation can be written as follows

$$(7) \qquad \dot{V}(t) = \bar{w} - rV(t) + a \int_{q'(t)}^{\infty} [(pq - c)B(t) - V(t)]dF(q),$$

where $B(t) = [1 - \exp(-rt)]/r$. Differentiating (6) and (7) with respect to the endogenous variable q' gives the optimal dynamic control for accepting the piece-rate work. The stationary and non-stationary solutions can be written as follows

(8a) $\quad q' \;= [V'r + c]/p$

(8b) $\quad q'(t) = \{V'(t)r/[1 - \exp(-rt)] + c\}/p.$

It is obvious that in a case of finite horizon q'(t) is decreasing when the time is passing. (Technically the remaining time t is approaching zero.) That finding gives an interesting prediction for the persons who can participate in the labour force for only short periods of time. One may expect that, for example, students and women are more amenable to be piece workers.

The probability of being paid at a piece rate is a product of the arrival rate of offers and the probability of accepting an offer. It can be written as follows

(9) $\quad \lambda(t) = a[1 - F(q'(t))].$

The selectivity of workers with respect to the offers is determined by the threshold value of q'(t). In a case of non-stationarity a time path of q'(t) determines the corresponding time path of $\lambda(t)$.

Appendix 1 of this chapter presents the effects of exogenous variables on both q' and λ. In the following these result are briefly discussed. The increase of the level of time-based wage $\bar{w}$ increases the threshold value of the productivity of the workers and makes the piece work less probable. This finding is in accordance with the Finnish collective wage agreements, which presumes that the earnings of the piece-rate work have to exceed the time-based wage of the contracts by a certain amount. In the metal industry the wage gain of the incentive wages has to be at least 20 per cent and in the wood industry it has to be 17 per cent compared to the contract wage. Usually the contract wage is lower than the true time-based wage. If the piece-rate wage does not exceed the time-based wage, the employer has to pay the time-based wage.

An implication of the effect of the time-based wage is that also all the additional forms of compensation related to the time-based wage, such as overtime and shift-work incrementals and fringe benefits, will have negative effects on the probability of being paid by the piece. A disadvantage of a high time-based wage is that the piece-rate work becomes less attractive.

The piece rate p is equal for all the workers. If the piece rate is high, the workers are eager to seek their ways to piece work and finally there may be few skilled workers left for the piece work. Accordingly, if the firm wants to encourage the workers to apply themselves in an efficient incentive work scheme, the wage differentials should be relatively small in similar type of jobs and reflect the differences of the earnings from piece work.

The monitoring costs of the output c have had a central role in the economic literature of incentive wages (see Lazear, 1986 and Brown, 1990). The meaning of the monitoring cost is identical to the difficulty of measuring the output of a worker. For example, it is not easy to monitor the effort of a travel agent, but it is easy to observe the number of items sold. The effects of the monitoring costs are similar to the effects of the time-based wage. When the monitoring costs are high or the increase of effort is costly, the required level of output increases and the probability of paying incentive wage falls. The monitoring costs of the time-based work are usually high. Therefore time rate is in many cases worthwhile.

Piece-rate workers are not always available in a firm. The direct effect of the arrival rate a on the probability of working on the incentive wage basis is clearly positive. The quality of workers better suits the needs of the firm. On the other hand, the availability of piece-rate workers will increase the selectivity of the firm, because it can choose from a broader set of workers. The indirect effect of the arrival rate is negative. As a consequence of these two reverse effects the sign of the arrival rate on the probability of paying piece-rate wage cannot generally be determined. Under reasonable assumptions the effect of the arrival rate is, however, positive. The sufficient conditions for the effect to be non-negative are summarized by van den Berg (1990).

The effect of piece rate p on the selectivity is clearly negative. Since piece-rate work is better paid, it is more attractive. The effect of piece rate on the probability of paying piece rate is positive. The piece rate is an efficient way of encouraging workers to apply themselves more effectively. The piece rate p is determined by the firm. The firms are, however, bound to the collective wage agreements, which stipulate that the earnings from the piece work has to exceed the time-based wage by a certain amount.

Macroeconomic shocks may affect the choice of the method of pay. If the demand for the products of the firm increases, also the piece rate increases in the longer run. That will in turn increase the number of piece workers in a firm. Consequently, the selectivity of a firm decreases. It may lead in an economic boom to a shortage of skilled workers.

The increase of the subjective rate of time preference (discount rate) makes the earnings of the present day more valuable compared to the earnings in the future. From the standpoint of corporate finance the required profitability of production increases with the discount rate. Therefore the discount rate will decrease the selectivity and increase the probability of piece work.

The distribution of the quality of the workers F(q) may have a shift to the right or left. A movement in the distribution to the right may occur, for example, when a firm decides to increase the firm specific skills of the workers by providing training. The shift may occur also due to an improvement in working conditions or technology. The management's skill in removing these obstacles to production have been detailed, for example, in an early work by Slichter (1941). The results are interesting, because the improvement in the distribution of the quality will increase the selectivity of workers and hence the wealth of workers. This leads, however, also to an increasing probability of piece work, because the increase in selectivity is negligible compared to the direct effect of the shift of the distribution.

The uncertainty regarding the quality or productivity of workers σ increases the required productivity of workers and decreases the probability of choosing incentive work. This result is familiar from the shopping literature. Consumers love bargains, which makes them more selective. Similarly the workers have an option of waiting for offers in the upper tail of the wage distribution. Piece rates are less likely chosen when the uncertainty of the output of the workers increases. If the firm knows in advance the output of each worker, the need for testing and choosing the best workers is non-existent. Imperfect information on the productivity of the workers implies a need to keep workers in time work. The workers who are badly mismatched with their job are usually working on time basis.

In the previous literature on the methods of pay the effect of a finite job tenure has been given different interpretations. Obviously one reason has been that the previous discussion has not been based on a unified dynamic model of the method of pay. The other reason is that simple explanations have been sought for the empirical findings including, for example, that women work more often on a piece work basis.

Goldin (1986) argues that better performance is rewarded through future promotion and less monitoring is employed. Such a system is efficient for men, who are planning a stable attachment to the firms. The promise of future promotion does not encourage those who are planning a short job tenure in the firm. Brown (1990) argues also that women might avoid the time-based wage, because supervisors have great discretion in merit pay systems. Therefore women concentrate in systems with the formal protection offered by either standard rates or piece rates. Using a dynamic model of the method of pay these previous explanations in the literature are not necessarily needed to explain why women would avoid the time-based wage. These explanations may be relevant, but in the theoretical model they can be replaced simply by a shorter job tenure.

It is evident that the optimal time path of the required level of ability or effort $q'(t)$ is decreasing as time passes (see Kettunen, 1993b). According to the model the persons who expect their employment to terminate in the near future are expected to be less selective and more likely to work on a piece work basis. For example, students on a summer holiday are presumably willing to be paid by incentive wages. Similarly women often expect an interrupted spell of employment, because they want to work at home and raise children. They are thus probably more attracted to piece work.

The previous discussion has been concentrated upon the pure time-based and piece-rate work. Often in practice a *two-part wage system* is applied. Most jobs fit somewhere in the middle of the time-based and piece-rate work. Consider a capital-intensive production process. With capital it is important for efficiency reason to keep the process running. It means that the wage system must have incentives for that. A two-part incentive wage system is an obvious candidate to satisfy these needs. A time-based wage is paid for the input of workers, but on the other hand it is efficient to pay simultaneously for the quantity or quality of the output.

Suppose for simplicity that each worker operates a machine which increases their productivity by a factor of k_l. On the other hand, workers require their part of the rent of a machine k_c. The compensation of a worker from the output q is equal to $pqk_l + k_c - c$. The effects of k_l and k_c are obvious and similar to the previous results of the effects of the piece rate p. The increase in labour productivity k_l will decrease the required quality of workers and increase the probability of selecting an incentive wage. Increasing labour's share of the rent has similar kind of effects.

3. Description of the Cross-Section Data

The data have been collected for bargaining purposes by the Confederation of Finnish Industry and Employers. The confederation has collected enormous amounts of data starting in the mid 1930's. Nowadays the data consist every year of about 300 000 blue-collar workers and 150 000 white-collar workers (see Kettunen and Marjanen, 1992, Kettunen and Vartiainen, 1993, Kettunen, 1993a,c, 1994a,b, 1995, 1996a,b,c). The information has been collected on every person who has been working in a member firm of the confederation. There is good reason to believe that the data are reliable, because they are not self-reported. The greatest strength of the data is that they have been obtained directly from the accounting figures of the firms.

The sample of this study is based on a cross-section of 8458 blue-collar workers. Every 15th worker was randomly drawn from those covered in 1990 by the collective wage agreements of the wood, paper and metal industries. These industries are the most important for Finnish manufacturing. They also have a central role when the wages are negotiated. The industries are analysed separately, because some of the explanatory variables are not comparable between the industries. The data refer to the last quarter of the year.

The number of workers in the samples of the wood, paper and metal industries are 1122, 2148 and 5188, respectively. Some of the workers in these samples have unbelievable low or high wages. These kinds of outliers can occur if the persons are working during a quarter a small number of hours and receive some part of their earnings in advance or afterwards. The hourly wages have been obtained by dividing the earnings by the hours of work during the quarter. Thus the hourly wages do not necessarily represent the true hourly wage. In this study the observations between FIM 20 and 110 were accepted. About 2.9 per cent of the observations were rejected. The final sample sets include 1095, 2060 and 5054 observations.

The information on the workers include, for example, the earnings, working hours, gender, age and occupation. There are information also on the jobs. The information on the required level of skill is available. The level of skill is ascribed in accordance with the collective wage agreement. There are data also on the overtime and Sunday work. Also some of the characteristics of the plants are available. They include the share of men in a plant, average age of the workers, number of workers and the location of a plant. There are some important limitations in the data. The human capital variables such as educational experience are omitted. Also socio-economic variables such as number of children and marital status are absent. Omitted variables is clearly a problem, which is explicitly taken into account in the estimations.

The earnings and working hours have been decomposed into three methods of pay in the data. Nearly half of the working hours are paid at the time-based wage in manufacturing. The remaining incentive wages have been decomposed into two groups. One group comprises the work based on the quantity of the output. The other group encompasses incentive wages based also on the quality of the output.

The incentive wages are not paid purely on a piece-rate basis, but they may include two parts related to time-based and incentive wages. The pure piece-rate work is usually based on the quantity of output. The incentive wage based on the quantity and quality is partly determined by the time-based wage and partly by the incentive wage. Unfortunately the data have no information on the breakdown between these two parts. There are many examples of incentive wages which are paid for quality. For example, bonuses may depend on sales revenue or profits, which are measures that weights quantity and quality. The purpose is that workers are not paid for low-quality work. Incentive wage based on the quality is close to individual bonus pay and commissions.

Another often used two part wage system is that, if the output falls below a certain threshold, the earnings of workers are determined using the time-based wage. Otherwise the workers are eligible for the incentive wage or the wage incremental related to the output.

Table 1 illustrates the shares of the working hours by the methods of pay in the different industries of the study. About 45 per cent of all the working hours are based on incentive wage in the wood industry. In the paper and metal industry the corresponding figures are 15 and 36 per cent, respectively. Most of the incentive work in the wood industry is done on a quantity basis. On the other hand, most of the incentive work in the paper industry is not based only on quantity but on both the quantity and quality. The paper industry is a typical example of a capital-intensive business. A major drawback of the individual data is that there are not enough observations for both types of incentive work in the wood and paper industries. In the metal industry both of the incentive wages are equally employed.

Table 1. Shares of the working hours by the methods of pay

(A) Time-based work
(B) Incentive work based on quantity
(C) Incentive work based on quantity and quality

	(A)	(B)	(C)
Wood industry	0.546	0.416	0.038
Paper industry	0.846	0.024	0.129
Metal industry	0.644	0.178	0.178

During a quarter workers can be paid by the hours worked and by the piece. It turns out that these mixed-rate workers can to a large extent be primarily classified into time or piece-rate workers according to their jobs. In the previous study by Seiler (1984) there are only time or incentive-paid workers. Usually this is true only at a selected point in time. It is typical that the method of pay depends on whether the compensation is from production or maintenance work. Time-based wages are usually applied temporarily for setup, needed maintenance or during the shifts of production. The monitoring costs in the form of calculating the piece-rate would be too high during these short periods in order to chose the incentive pay (see Chen and Edin, 1992).

The wage of a worker consists of the basic wage, which depends on the method of pay. According to the collective wage agreements the time-based wage has been defined using the wage groups which are classified according to the required level of skill in a job. The basic wage includes also the incrementals related to the high cost areas of residence. These areas have been determined by the government. They include the largest towns, islands and Lapland. The basic wage and wage incrementals based on shift work and work conditions form the regular wage. The regular wage together with the incrementals from the overtime and Sunday work form the total wage of the worker. During the period of study the additional compensation constituted on average about 9 per cent of the total wage in the Finnish industry.

Table 2. Shares of the working hours by the classification of workers by the method of pay

	Most hours by time work	Most hours by incentive work based on quantity	Most hours by incentive work based on quantity & quality
Wood industry:			
Time-based work	0.917	0.170	0.125
Incentive work[1]	0.072	0.826	0.026
Incentive work[2]	0.010	0.004	0.849
Paper industry:			
Time-based work	0.981	0.130	0.142
Incentive work[1]	0.005	0.864	0.003
Incentive work[2]	0.013	0.006	0.854
Metal industry:			
Time-based work	0.948	0.167	0.121
Incentive work[1]	0.028	0.813	0.017
Incentive work[2]	0.024	0.020	0.862

1. Based on quantity. 2. Based both on quantity and quality.

To obtain the indicators of the method of pay the workers are classified into time-based or incentive wage workers according to type of hours that they work most during the quarter of the year. This classification is used as a basis of the estimations of the logit models. The classification is reasonable, since according to the data the workers in the plants are classified in one or the other way.

A general view among the experts of the labour market is that the firms are classified according to whether they pay the time-based or piece-rate wage (see Vartiainen, 1993). An interview of the experts confirm that the tasks in the firms are classified as time-based or incentive work. Hence the workers are classified according to the methods of pay. *Table 2* shows that 92-98 per cent of all the working hours of the persons who have been classified as time workers are from the time-based work. Similar figures for the two kinds of incentive work are 81-86 and 85-86 percent, respectively.

An alternative approach to the discrete choice is to use the individual data on working hours to analyse the choice of the method of pay. The working hours can be used to calculate the shares of working hours by the method of pay. The models of grouped data on the working hours can be estimated using the proportions of working hours instead of the discrete indicators for the choice of the method of pay. One may believe that the shares of working hours are more precise having more information than the indicators. On the other hand, an incentive worker may, however, be temporarily engaged in time-based work, since incentive work is not available at the moment. Therefore the decision to use the indicators or shares in the study is an empirical question. Various experiments were made using the discrete and grouped data. The log-likelihood functions were, however, clearly lower in the models using grouped data. Therefore the approach based on grouped data was rejected and the results are not reported to save space.

Table 3 presents the descriptive statistics of the data. It turns out the incentive wages are clearly higher than the time-based wage in all the studied industries. The largest differences between the time-based and piece-rate wages are in the paper industry. Most workers are men in industry. The share of men vary between 76 - 81 per cent. The average age of workers in the wood, paper and metal industries are 39, 40 and 38 years, respectively. The largest plants can be found from the paper industry.

Table 3. Descriptive statistics of the cross-section data on wages in 1990

Wood industry:

Variables		Mean	Std.Dev.	Minimum	Maximum
Time-based hourly wage[1], FIM		38.04	5.82	24.00	78.20
Incentive hourly wage[2], FIM		41.83	6.16	26.76	92.50
Incentive hourly wage[3], FIM		41.86	8.40	28.89	78.87
Sex, 1=male		0.76	0.43	0.00	1.00
Share of men in a plant		0.76	0.11	0.33	1.00
Age, years		38.75	10.79	16.00	63.00
Average age in a plant, years		38.27	2.28	29.00	47.00
Number of workers in a plant		892.16	1002.49	8.00	2957.00
County of Uusimaa, 1=yes		0.02	0.16	0.00	1.00
High cost area, 1=yes		0.15	0.36	0.00	1.00
Poor working conditions, 1=yes		0.19	0.39	0.00	1.00
Overtime work, 1=yes		0.48	0.50	0.00	1.00
Sunday work, 1=yes		0.15	0.36	0.00	1.00
Required level of skill, 1=yes:	1	0.08	0.27	0.00	1.00
	2	0.21	0.41	0.00	1.00
	3	0.28	0.45	0.00	1.00
	4	0.23	0.42	0.00	1.00
(high)	5	0.20	0.40	0.00	1.00
Number of work shifts, 1=yes:	1	0.42	0.49	0.00	1.00
	2	0.30	0.46	0.00	1.00
	3	0.19	0.39	0.00	1.00
	unknown	0.09	0.29	0.00	1.00

N = 1095, 1. N = 743, 2. Based on quantity, N = 746, 3. Based on quantity and quality, N = 119.

Paper industry:

Variables	Mean	Std.Dev.	Minimum	Maximum
Time-based hourly wage[1], FIM	43.30	5.20	31.25	79.25
Incentive hourly wage[2], FIM	57.50	17.68	38.23	107.50
Incentive hourly wage[3], FIM	47.92	6.51	32.47	95.73
Sex, 1=male	0.81	0.39	0.00	1.00
Share of men in a plant	0.81	0.05	0.30	0.94
Age, years	40.09	10.18	18.00	63.00
Average age in a plant, years	40.17	1.41	32.00	47.00
Number of workers in a plant	3414.48	2252.39	33.00	6584.00
County of Uusimaa, 1=yes	0.01	0.11	0.00	1.00

High cost area, 1=yes	0.16	0.37	0.00	1.00
Poor working conditions, 1=yes	0.41	0.49	0.00	1.00
Over-time work, 1=yes	0.49	0.50	0.00	1.00
Sunday work, 1=yes	0.66	0.47	0.00	1.00
Required level of skill, 1=yes: 1	0.12	0.32	0.00	1.00
2	0.14	0.34	0.00	1.00
3	0.21	0.41	0.00	1.00
4	0.25	0.43	0.00	1.00
(high) 5	0.29	0.45	0.00	1.00
Number of work shifts, 1=yes: 1	0.35	0.48	0.00	1.00
2	0.14	0.34	0.00	1.00
3	0.51	0.50	0.00	1.00

N = 2060, 1. N = 1104, 2. N = 92, 3. N = 1123.

Metal industry:

Variables	Mean	Std.Dev.	Minimum	Maximum
Time-based hourly wage[1], FIM	42.86	7.63	20.00	91.41
Incentive hourly wage[2], FIM	50.09	9.47	21.46	108.12
Incentive hourly wage[3], FIM	46.91	7.08	24.00	95.53
Sex, 1=male	0.77	0.42	0.00	1.00
Share of men in a plant	0.77	0.22	0.13	1.00
Age, years	38.30	10.43	16.00	66.00
Average age in a plant	38.05	2.94	25.00	49.00
Number of workers in a plant	981.02	1254.45	5.00	4930.00
County of Uusimaa, 1=yes	0.18	0.38	0.00	1.00
High cost area, 1=yes	0.35	0.48	0.00	1.00
Poor working conditions, 1=yes	0.11	0.31	0.00	1.00
Over-time work, 1=yes	0.47	0.50	0.00	1.00
Sunday work, 1=yes	0.26	0.44	0.00	1.00
Required level of skill, 1=yes: 1	0.40	0.49	0.00	1.00
2	0.43	0.50	0.00	1.00
(low) 3	0.17	0.38	0.00	1.00
Number of work shifts, 1=yes: 1	0.66	0.47	0.00	1.00
2	0.20	0.40	0.00	1.00
3	0.09	0.28	0.00	1.00
unknown	0.06	0.23	0.00	1.00

N = 5054, 1. N = 4117, 2. N = 1383, 3. N = 1821.

There are rather few workers in the forest industry located in the county of Uusimaa compared to the metal industry. About 15-16 per cent of the jobs in the forest industry are situated in the high cost area. In the metal industry the corresponding share is 35 per cent. In the forest industry the work conditions are clearly worse than in the metal industry. Nearly every second worker has been working over their regular working hours. Sunday work is common in the paper industry, where the production is characterized as an ongoing work. This can be seen also from the number of work shifts. Working in three shifts is common in the paper industry. The required level of skill is classified so that the most workers are on the middle and high levels.

4. Empirical Evidence on the Choice of Method of Pay

4.1. Unobserved Heterogeneity Across Workers in Logit Models

In this section the logit model of the method of pay is studied. Special attention is paid to the unobserved heterogeneity across workers. The probability of the alternative i given by the well known logit model can be written as follows

$$(10) \qquad p(i|x, \beta) = \frac{\exp(x\beta_i)}{\sum_{j=1}^{J} \exp(x\beta_j)},$$

where x is a (N x k) matrix of explanatory variables having information on N workers and β_i is a (k x 1) vector of k coefficients for a choice i. Note that the explanatory variables are the same for the different choices. In order to avoid singularity of the Hessian matrix one of the alternatives has to be normalized as a reference group. It is done by setting $\beta_J = 0$.

A confusing variant of the logit model (10) is called a discrete choice model, where the J alternatives are characterised by J sets of regressors related to each of the choices and a single parameter vector (see McFadden, 1974, 1976, 1984). Regardless of the number of choices, there is a single (k x 1) vector of parameters to be estimated. That model is sometimes called also the random utility model.[2]

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[2] The alternative discrete choice model can be written as follows

$$p(i \mid x,\beta) = \frac{\exp(x_i \beta)}{\sum_{j=1}^{J} \exp(x_j \beta)}.$$

Apart from the denominator the discrete choice model resembles the famous Cox's (1972, 1975) model

$$p(i \mid x,\beta) = \frac{\exp(x_i \beta)}{\sum_{j \in R(t_i)}^{J} \exp(x_j \beta)},$$

In our logit model there is a single regressor vector and J-1 parameter vectors. The extended logit model developed in this chapter is inspired by a similar extension by Chesher and Santos Silva (1992) in the context of discrete choice models. *Appendix 2* presents the main characteristics of their model. Unfortunately there is no appropriate data on the method of pay in order to estimate a discrete choice model. The differences between the data and formulations of the model are the reasons for extending the small variance approximation by Chesher and Santos Silva to our logit model.

Suppose that the model is misspecified in such a way that the explanatory variables do not control completely for the heterogeneity between the workers. This doubt is reasonable, since in the logit model the explanatory variables do not take different values between the alternatives as in the discrete choice model.

Let us assume that unobserved heterogeneity across workers can be represented by a random term $u = [u_j]$ which is additive to the observed heterogeneity. The term of heterogeneity u can be interpreted as intrinsic heterogeneity between workers or measurement error in the regressors x or the dependent variables y; for a discussion see Lancaster (1983, 1985) and Chesher (1991). The conditional choice probabilities given x and u can be written as follows

$$(11) \qquad p(i|x,\beta,u) = \frac{\exp(x\beta_i + u_i)}{1 + \sum_{j=1}^{J-1} \exp(x\beta_j + u_j)} .$$

The conventional logit model assumes that the utilities of different individuals are independently distributed. This assumption is hardly met in the real world, since the unobserved characteristics may be correlated among the individuals who have chosen a certain alternative. Unobserved heterogeneity has usually been neglected for the sake of convenience as pointed out by Amemiya (1981). Apparently one reason is the difficulty in specifying the correct structure of the neglected heterogeneity.

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where $R(t_i)$ is the risk set. It includes the observations which are still in the cohort at the duration t_i. A small variance approximation in the context of Cox's model seems to be a difficult problem and to our knowledge it has not yet been solved.

Since u is unobserved the relevant marginal density can be written as follows

$$(12) \quad \bar{p}(i|x,\beta) = \int_{-\infty}^{\infty} p(i|x,\beta,u)f(u|x)du,$$

where $f(u|x)$ is the density function of u given x. The functional form of $f(u|x)$ is generally unknown.

In order to avoid imposing any specific form for the function $f(u|x)$ a small variance approximation is derived. It is obtained by expanding $p(i|x,\beta,u)$ in a second order Taylor series in u and integrating u. It gives the following approximation

$$(13) \quad \bar{p}(i|x,\beta) = p_i + 0.5\omega_i p_i^{ii} + o(\omega^2),$$

where ω_i is the variance of the unobserved heterogeneity, $p_i^{ii} = p_i(1 - 3p_i + 2p_ip_i)$ and $p_i = p(i|x,\beta)$. The variance ω_i related to the choice i is a scalar. The remainder term $o(\omega^2)$ is of negligible magnitude. The approximation (13) cannot, however, be used in this form as the basis for estimating the unknown parameters, since it does not in general lie in (0, 1).

In order to obtain an expression which lies in (0, 1) and has a first order Taylor series in ω identical to (13) consider the following choice probability

$$(14) \quad g(i|x,\beta,\omega) = \frac{\exp(x\beta_i + r_i\omega_i)}{1 + \sum_{j=1}^{J-1} \exp(x\beta_j + r_j\omega_j)}\,.$$

In the appealing formula (14) the puzzling interest is in the new unknown terms r_j, which are worth of examining more closely.

The first order Taylor series expansion of $g(i|x,\beta,\omega)$ can be written as follows

$$(15) \quad g(i|x,\beta,\omega) = p_i + \omega_i r_i p_i(1 - p_i) + o(\omega^2).$$

Setting (13) equal to (15) gives the needed expression for the unknown term r_j, which can simply be written as $r_j = 0.5 - p_j$.

Substituting $0.5 - p_j$ for r_j in equation (14) leads to an extended multinominal logit model which can be written as follows

$$(16) \quad g(i|x,\beta,\omega) = \frac{\exp[x\beta_i+(0.5-p_i)\omega_i]}{1 + \sum_{j=1}^{J-1} \exp\left[x\beta_j + (0.5-p_j)\omega_j\right]} .$$

Formula (16) allows one to identify the variances of unobserved heterogeneity ω_i related to the choices $j = 1,...,J-1$. There are as many coefficients of variances as vectors of the structural parameters. The covariances between the alternative choices are zero unlike in the model by Chesher and Santos Silva (1992).

The likelihood contribution of a conventional logit model can be written using the indicators y_j, $j = 1,...,J$, valued zero or unity as follows

$$(17) \quad L_1 = \Pi \; p(i|x,\beta)^{y_j} ,$$

where the product is over the choices. Correspondingly, for the extended logit model the likelihood function can be written as follows

$$(18) \quad L_2 = \Pi \; g(i|x,\beta,\omega)^{y_j} .$$

The first order condition of the maximum likelihood in a logit model can be written for each choice i as follows

$$(19) \quad \frac{\partial \log L_1}{\partial \beta_i} = \Sigma \, (y_i - p_i)x,$$

where $p_i = p(i|x,\beta)$. The first order conditions for the extended logit model can be written as follows

$$\text{(20a)} \quad \frac{\partial \log L_2}{\partial \omega_i} = \Sigma\ (0.5 - p_i)(y_i - g_i)$$

$$\text{(20b)} \quad \frac{\partial \log L_2}{\partial \beta_i} = \Sigma\ [(1 - \omega_i p_i)(y_i - g_i)$$

$$+ \sum_{j=1}^{J-1} \omega_j p_i p_j (y_j - g_j)]x,$$

where $g_i = g(i|x,\beta,\omega)$. It is easy to verify that $\partial \log L_1/\partial \beta_i = \partial \log L_2/\partial \beta_i$ if $\omega_i = 0$. The data consist of the indicators of the method of pay y_j and the explanatory variables x.

For the estimation of the logit models a programme using SAS/IML matrix language was written (SAS/IML, 1985). It is based on Andrew Chesher's SAS/MATRIX programme for estimating censored Weibull models of transition data. The original programme has been used, for example, to estimate models of female fertility (Chesher, 1986).

The maximum likelihood algorithm of the programme is a modification of the well-known Newton-Raphson method. The Newton-Raphson method requires the analytic second derivatives of the log-likelihood function with respect to the unknown parameters. Often the second derivatives are awkward and time consuming to derive. Therefore they are avoided by using the IM-identity. This leads to the algorithm by Berndt, Hall, Hall and Hausman (1974), which in our case requires the analytic first derivatives (19) or (20a and 20b). The variance matrix for the coefficients is the summed outer products of the first derivatives of the log-likelihood function.

The algorithm of the programme uses a line search method in order to determine the size of the step. If a decreasing value of the log-likelihood function is observed near the solution, the size of the step is halved as many times as needed in order to reach the increasing value of the function. The programme is presented in *Appendix 3*. It has an option of estimating a conventional logit model (SIGMA=0) and a model allowing for unobserved heterogeneity (SIGMA=1). The modified versions of the programme have been used to estimate also the other maximum likelihood models of this thesis.

4.2. Estimation Results

The models for the wood, paper and metal industries have been estimated separately, because the wage agreement and the determinants of wages in the collective agreement vary between these industries. Also the classification of occupations are industry specific. Previous studies of incentive schemes provide evidence of tremendous variation between industries in the share of incentive work (e.g. Seiler, 1984). There is a collective wage agreement in the wood and paper industries, but there are also local negotiations on the wages. The firms in the metal industry closely follow the collective wage agreements. The wage incrementals based on overtime, Sunday and shift work and the required levels of skill are not comparable between the industries.

Regarding the choice of explanatory variables in the logit models, the variables that are related to the choice of the method of pay are selected. Sex and share of men are needed to examine the predictions of the economic model. Age variables are assumed to be related to the ability and productivity of workers. Also the required level of skill is a variable which is clearly related to ability. The monitoring costs are not observed in the data, but the number of workers in a plant, poor working conditions, overtime work, Sunday work, number of work shifts and occupational indicators are assumed to be related to the monitoring costs.

According to the economic model the regional indicators for the county of Uusimaa and high cost area do not affect to the choice of the method of pay. These indicators are used as the identifying variables in the wage equations. Many household characteristics such as marital status or the number of children would be good choices for the identifying variables. Unfortunately these variables are not available in the data set.

The results of estimations for a choice of incentive wage in the wood industry have been reported in *Table 4*. The results of the empirical analysis seem to be generally in line with the theoretical prediction. The time-based and incentive wages are the choices of the binary logit model. There are not enough observations in the data for a three-choice model.

It turns out that the estimate of the variance of the unobserved heterogeneity takes a statistically significant value. Allowing for unobserved heterogeneity increases the log-likelihood function considerably. Also the absolute values of the parameter estimates increase. They increase also if additional explanatory variables are included in the model. As a consequence the results based on the conventional logit model are biased. These results are similar to the findings of Lancaster (1979) in the context of unemployment duration models.

According to the results of estimations it is more likely to find female workers engaged in incentive work. Also the share of men in a plant has negative coefficients. These findings support the results based on the dynamic economic model of the method of pay. The limited attachment of women to their employer increases their incentives to seek out the better paying jobs with piece work.

The effect of age is according to the parameter estimates of the model increasing up to 36 years.[3] Thereafter the effect is decreasing. The workers who are near their age of retirement are more seldom paid at a piece rate than the youngest workers. The average age of the workers in a plant is positively related to the probability of choosing incentive work.

The size of a plant is measured using the number of workers in a plant. The incentive wage is most often applied in small plants. This result gives support to the importance of monitoring costs. Oi (1983) and Garen (1985) have argued that the monitoring costs may be high in large firms. Therefore the incentive wage is less attractive in these firms.

The wage incrementals due to poor working conditions are negatively related to the probability of choosing incentive wage. The wage incrementals based on the poor working conditions increase the time-based wage. The incentive wage is apparently less attractive for the persons having a

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3 The effect of age $A = 0.243*\text{age} - 0.339*\text{age}^2/100$. Then $\partial A/\partial \text{age} = 0.243 - 0.00678*\text{age}$, which peaks at 36 years of age.

high time-based wage. The results give support to the economic model of the method of pay. The time-based wage itself cannot be used in these models, because it is not available to the persons who work entirely on an incentive work basis. The indicators for overtime and Sunday work do not have statistically significant coefficients.

The required level of skill has been defined in the wage agreement between the trade union of the wood industry and the corresponding employers' association. According to the results there is a positive relationship between the required level of skill and the probability of working on an incentive wage basis. Some of the coefficients are statistically insignificant. That is due to the fact that the required level of skill increases the time-based wage, which has a negative effect. Therefore the coefficients of these indicators reflect the negative effect of the time-based wage and the positive effect of the skill.

The number of work shifts is positively related to the choice of the incentive wage. This reflects the effects of monitoring costs. Usually the monitoring of incentive work is easy. Therefore the tasks are not bound to the daytime and can be carried out at any time. The output is usually measured during the day shift.

The coefficients of 14 occupational indicators reflect notable differences between the occupations. These coefficients have been omitted to save space. According to the theory and previous literature the costs of monitoring is an important factor explaining differences in method of pay (e.g. Brown, 1990). The occupational indicators are expected to control for the costs of monitoring across jobs. An investigation of the coefficients indicates that incentive work is used often in production work and rather seldom in maintenance work and service.

The results of estimations for the choice of incentive wage in the paper industry have been reported in *Table 5*. The estimate of the variance of the unobserved heterogeneity takes a statistically significant value, which is slightly larger than the corresponding estimate of the models for the wood industry. The allowance for unobserved heterogeneity increases the log-likelihood function and in most cases also the absolute values of the parameter estimates.

Table 4. Results of estimations for a choice of incentive wage in the wood industry from binary logit models[1]

(A) Conventional logit model
(B) Extended logit model allowing for unobserved heterogeneity

	(A)	(B)
Variance of heterogeneity		5.936
		(0.384)
Constant	-5.682	-9.253
	(1.910)	(3.351)
Sex, 1=male	-0.463	-1.136
	(0.219)	(0.370)
Share of men in a plant	-1.306	-8.712
	(0.831)	(1.579)
Age, years	0.094	0.243
	(0.048)	(0.082)
Age squared, years/100	-0.129	-0.339
	(0.062)	(0.105)
Average age in a plant, years	0.161	0.374
	(0.038)	(0.071)
Number of workers in a plant/1000	-0.389	-0.582
	(0.101)	(0.159)
Poor working conditions, 1=yes	-0.120	-0.817
	(0.187)	(0.315)
Overtime work, 1=yes	-0.176	0.064
	(0.157)	(0.253)
Sunday work, 1=yes	-0.158	-0.597
	(0.241)	(0.416)
Required level of skill, 1=yes:		
1 (reference group)		
2	-0.031	0.845
	(0.308)	(0.502)
3	-0.001	-0.119
	(0.310)	(0.513)
4	0.277	1.137
	(0.333)	(0.548)
5 (the highest level)	0.083	0.917
	(0.364)	(0.592)
Number of work shifts, 1=yes:		
1 (reference group)		
2	0.540	2.059
	(0.181)	(0.313)
3	1.332	2.813
	(0.265)	(0.402)
unknown	0.265	0.748
	(0.247)	(0.499)
Number of occupational indicators	14	14
Log likelihood	-595.3	-579.9
Number of observations	1095	1095

1. The standard errors are in the parentheses.

Table 5. Results of estimations for a choice of incentive wage in the paper industry from binary logit models[1]

(A) Conventional logit model
(B) Extended logit model allowing for unobserved heterogeneity

	(A)	(B)
Variance of heterogeneity		7.086
		(0.339)
Constant	15.055	36.176
	(1.840)	(2.699)
Sex, 1=male	0.237	0.903
	(0.154)	(0.230)
Share of men in a plant	-5.117	-11.942
	(1.102)	(1.576)
Age, years	0.059	0.140
	(0.035)	(0.048)
Age squared, years/100	-0.080	-0.181
	(0.043)	(0.061)
Average age in a plant, years	-0.307	-0.827
	(0.035)	(0.055)
Number of workers in a plant/1000	-0.076	0.252
	(0.022)	(0.032)
Poor working conditions, 1=yes	-0.218	-0.460
	(0.112)	(0.160)
Overtime work, 1=yes	-0.102	-0.033
	(0.104)	(0.143)
Sunday work, 1=yes	0.137	0.456
	(0.139)	(0.193)
Required level of skill, 1=yes:		
1 (reference group)		
2	0.154	0.389
	(0.198)	(0.274)
3	-0.092	-0.272
	(0.191)	(0.250)
4	-0.229	-0.481
	(0.195)	(0.261)
5 (the highest level)	-0.233	-0.668
	(0.213)	(0.283)
Number of work shifts, 1=yes:		
1 (reference group)		
2	0.482	0.699
	(0.168)	(0.243)
3	0.172	0.154
	(0.169)	(0.241)
Number of occupational indicators	17	17
Log likelihood	-1339.5	-1304.1
Number of observations	2060	2060

1. The standard errors are in the parentheses.

In the paper industry men are more often engaged in incentive work than women. In some of the experiments the effect of sex was insignificant. On the other hand, the share of men is negatively related to the probability of working on an incentive wage basis. This reflects that in the paper industry the decision of starting at a piece rate does not depend primarily on the individuals but rather on the prevalence of working groups. The working groups are rather common in the plants, because the character of the work is to control the processes of a paper mill.

The effect of age on the individual level is concave and it peaks at 39 years of age. The propensity of working on a piece work basis is slightly smaller for the older than the younger workers. The average age of workers in the plant has a negative and significant coefficient. Possibly it reflects the decisions of working groups. Older groups may be inclined to avoid piece-rate work in order to protect some weak members of the group. The size of the plant measured as the number of workers does not have a statistically significant effect on the choice of incentive work.

The wage incrementals based on the poor working conditions are negatively related to the probability of choosing the incentive wage. Because the wage incrementals are contributions to the time-based wage, the negative coefficients were expected by the economic model. The indicator of the overtime work has statistically insignificant coefficient in these models. The indicator of the Sunday work has a positive and significant coefficient in incentive work.

The required level of skill does not have statistically significant effects on all the levels. The effect is negative on the highest level. The coefficients reflect according to the theoretical model the negative effect of time-based wage and the positive effect of skill. The indicator of working in two shifts have significant and positive coefficients with respect to the incentive wage. The indicators for the occupations of the paper industry show clearly smaller differences between the occupations than in the models for the wood industry.

The results of estimations for a choice of incentive wage in the metal industry have been reported in *Table 6*. The essential difference here is that the second incentive wage has been added as an alternative incentive wage. The three choices of the model are: 1) incentive wage based only on quantity, 2) incentive wage based both on quantity and quality and 3) the time-based wage. The time-based wage is the reference choice of the model.

The estimates of the variances of the unobserved heterogeneity related to the both types of incentive wages take statistically insignificant values. Hence, as a consequence, it can be concluded that there is no need to correct for neglected heterogeneity in these models and the conventional logit models can be used to draw the conclusions. In addition, it cannot be observed that the absolute values of the parameter estimates would increase when unobserved heterogeneity is allowed in these models. This finding is in line with the previous models where the neglected heterogeneity biased the parameter estimates towards zero.

Men have negative but statistically insignificant coefficients regarding the choice of incentive wage based on quantity. In the incentive wage based on quantity and quality men have statistically significant and negative coefficient. Men have lower probability to work in incentive wage based on quantity and quality than women. The share of men in a plant is positively related to the probability of choosing the incentive wage based on quantity, but negatively related in the incentive work based on quantity and quality. The effect of age on an individual level has a concave relationship with both types of the incentive wages. The effects peak at the 43 and 42 years of age in the first and second alternatives of the choices, respectively. The effects of age are slightly smaller for the older workers compared to the younger workers. The average age of the workers in the plant has a positive relationship for both types of incentive wages.

The number of workers in a plant is positively related to the incentive wage based on quality and quantity. Brown (1990) argues that in large firms the monitoring costs for a worker are usually lower (see also Cleland, 1955 and ILO, 1984). Therefore the incentive work would be more attractive. The indicators of the overtime and Sunday work do not take statistically significant coefficients.

The required level of skill has a statistically significant and positive effect in the both types of incentive wages. Working in two or three shifts are positively related to the choice of incentive wages. The parameter estimates of the occupational indicators show that there are notable differences between the occupations. The incentive wage is seldom used in the maintenance departments of the factories, but it is often used in the production work.

Table 6. **Results of estimations for a choice of the method of pay in the metal industry from multinominal logit models[1]**

(A) The conventional logit model
(B) The extended logit model allowing for unobserved heterogeneity

	(A)	(B)
Incentive wage based on quantity:		
Variance of heterogeneity, ω_1		0.352 (3.947)
Constant	-8.935 (1.058)	-8.821 (2.433)
Sex, 1=male	-0.198 (0.150)	-0.136 (0.105)
Share of men in a plant	0.732 (0.290)	0.320 (0.224)
Age, years	0.066 (0.028)	0.059 (0.024)
Age squared, years/100	-0.079 (0.035)	-0.069 (0.030)
Average age in a plant, years	0.084 (0.016)	0.094 (0.026)
Number of workers in a plant/1000	0.040 (0.057)	0.050 (0.034)
Poor working conditions, 1=yes	-0.343 (0.150)	-0.098 (0.109)
Overtime work, 1=yes	-0.179 (0.098)	-0.095 (0.075)
Sunday work, 1=yes	0.096 (0.122)	0.061 (0.088)
Required level of skill, 1=yes:		
1 (reference group)		
2	0.397 (0.100)	0.298 (0.106)
3 (the lowest level)	0.413 (0.157)	0.292 (0.144)
Number of work shifts, 1=yes:		
1 (reference group)		
unknown	0.723 (0.173)	-0.438 (0.190)
2	0.664 (0.111)	0.443 (0.112)
3	0.331 (0.248)	0.200 (0.161)
Number of occupational indicators	23	23

Incentive wage based on quantity and quality:

Variance of heterogeneity, ω_2		-6.509
		(5.083)
Constant	-4.755	-2.362
	(0.747)	(0.345)
Sex, 1=male	-0.197	-0.089
	(0.122)	(0.042)
Share of men in a plant	-0.077	-0.013
	(0.027)	(0.076)
Age, years	0.049	0.026
	(0.025)	(0.009)
Age squared, years/100	-0.060	-0.031
	(0.032)	(0.011)
Average age in a plant, years	0.057	0.036
	(0.015)	(0.006)
Number of workers in a plant/1000	0.694	0.179
	(0.035)	(0.031)
Poor working conditions, 1=yes	-0.131	-0.044
	(0.128)	(0.041)
Overtime work, 1=yes	0.016	-0.017
	(0.087)	(0.029)
Sunday work, 1=yes	0.153	0.050
	(0.106)	(0.037)
Required level of skill, 1=yes:		
1 (reference group)		
2	-0.009	0.071
	(0.092)	(0.032)
3 (the lowest level)	-0.104	0.037
	(0.141)	(0.048)
Number of work shifts, 1=yes:		
1 (reference group)		
unknown	-0.836	-0.100
	(0.192)	(0.074)
2	1.050	0.340
	(0.097)	(0.058)
3	1.047	0.228
	(0.170)	(0.068)
Number of occupational indicators	23	23
Log likelihood	-4313.2	-4305.4
Number of observations	5054	5054

1. The standard errors are in the parentheses.

5. Wage Equations by Method of Pay

5.1. Two-stage Estimation

In this section the wage equations are estimated by the method of pay. Special emphasis is devoted to the selectivity of workers to be paid on an incentive wage basis. The model with selectivity is called a switching regression model with endogenous switching in two regimes as suggested by Maddala and Nelson (1975). The two-stage estimation method was suggested by Heckman (1974, 1976, 1979) and further extended by Lee (1978, 1979) and Amemiya (1978, 1979). It is often called a mover-stayer model. Variants of the mover-stayer model have been used in a number of studies (e.g. Willis and Rosen, 1979).

Consider for simplicity a two-equation model of wages, one for the time-based wage and the other for the incentive wage. A straightforward multinominal extension is discussed later. The theory of the method of pay suggests that a worker will participate in an incentive wage scheme only if the worker's ability q exceeds the threshold value q'. It is clear that the distribution of observed incentive wages is truncated. Because the threshold value q' is not directly observable, it is difficult to test the implications of the economic model directly.

Consider an unobservable latent variable $q^* = q - q'$ that is greater than or equal to zero if the worker is paid at the piece rate and less than zero if he is paid at the time rate. Then the latent variable can be written as follows

$$(21) \quad q_n^* = x_n\beta + u_n,$$

where $n = 1,...,N$ refer to the individuals of the sample, x_n includes the worker characteristics, monitoring costs and other characteristics related to the job and $u_n \sim N(0,\sigma^2)$. The equation for q_n^* is an auxiliary regression equation that merely serves to derive a probit model for the participation in incentive work.

There is a criterion function that determines which of these methods of pay is applicable. An indicator is the observed counterpart of the threshold value q_n^*. An indicator for the choice of possible alternatives is defined as follows

(22a) $I_n = 0, \text{ if } q_n^* \leq 0$

(22b) $I_n = 1, \text{ if } 0 < q_n^*.$

The latent variable q_n^* and criterion function lead to a probit model $\Pr(I_n = 1) = \Phi\ (x\beta/\sigma)$, where Φ is the normal distribution function. Given the structure of the model the parameters β are identifiable under the normalization that the variance of the disturbance σ^2 is one. The normalization simplifies the notation.

For a random sample of workers the wage equations of an unobserved underlying response variables w_{jn}^*, j = 1, 2, are in our case based on the choices of the method of pay. The natural logarithms of the time-based and incentive hourly wages log w_{1n}^* and log w_{2n}^* respectively are defined by the equations as follows

(23a) $\log w_{1n}^* = z_{1n}\gamma_1 + u_{1n}, \text{ if } q_n^* \leq 0$

(23b) $\log w_{2n}^* = z_{2n}\gamma_2 + u_{2n}, \text{ if } 0 < q_n^*,$

where z_1 and z_2 are exogenous variables. Note that z_1 and z_2 are not necessarily identical, although they are very often the same. In our case they are identical. It is assumed that the hourly wages have a log-normal distribution. This assumption greatly facilitates the computation of the estimates.

The dependent variables log w_{1n}^* and log w_{2n}^* are not observed for the whole sample. Values of w_1 are observed when the indicator I equals 0 and values of w_2 are observed when I equals 1. At any point in time the choices of the method of pay define an exhaustive set of mutually exclusive possibilities for each of the workers. The problem is that the workers are not randomly selected from the entire population. Instead they represent persons who were selected in the methods of pay.

It is assumed that u_n are correlated with u_{1n} and u_{2n} and that u_{1n}, u_{2n} and u_n have a trivariate normal distribution. In the following the appropriate covariances are denoted by σ_{1u} and σ_{2u}. Let ϕ and Φ be the density and distribution functions respectively of the standard normal distribution. Note that $E(u_1|u) = \sigma_{1u}u$. Then the expected values of the residuals u_{1n} and u_{2n} can be written as follows[4] (Johnson and Kotz, 1972, 112-113)

$$\text{(24a)} \quad E(u_{1n}|q_n^* \leq 0) = E(\sigma_{1u}u_n|q_n^* \leq 0) = \sigma_{1u}\lambda_{1n}$$

$$\text{(24b)} \quad E(u_{2n}|0 < q_n^*) = E(\sigma_{2u}u_n|0 < q_n^*) = -\sigma_{2u}\lambda_{2n},$$

where

$$\text{(25a)} \quad \lambda_{1n} = \phi(x_n\beta)/[1 - \Phi(x_n\beta)]$$

$$\text{(25b)} \quad \lambda_{2n} = \phi(x_n\beta)/\Phi(x_n\beta).$$

It can be recognized that λ_{jn} is the inverse of Mill's ratio. It is a monotone decreasing function that an observation is selected into the sample.

Including the expected values of the residuals (25a) and (25b) into (23a) and (23b) conditions the wage equations with the choice of the method of pay. The wage equations can then be written as follows

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4 Suppose the random variable $X \sim N(0, 1)$ has a truncated distribution $X \leq c_1$. Then $E(X) = -\phi(c_1)/\Phi(c_1)$. If the truncation is from below $X \geq c_2$, then $E(X) = \phi(c_2)/[1 - \Phi(c_2)]$. If X has the normal distribution with mean μ and variance σ^2, then $(X - \mu)/\sigma$, $(c_1 - \mu)/\sigma$ and $(c_2 - \mu)/\sigma$ are substituted for X, c_1, c_2, respectively.

(26a) $\log w_{1n} = z_{1n}\gamma_1 + \sigma_{1u}\lambda_{1n} + \in_{1n}$

(26b) $\log w_{2n} = z_{2n}\gamma_1 - \sigma_{2u}\lambda_{2n} + \in_{2n}$,

where $\in_{1n}$ and $\in_{2n}$ are the new residuals with zero conditional means.

The two-stage estimation of the model proceeds as follows:

(1) The first stage of the procedure is to estimate the parameters β from the probit analysis of the method of pay on the full sample using the indicators I_n and the method of maximum likelihood. Compute $x\beta$, λ_{1n} and λ_{2n}. All these estimates are consistent.

(2) In the second stage the wage equations are estimated using the method of ordinary least squares separately for the individuals working on the different methods of pay. Then λ_{1n} and λ_{2n} are used as regressors in each of the wage equations to obtain consistent estimates of γ_1, γ_2, σ_{1u} and σ_{2u}. If the estimates σ_{1u} and σ_{2u} are statistically insignificant, then the ordinary least squares estimators are fully efficient.

A thorough discussion about limited dependent variables and the identification problems of these models can be found in Lee (1982) and Maddala (1983). The identification problems of these models are same as those in the usual simultaneous-equations model. In our model the structural equations in each regime can be identified under the usual rank condition.

The identification problem has been discussed by Kiefer and Neumann (1989) based on an implication of the underlying theoretical search model with a reservation wage, which corresponds to our threshold value of productivity. Suppose λ_{jn} is omitted from the wage equations. Then one may incorrectly specify the wage equation by including in the wage equation some variables related to the monitoring costs. These variables are approximations of λ_{jn} and may take statistically significant coefficients. Thus the variables which affect the choice of the method of pay but not the wage offer may then appear significant in a wage equation.

The worker's threshold value of the method of pay is according to the theoretical model a function of the wage distribution. Therefore elements of z should be contained in the probit equation. This line of argument has been presented by Kiefer and Neumann (1989, 32). There are two kind of explanatory variables in x which are the variables from the wage equations z' and the variables related only to the choice of the method of pay x'. This formulation requires that z' and x' are contained in x.

If all the variables affecting the wages also affect the productivity of the worker, the equation of the method of pay will be perfectly collinear. Nelson (1975) has derived the conditions of identification, which have been discussed also by Maddala (1983). The conditions of identification are:

(1) The first condition is that u_j and u are statistically independent $\sigma_{ju} = 0$, $j = 1, 2$. In his empirical work Nelson (1975) imposed this condition, because all the variables in z were also included in x.

(2) The second condition is that there is at least one variable in z not included in x. This means in our case that there is at least one explanatory variable in the wage equation not included in the equation of the method of pay.

Many economic problems, such as the method of pay, do involve multiple choice and censored dependent variables. The multinominal probit model is, however, computationally complicated with many categories. Also the normality assumption may not always be realistic, because the parameter estimates may be sensitive to departures from normality. Rather than estimating a probit model in the first stage a logit model is estimated in our case, because the logit model has obvious advantages in the estimation of multinominal cases.

Lee (1983) has presented a reformulation of the selection model which allows a general specification of the criterion function. Following Lee the two-stage method for the switching regression model is extended for generalized selectivity models. Replacing the probit by the logit equation leads to a two-stage logit-ols procedure. Let $u^* = \mathbf{J}_1(u) = \Phi^{-1}(\mathbf{F}(u))$, where Φ^{-1} is the inverse of the standard normal distribution function and $\mathbf{F}$ the marginal distribution function of u. This method is flexible, because it can be applied to choice models with any assumption about the distribution function $\mathbf{F}$. As a result a trivariate distribution of (u, u_1, u_2) is obtained in our case. It is assumed that the transformed variable u^* is normally distributed with zero means and covariances σ_{1u} and σ_{2u}.

The two-stage estimation method suggested by Heckman (1976, 1979) can be extended to a case where the logit model is used in the first stage as a choice equation. The wage equations can be written using the function $\mathbf{J}_1 = \Phi^{-1}\mathbf{F}$ as follows

(27a) $\log w_{1n} = z_{1n}\gamma_1 - \sigma_{1u}\phi(\mathbf{J}_1(x_n\beta))/[1 - \mathbf{F}(x_n\beta)] + \in_{1n}$

(27b) $\log w_{2n} = z_{2n}\gamma_2 + \sigma_{2u}\phi(\mathbf{J}_1(x_n\beta))/\mathbf{F}(x_n\beta) + \in_{2n}$,

since $\Phi(\mathbf{J}_1(x_n\beta)) = \mathbf{F}(x_n\beta)$ in the denominator.

The reformulation of the selection model can be extended from the binary case to multinominal choice models with selectivity. The multinominal case is a straightforward extension, where the needed additional correction terms in the index function based on the selectivity are $\lambda_{jn} = -\sigma_{ju}\phi(\mathbf{J}_{1j}(x_n\beta_j))/\mathbf{F}_j(x_n\beta_j)$. Consequently, the choice equations with categories $j = 1,\dots,J$ can be written as follows

(28) $q_{jn}^* = x_{jn}\beta_j + u_{jn}$

and the wage equations can be written as follows

(29a) $\log w_{jn}^* = z_{jn}\gamma_j - \sigma_{ju}\phi[\mathbf{J}_{1j}(x_n\beta_j)]/\mathbf{F}_j(x_n\beta_j) + \in_{jn}$

(29b) $\log w_{1n}^* = z_{1n}\gamma_1 + \sigma_{1u}\phi[\mathbf{J}_{11}(x_n\beta_j)]/[1 - \Sigma\ \mathbf{F}_1(x_n\beta_1)] + \in_{1n}$,

where $\mathbf{J}_{1j} = \Phi^{-1}\mathbf{F}_j$, $j = 2,\dots,J$. The latter equation (29b) stands for the normalized reference choice. In our case there are three categories, where the time work is the reference choice. Category s is chosen if $q_s^* > \max q_j$, $j = 2,\dots,J$, $j \neq s$. The indicators are defined equivalently. As a result we have the multinominal logit-ols two-stage estimation method.

5.2. Wage Equations

Since w_1 and w_2 are the natural logarithms of the hourly basic wages, the estimated coefficients of the indicators in the wage equation are the contributions of that explanatory variable on the wage level expressed in the logarithm form. In the discussion of the results of estimations it is, however, more reasonable to use the conventional percentages. The conventional percentages are obtained as $P = 100(\exp(\gamma)-1)$. The coefficients of the continuous variables express the relative change of the wage level when the explanatory variable changes by one unit. In other words the coefficients are the average prices of the factors of wages which are paid in the labour market.

Many of the explanatory variables of the wage equations are determined by the wage agreements. These contracts determine wage incrementals related to the high cost area, poor working conditions, overtime work, Sunday work, required level of skill, number of work shifts. The explanatory variables include also sex and age variables and the number of workers in a plant. The regional indicators are used as the identifying variables in the wage equations.

The results of estimations of the wage equations for the workers in the wood industry are presented in *Table 7.* The wage concept is the basic wage of the workers. It does not include the incrementals based on the shift work, work conditions, overtime and Sunday work, which are known from the wage agreements.

The effect of sex is slightly larger on the time-based wage. In the time-based work men receive an 8 per cent higher wage than women, but in the incentive work the difference is 6 per cent. To a large extent the wage differentials are due to the differences in the productivity. The share of men in a plant has a statistically insignificant coefficient.

The age on the individual level increases the wage, but the effect turns decreasing for the elderly workers. The effect is slightly larger with respect to the time-based wage. The effect peaks at 41 years for the time-based wage and at 43 years for the incentive wage. The effect of age does not differ very much between the younger and older workers. The average age of workers in a plant is positively related to the wage. It is surprising that the larger plants in the wood industry pay lower incentive wages.

The capital of Finland is situated in the county of Uusimaa. According to the previous results (Kettunen, 1993c) the wage level in Uusimaa is generally higher in manufacturing, but there are notable differences between the industries. In the wood industry Uusimaa has no effects on the time-based wage, but the incentive wage is 6 per cent lower in Uusimaa than in the other parts of the country. The negative effect of the high cost area on an incentive wage is 2 per cent.

The indicators for the poor working conditions take negative but statistically insignificant coefficients. On the other hand, the overtime and Sunday work have positive coefficients. Their economic importance is, however, rather small.

The wage groups of the workers are defined using the required levels of skill in the collective wage agreements. The required level of skill in a job increases the wage level much more in the time-based work than in the incentive work. These results support the argument that the wage groups of the wage agreements have too much dispersion to be in line with the productivity of the workers. The indicators for the number of work shifts have only minor effects on the wages.

The estimate of the coefficients of the selectivity variables indicate no statistically significant sample selection bias in these models. Consequently, ordinary least squares techniques give consistent parameter estimates in our case. It turned out using various experiments that a rich set of explanatory variables reduces the need to correct the model for the sample selection bias. This finding can be verified by dropping out explanatory variables in turn. Using rather few explanatory variables leads to models with a significant sample selection bias.

The wage equations for the workers in the paper industry are presented in *Table 8*. According to the results men earn 9 per cent more than women in the incentive work, but in the time-based work they earn only 4 per cent more than women. This indicates a notable difference in the productivity between men and women. The share of men in a plant has a larger effect on the time-based wage than on the incentive wage.

Table 7. Results of estimations for the wage equations of the workers in the wood industry[1]

(A) Time-based wage
(B) Incentive wage

	(A)	(B)
Constant	2.933	3.257
	(0.135)	(0.104)
Sex, 1=male	0.079	0.057
	(0.016)	(0.011)
Share of men in a plant	0.084	0.026
	(0.061)	(0.042)
Age, years	0.016	0.012
	(0.003)	(0.003)
Age squared, years/100	-0.020	-0.012
	(0.004)	(0.003)
Average age in a plant, years	0.005	0.004
	(0.003)	(0.002)
Number of workers in a plant/1000	-0.008	-0.031
	(0.006)	(0.005)
County of Uusimaa, 1=yes	-0.009	-0.060
	(0.043)	(0.024)
High cost area, 1=yes	0.010	-0.019
	(0.014)	(0.012)
Poor working conditions, 1=yes	-0.013	-0.014
	(0.014)	(0.010)
Overtime work, 1=yes	0.027	0.006
	(0.012)	(0.008)
Sunday work, 1=yes	0.033	0.023
	(0.017)	(0.012)
Required level of skill, 1=yes:		
1 (reference group)		
2	0.018	0.029
	(0.022)	(0.017)
3	0.049	0.039
	(0.022)	(0.017)
4	0.090	0.061
	(0.023)	(0.018)
5	0.161	0.102
	(0.023)	(0.019)
Number of work shifts, 1=yes:		
1 (reference group)		
unknown	-0.012	0.010
	(0.018)	(0.015)
2	0.018	0.028
	(0.014)	(0.011)
3	-0.045	0.022
	(0.018)	(0.013)
σ	-0.015	-0.015
	(0.016)	(0.015)
R^2	0.472	0.290
Number of observations	373	722

1. The dependent variables are the logarithms of the hourly wages. The standard errors are in the parentheses.

Table 8. Results of estimations for the wage equations of the workers in the paper industry[1]

(A) The time-based wage
(B) The incentive wage

	(A)	(B)
Constant	3.606	3.577
	(0.187)	(0.136)
Sex, 1=male	0.044	0.085
	(0.010)	(0.010)
Share of men in a plant	0.438	0.177
	(0.079)	(0.066)
Age, years	0.004	0.002
	(0.002)	(0.002)
Age squared, years/100	-0.005	-0.001
	(0.003)	(0.003)
Average age in a plant, years	-0.009	0.001
	(0.004)	(0.003)
Number of workers in a plant/1000	-0.003	-0.005
	(0.002)	(0.001)
County of Uusimaa, 1=yes	-0.057	-0.175
	(0.023)	(0.038)
High cost area, 1=yes	0.012	-0.020
	(0.007)	(0.017)
Poor working conditions, 1=yes	-0.010	-0.045
	(0.007)	(0.007)
Overtime work, 1=yes	-0.004	0.001
	(0.006)	(0.007)
Sunday work, 1=yes	-0.001	0.025
	(0.008)	(0.008)
Required level of skill, 1=yes:		
1 (reference group)		
2	0.043	0.019
	(0.013)	(0.012)
3	0.056	0.043
	(0.012)	(0.012)
4	0.090	0.075
	(0.012)	(0.012)
5	0.144	0.115
	(0.013)	(0.013)
Number of work shifts, 1=yes:		
1 (reference group)		
2	0.010	-0.004
	(0.010)	(0.011)
3	-0.008	-0.022
	(0.009)	(0.010)
σ	0.035	0.015
	(0.027)	(0.017)
R^2	0.364	0.307
Number of observations	925	1135

1. The dependent variables are the logarithms of the hourly wages. The standard errors are in the parentheses.

The age of workers on an individual level peaks at 41 years of age in the time-based work. The average age in the plant has a small negative effect on the wages in the time-based work. In the incentive work the age effects are insignificant. The framework of the wage contacts in the paper industry are made on the union level, but the actual wages are negotiated on the firm level. Also the piece-rates are determined on the firm level. One plausible explanation is that the wage negotiations on the local level lead to small differences between the age groups. The small plants are able to pay slightly higher wages than the large plants.

The time-based wage is 6 per cent lower and the incentive wage is 19 per cent lower in Uusimaa than in the other parts of the country. This reflects the fact that Uusimaa is not the core area of the Finnish forest industry, which is situated in the middle part of the country. The high cost area has a positive effect on the time-based wage.

The poor working conditions decrease the incentive wage by 5 per cent. According to this result the working conditions are important in order to increase the earnings and also the productivity of the workers. The overtime or Sunday work do not have remarkable effects on the wages.

The required level of skill increases both the incentive and time-based wage. The effect is clearly higher as regards the time-based wage. The number of work shifts decrease slightly the wage level in the incentive work. A plausible explanation is that the productivity of workers is lower during the night shifts.

The selectivity variable does not take a statistically significant coefficient. Consequently, there is no need to correct the models of ordinary least squares for the sample selection bias.

Table 9 presents the wage equations for the workers in the metal industry. According to the results the sex of workers has notable effects on the wages. Men earn about 6 per cent more than women in the time-based work. It is slightly more than in the incentive work. The share of men in a plant is positively related to the wage in all the wage equations.

The age of an individual has small positive effects in all the methods of pay. Again the effect of age is the largest with respect to the time-based wage as it was in the wood and paper industries. The concave effect of

Table 9. Results of estimations for the wage equations of the workers in the metal industry[1]

(A) The time-based wage
(B) The incentive wage based on quantity
(C) The incentive wage based on quantity and quality

	(A)	(B)	(C)
Constant	3.319	3.529	3.747
	(0.034)	(0.092)	(0.056)
Sex, 1=male	0.063	0.055	0.055
	(0.006)	(0.015)	(0.008)
Share of men in a plant	0.125	0.195	0.189
	(0.010)	(0.026)	(0.017)
Age, years	0.014	0.010	0.006
	(0.001)	(0.003)	(0.002)
Age squared, years/100	-0.015	-0.012	-0.007
	(0.002)	(0.003)	(0.002)
Average age in a plant, years	0.001	0.016	-0.015
	(0.007)	(0.016)	(0.011)
Number of workers in a plant/1000	0.006	0.011	0.014
	(0.003)	(0.006)	(0.003)
County of Uusimaa, 1=yes	0.051	0.027	0.020
	(0.006)	(0.012)	(0.008)
High cost area, 1=yes	0.023	0.049	0.006
	(0.005)	(0.009)	(0.006)
Poor working conditions, 1=yes	0.003	0.008	-0.003
	(0.007)	(0.015)	(0.007)
Overtime work, 1=yes	0.018	0.019	-0.004
	(0.004)	(0.010)	(0.006)
Sunday work, 1=yes	0.010	0.011	0.007
	(0.006)	(0.012)	(0.007)
Required level of skill, 1=yes:			
1 (reference group)			
2	-0.112	-0.087	-0.082
	(0.005)	(0.009)	(0.006)
3 (the lowest level)	-0.211	-0.143	-0.175
	(0.007)	(0.016)	(0.010)
Number of work shifts, 1=yes:			
1 (reference group)			
unknown	-0.012	-0.050	0.020
	(0.009)	(0.017)	(0.015)
2	-0.002	-0.012	-0.015
	(0.007)	(0.010)	(0.007)
3	-0.037	-0.008	-0.081
	(0.010)	(0.024)	(0.010)
σ	0.058	0.035	0.070
	(0.007)	(0.016)	(0.013)
R^2	0.612	0.501	0.531
Number of observations	2554	982	1518

1. The dependent variables are the logarithms of the hourly wages. The standard errors are in the parentheses.

age comes to a halt at 46 years of age in the time-based wage, at 42 years in the incentive wage based on quantity and at 44 years in the incentive work based on quantity and quality. The effect of age for the older workers is clearly higher than for the younger workers in the time-based wage. In the incentive work the effect does not differ very much between the younger and older workers. The average age of workers in a plant does not have remarkable effects.

The size of the plant measured as a number of workers has a positive effect on wages in all the methods of pay. In the county of Uusimaa the workers have about 5 per cent higher wages in the time-based work than in the other parts of the country. The effect is 2-3 per cent with respect to the incentive wages. The high cost area has positive effects of 1-5 per cent on the wages.

The poor working conditions, overtime and Sunday work have only minor effects on the wages. The persons who work over their regular working hours or the persons who work on Sundays have on average 0-2 cent higher regular wages than the others.

The required level of skill in a job has the largest effects in the time work. In this respect the result is similar to that in the wood and paper industries. The indicators for the number of work shifts have in many cases negative coefficients. The largest negative effect is in the three-shift work in the incentive wage based on quantity and quality.

The selectivity variable takes statistically significant coefficients in all the methods of pay. The correction for the selectivity bias has a great importance in the wage equations for the metal industry. In this respect there are differences between the forest and metal industries. There is a great dissimilarity between the metal and the forest industry in the sense that the wages are negotiated quite often on the local level in the forest industry. The importance of the negotiations on the choice of the method of pay needs, however, a more rigorous investigation to draw strong conclusions.

As a remark based on the logit models it can be concluded that there was unobserved heterogeneity in the choice models for the workers in the forest industries but not in the models for the workers in the metal industry. This result was obtained from an extended logit model based on the small variance approximation of the unobserved heterogeneity. The number of choice alternatives is a plausible factor affecting the unobserved heterogeneity.

Another remark is that the wage equations were not biased for the workers in the forest industries. On the other hand, the wage equations for the workers in the metal industry were found to be biased. It can be concluded that the inclusion of relevant explanatory variables and the specification of the choice model is of great importance. A well specified choice model is essential for estimating well specified wage equations in the second stage of the procedure.

6. Conclusions

This chapter extended the static model of the method of pay presented by Lazear (1986) to a dynamic model. The results of the extended model are in concordance with the previous model, but it brings also new explanations based on the limited time horizon. The model gives a prediction that the persons who have no possibility of planning a stable and long lasting attachment to the firm are more apt to engage in incentive work. For example, women cannot in many cases stay as long time in the firm as men. This finding sheds new light on the discussion of sex discrimination and career planning of women.

The econometric part of the study used a large cross- section data set which was collected for this study from the files of the Confederation of Finnish Industry and Employers. The data are fairly rich in individual, job and plant specific characteristics. The access to the administrative data is clearly an advantage of this study. The data are reliable, since they are obtained directly from the bookkeeping of the firms.

Logit models were used to examine the effects of various explanatory variables on the probability of a person engaging in a piece-rate work. There are tens of factors affecting the choice of the method of pay and individual wages. It is plausible that all the factors are not available in the data set or the importance of some variables cannot be even suspected. Therefore special attention is paid on unobserved explanatory variables. An extended logit model was derived. It is based on a small variance approximation of unobserved heterogeneity. The results of estimations show that allowing for unobserved heterogeneity in the logit models is of great importance in getting better estimates even though the data are rich and reliable.

The logit models support the findings based on the theoretical model. The incrementals of the time-based wage were negatively related to the probability of working on the incentive wage basis. According to some of the models women work more frequently than men on an incentive wage basis. The age has an increasing effect which turns decreasing for the elderly persons. The required level of skill is in many cases positively related to the probability of working on an incentive wage basis, as is to be expected according to economic theory. Also shift work is positively related to the choice of incentive work.

In the estimation of the wage equations special attention is paid to the selectivity of the method of pay. A two-stage logit-ols procedure was used to estimate the effects of various factors conditional on the presumption that the person is working in accordance with the chosen method of pay.

According to the wage equations men have higher wages than women. The difference is even larger in the incentive wage. One interpretation is that men are more effective. It is well known that the wage contracts have been used to decrease the wage differentials between men and women during the 1980's. This has led to smaller differences between men and women in the time-based wage.

The age has a concave effect on the wage level. The required level of skill has a positive effect on the wage level. This is no wonder, since the wage groups are defined by the collective wage agreements. An interesting result is that the required level of skill has larger effects on the time-based wage than on the incentive wage. It seems that in all the studied industries the defined wage dispersion related to the wage groups is too wide to reflect the differences in the productivity between workers.

There was unobserved heterogeneity in the choice models for the workers in the forest industries but not in the models for the workers in the metal industry. The wage equations were not biased for the forest industries, but they were biased for the metal industry. The inclusion of relevant explanatory variables and the use of the multinominal choice model instead of a binary model is of great importance in the estimation of the choice model. A well specified choice model is essential for obtaining well specified wage equations in the second stage of the procedure.

References

Amemiya, T. (1978), The Estimation of a Simultaneous Equation Generalized Probit Model, Econometrica 46, 1193-1205.

Amemiya, T. (1979), The Estimation of a Simultaneous Equation Tobit Model, International Economic Review 20, 169-181.

Amemiya, T. (1981), Qualitative Response Models: A Survey, Journal of Economic Literature 19, 1483-1536.

Beach, D. (1975), Personnel: The Management of People at Work, MacMillan, New York.

Berg, G.J. van den (1990), The Effect of an Increase of the Rate of Arrival of Job Offers on the Duration of Unemployment, Department of Economics, Groningen University, The Netherlands, Unpublished manuscript.

Berndt, E.R., Hall, B.H., Hall, R.E. and Hausman, J.A. (1974), Estimation and Inference in Nonlinear Structural Models, Annals of Economic and Social Measurement 3/4, 653-666.

Brown, C. (1990), Firm's Choice of Method of Pay, Industrial and Labor Relations Review 43, 165S-182S.

Chen, P. and Edin, P.-A. (1992), Industry Wage Differentials, Efficiency Wages, and Method of Pay, Department of Economics, Uppsala University, Working Paper 1992:18.

Chesher, A.D. (1986), Age at First Marriage, the Timing of Births and Age Specific Fertility Rates in Peninsular Malaysia, The International Labour Organisation, Discussion Paper No. 16.

Chesher, A. (1991), The Effect of Measurement Error, Biometrika 78, 451-462.

Chesher, A. and Santos Silva, J. (1992), Discrete Choice Models Without the IIA Property, University of Bristol, Department of Economics Discussion Paper No. 92/318.

Cleland, S. (1955), The Influence of Plant Size on Industrial Relations, Industrial Relations Section, Princeton University, Princeton, N.J.

Cox, D.R. (1972), Journal of the Royal Statistical Society, Series B, 34, 187-220.

Cox, D.R. (1975), Partial Likelihood, Biometrika 62, 269-276.

Garen, J. (1985), Worker Heterogeneity, Job Screening, and Firm Size, Journal of Political Economy 93, 715-739.

Goldin, C. (1986), Monitoring Costs and Occupational Segregation by Sex, Journal of Labor Economics 4, 1-27.

Heckman, J.J. (1974), Shadow Prices, Market Wages, and Labour Supply, Econometrica 42, 679-694.

Heckman, J.J. (1976), The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for such Models, Annals of Economic and Social Measurement, 5/4, 475-492.

Heckman, J.J. (1979), Sample Selection Bias as a Specification Error, Econometrica 47, 153-161.

ILO (International Labour Organization) (1984), Payment by Results, Geneva.

Johnson, P.D. and Kotz, S. (1972), Distributions in Statistics: Continuous Multivariate Distributions, Wiley, New York.

Kettunen, J. (1993a), Förändringar i lönestrukturen inom den finska industrin under 1980-talet, Ekonomiska Samfundets Tidskrift, nr 3, 153-158.

Kettunen, J. (1993b), Re-employment of Finnish Unemployed Workers, The Research Institute of the Finnish Economy, A 17, Helsinki.

Kettunen, J. (1993c), Suomen teollisuuden palkkarakenne, The Research Institute of the Finnish Economy, B 83, Helsinki.

Kettunen, J. (1994a), Kannustava palkkaus teollisuusyritysten paikallisen sopimisen muotona, The Research Institute of the Finnish Economy, B 90, Helsinki.

Kettunen, J. (1994b), Suomen teollisuuden palkkarakenteen muutos 1980-luvulla, The Research Institute of the Finnish Economy, Discussion papers, No. 463.

Kettunen, J. (1995), Method of Pay in Finnish Industry, The Research Institute of the Finnish Economy, Discussion papers, No. 535.

Kettunen, J. (1996a), Metalli- ja metsäteollisuuden työntekijöiden työsuhteiden kestot, Yearbook of the Finnish Statistical Society 1995, Helsinki.

Kettunen, J. (1996b), Teollisuuden työllisyys ja työvoiman vaihtuvuus, The Research Institute of the Finnish Economy, B 116, Helsinki.

Kettunen, J. (1996c), Työvoiman vaihtuvuus ja palkkaprofiilit metalli- ja metsäteollisuudessa, Finnish Labour Review 1/1996, 69-76.

Kettunen, J. and Marjanen, R. (1992), Suomen Työnantajain Keskusliiton palkkatilastot, The Research Institute of the Finnish Economy, Discussion papers, No. 425.

Kettunen, J. and Vartiainen, J. (1993), Suomen teollisuuden työntekijöiden palkkarakenne, The Research Institute of the Finnish Economy, Discussion papers, No 431.

Kiefer, N.M. and Neumann, G.R. (1989), Search Models and Applied Labor Economics, Gambridge University Press, Gambridge.

Lancaster, T. (1979), Econometric Methods for the Duration of Unemployment, Econometrica 47, 939-956.

Lancaster, T. (1983), Generalised Residuals and Heterogeneous Duration Models: The Exponential Case, Bulletin of Economic Research 35, 71-85.

Lancaster, T. (1985), Generalised Residuals and Heterogeneous Duration Models: With Applications to the Weibull Model, Journal of Econometrics 28, 155-169.

Lazear, E.P. (1986), Salaries and Piece Rates, Journal of Business, 59, 405-431.

Lee, L.F. (1978), Unionism and Wage Rates: A Simultaneous Equation Model with Qualitative and Limited Dependent Variables, International Economic Review 19, 415-433.

Lee, L.F. (1979), Identification and Estimation in Binary Choice Models with Limited (Censored) Dependent Variables, Econometrica 47, 977-996.

Lee, L.F. (1982), Simultaneous Equations Models with Discrete and Censored Dependent Variables, In Manski, C. and McFadden, D. (eds.), Structural Analysis of Discrete Data with Econometric Applications, M.I.T Press, Gambridge, 346-364.

Lee, L.-F. (1983), Generalized Econometric Models with Selectivity, Econometrica 51, 507-512.

Maddala, G.S. (1983), Limited-dependent and Qualitative Variables in Econometrics, Gambridge University Press, Gambridge.

Maddala, G.S. and Nelson, F. (1975), Switching Regression Models with Exogenous and Endogenous Switching, Proceedings of the American Statistical Association (Business and Economics Section), 423-426.

McFadden, D.L. (1974), Analysis of Qualitative Choice Behaviour, In Zarembka, P. (ed.), Frontiers in Econometrics, Academic Press, New York.

McFadden, D.L. (1976), Quantal Choice Analysis: A Survey, Annals of Economic and Social Measurement 5, 363-390.

McFadden, D.L. (1984), Qualitative Response Models, In Griliches, Z. and Intrilligator, M.D. (eds.), Handbook of Econometrics, Vol. 2, North-Holland, Amsterdam.

Mortensen, D.T. (1986), Unemployment Insurance and Job Search Decisions, Industrial and Labor Relations Review 30, 505-517.

Nelson, F.D. (1975), Estimation of Economic Relationships with Censored, Truncated and Limited Dependent Variables, Ph.D. Dissertation, University of Rochester.

Oi, W. (1983), Heterogenous Firms and the Organization of Production, Economic Inquiry 21, 149-171.

Pencavel, J.H. (1977), Work Effort, On the Job Screening, and Alternative Methods of Remuneration, Research in Labor Economics, JAI Press, Greenwich Connecticut, 225-259.

Phelps, E.S. (1970), Microeconomic Foundations of Employment and Inflation Theory, MacMillan and Co Ltd, London.

Rothschild, M. and Stiglitz, J. (1970), Increasing Risk I: A Definition, Journal of Economic Theory 2, 225-243.

SAS/IML, User's Guide, Version 5 Edition (1985), SAS Institute Inc., Gary, North Carolina.

Seiler, E. (1984), Piece Rate vs. Time Rate: The Effect of Incentives on Earnings, The Review of Economics and Statistics 66, 363-376.

Slichter, S. (1941), Union Policies and Industrial Management, The Brookings Institution, Washington, D.C.

Stiglitz, J.E. (1985), Equilibrium Wage Distributions, The Economic Journal 95, 595-618.

Vartiainen, J. (1993), Metalliteollisuuden työntekijöiden palkanmuodostus työehtosopimuksen valossa, Labour Institute for Economic Research, Tutkimuksia 44, Helsinki.

Willis, R.J. and Rosen, S. (1979), Education and Self-Selection, Journal of Political Economy 89, S7-S36.

Appendix 1. Comparative Static Results

For simplicity the effects of exogenous variables are solved in the case of an infinite horizon. Setting (6) to zero, substituting V = (pq - c)/r and rearranging the terms gives

$$(27)\quad q' = \{\bar{w} + c + a\int_{q'}^{\infty} [(pq - c)/r - V]dF(q)\}/p.$$

$$= (\bar{w} + c + aQ/r)/p, \text{ where } Q = \int_{q'}^{\infty} (q' - q)dF(q).$$

The comparative static results can be written as follows

$$(28)\quad \frac{\partial q'}{\partial \bar{w}} = 1/p > 0 \quad \text{and} \quad \frac{\partial \lambda}{\partial \bar{w}} = -af(q')\frac{\partial q'}{\partial \bar{w}} < 0$$

$$(29)\quad \frac{\partial q'}{\partial c} = 1/p > 0 \quad \text{and} \quad \frac{\partial \lambda}{\partial c} = -af(q')\frac{\partial q'}{\partial c} < 0$$

$$(30)\quad \frac{\partial q'}{\partial a} = Q/rp > 0 \text{ and } \frac{\partial \lambda}{\partial a} = [1 - F(q')] - f(q')\frac{\partial q'}{\partial a}$$

$$(31)\quad \frac{\partial q'}{\partial p} = -q'/p < 0 \quad \text{and} \quad \frac{\partial \lambda}{\partial p} = -af(q')\frac{\partial q'}{\partial p} > 0$$

$$(32)\quad \frac{\partial q'}{\partial r} = -aQ/pr^2 < 0 \text{ and } \frac{\partial \lambda}{\partial r} = -af(q')\frac{\partial q'}{\partial r} > 0.$$

The effects of the exogenous variables on the probability of working on a piece work basis $\lambda = a[1 - F(q')]$ have reverse effects except for the arrival rate of offers. Its effect is generally ambiguous, since the direct effect is positive, but the indirect effect via q' is negative.

To solve the effects of the offer distribution a translation of F to the right is made so that $F(q) = G(q + \mu)$, for all q and $\mu > 0$. This method was used by Mortensen (1986). The translation is said to first order stochastically dominate $F(q)$. Substituting the following useful transformation

$$(33)\quad \int_{q'}^{\infty} (q - q')dF(q) = E_F(q) - q' + \int_{0}^{q'} F(q)dq$$

and $F(q) = G(q + \mu)$ into (27) and noting that $E_G(q) = \mu + E_F(q)$ gives

$$(34)\quad q' = \bar{w} + c + a[\mu + E_F(q) - q' + \int_{0}^{q'} F(q - \mu)dq]/r,$$

where the effect of offer distribution on the required level of quality is solved as

$$(35)\quad \frac{\partial q'}{\partial \mu} = \lambda/(r + \lambda) > 0.$$

where $\lambda = a[1 - F(q' - \mu)]$. The effect of μ on λ is

$$(36)\quad \frac{\partial \lambda}{\partial \mu} = af(q' - \mu)(1 - \frac{\partial q'}{\partial \mu}) > 0,$$

since $\partial q'/\partial \mu < 1$.

Next the effect of uncertainty of job offers is studied. Rothschild and Stiglitz (1970) have introduced uncertainty into economics under the name 'mean preserving spread'. The distribution H is a mean preserving spread of F given that they have the same mean if and only if

$$(37)\quad \int_{0}^{q_1} H(q)dq \geq \int_{0}^{q_1} F(q)dq, \text{ for all } q_1 > 0.$$

Substituting (33) and $F(q) = H(q,\sigma)$ into (27) gives

$$(38)\quad q' = \bar{w} + c + a[E_F(q) - q' + \int_0^{q'} H(q, \sigma)dq]/r,$$

where σ is the parameter of relative dispersion. The effect of uncertainty on the required level is then

$$(39)\quad \frac{\partial q'}{\partial \sigma} = a \int_0^{q'} H_\sigma dq/(r + \lambda) > 0.$$

The effect of σ on $\lambda = a[1 - H(q', \sigma)]$ is

$$(40)\quad \frac{\partial \lambda}{\partial \sigma} = -aH_{q'} \frac{\partial q'}{\partial \sigma} - aH_\sigma < 0.$$

Appendix 2. An Extended Model of Discrete Choice

The probability that a choice is made in a random utility model can be written as follows

$$(41) \quad p(i|x,\beta) = \frac{\exp(x_i\beta)}{\sum_{j=1}^{J} \exp(x_j\beta)} .$$

A derivation based on the small variance approximation of unobserved heterogeneity leads to an extended discrete choice model by Chesher and Santos Silva (1992)

$$(42) \quad g(i|x,\beta,\omega) = \frac{\exp(x_i\beta+0.5\omega_{st}p_i^{st}/p_i)}{\sum_{j=1}^{J} \exp(x_j\beta+0.5\omega_{st}p_j^{st}/p_j)} ,$$

where the parameters ω_{st} are the variances and covariances of the unobserved utility components and the Einstein summation convention is used over indices that appear raised and lowered. The additional terms in the index function based on the second derivatives can be written as follows

$$(43) \quad p_i^{st}/p_i = \delta_{is}\delta_{it} - \delta_{is}\delta p_t - \delta_{it}p_s - \delta_{st}p_s + 2p_sp_t,$$

where the Kronecker delta $\delta_{is} = 1$ if $i = s$ and 0 otherwise. Clearly the discrete choice model is more demanding with respect to the data, because for each observation there must be J values of the explanatory variable x_i, which are related to the choices.

Appendix 3. A SAS/IML Programme for Estimating Logit Models of Three Choices

```
* A LOGIT MODEL ALLOWING FOR UNOBSERVED HETEROGENEITY;
* VMS OPERATING SYSTEM;
OPTIONS LS=80 PS=500;
LIBNAME SASLIBR '[JKETTUNEN.SASFILES]';
FILENAME RAWDATA 'MET90.ASC';
DATA SASLIBR.ADATA;
INFILE RAWDATA;
INPUT Y1 Y2 Y3 CONSTANT HIGHCOST AGE AGE2 SEX TIMEH PIECE1H
  PIECE2H HOURS COND SHIFTW WAGET WAGEP1 WAGEP2 SHIFTD CONDD
  TOTWAGE REGGWAGE NOWORKER SHAREMEN AVAGE WAGEG1
  WAGEG2 WAGEG3  WAGEG12 SHIFTS0 SHIFTS1 SHIFT2 SHIFT3 TAM23
  YLITYO SUNTYO UUSIMAA A01 A02 A03 A10 A11 A12 A13 A20 A21 A22 A23
  A30 A31 A32  A33 A34 A41 A42 A50 A60 A61 A62 A63 A64 A65 A66 A70 A71
  A72 A80;
PROC IML WORKSPACE=3000;
START;
*POS OF Y DATA;         IND1={6 7 8};
                        IND2={4 5 6 7 8 13 22 23 24 26 27 29 31 32
                              34 35 36 40 41 42 43 44 45 46 47 49
                              50 51 52 53 54 55 56 58 59 60 61 62
                              63 64 };
*LINE SEARCH LIMIT;     LLS =100;
*ITERATION LIMIT;       LIT =300;
*ACCY REL FUN;          ACC1=0.01;
*ACCY GRAD;             ACC2=0.01;
*STEP ADJUSTMNT;        ALPHA=1;
*SUPRESS LINE SEARCH; SUPRESLS=1;
*SUPRESS ITERATION; SUPRESIT=0;
*ESTIMATE SIGMA;        SIGMA=0;
*START POINT;
IF SIGMA=0 THEN
B={-4.795447   -0.224574    0.0435685   -0.000529    -0.19322     -0.167024
    0.7078354   0.0337136   0.0614143   -0.008406    -0.125614    -0.81346
    1.0310616   1.0125758   0.0269138    0.158475    -0.128033     0.2454417
    0.1007722   1.4218021   0.2515838    0.4263327    0.1580005    0.5715267
    1.4233164   0.492516   -0.013536     0.6406517    1.1065724    0.8125356
    0.4876416   0.6243476   0.4697076    0.394200    -0.573642    -1.526388
   -0.612142   -0.432936   -0.68943     -0.157879    -8.436945     0.3336512
    0.049062   -0.000569   -0.193023    -0.311617     0.054845     0.5998789
    0.082641    0.3602892   0.3692047    0.5868867    0.6252224    0.1908671
   -0.156279    0.094889   -0.613154     0.6114095    2.7003294    3.2856467
    2.7484809   3.3716904   3.4667883    3.5779798    4.0701065    0.1283841
    2.8942342   2.7788763   3.5507101    3.2361216    2.5282209    2.6027545
    2.667636    2.2249067   1.1387676    2.432473     3.4396509    2.150753
  -2.270741     0.5557055};
IF SIGMA=1 THEN
B={-4.920894   -6.181794   -2.912492    -0.109122     0.029898    -0.000359
  -0.112251    -0.111714    0.3665742    0.0623268    0.043195     0.0349804
  -0.045331    -0.358245    0.5850103    0.487058    -0.010435     0.0886148
  -0.103188     0.1444813   0.3314687    1.0223564    0.5791117    0.554055
```

```
 0.4344414    0.6953964    1.1896892    0.2525661    0.2583204    0.596254
 0.9274092    0.7335701    0.4973468    0.5676474    0.4957673    0.405121
-0.22593     -0.621746     0.058099    -0.023955    -0.470078    -0.066892
-4.168477     0.0855997    0.031007    -0.000358    -0.089541    -0.163542
 0.1515053    0.251739     0.0489124    0.1595082    0.1338529    0.0964775
 0.431594     0.196695    -0.073447     0.067635    -0.262529     0.2840384
 1.3503344    1.8058228    1.5354183    1.6801836    1.6906405    1.8230352
 2.1828494    0.1297709    1.3957262    1.4544289    1.8752143    1.6934593
 1.3121626    1.3739706    1.376872     1.1440761    0.503657     1.0091878
 1.5704963    1.012789    -1.565204     0.2660239};
PRINT 'MAXIMUM LIKELIHOOD ESTIMATION: BHHH MODIFIED NEWTON
RAPHSON METHOD';
    USE SASLIBR.ADATA;
    READ ALL INTO A;
    CALL DELETE('SASLIBR','ADATA');
    X=A(|,IND2|); Y1=A(|,1|); Y2=A(|,2|); Y3=A(|,3|);
    FREE A;
NAMES1={'SEARCH NO' ' OLD L' 'NEW L' 'ALPHA'};
NAMES2={'OLD B' 'NEW B'};
NAMES3={'ITER NO' L};
NAMES4={PARAMETR GRADIENT};
NAMES5={PARAMETR 'S.ERROR' 'T STAT' GRADIENT};
NAMES9={ACC1 ACC2 ALPHA 'NO OBS' 'NO PARS'};
NAMES13={Y1 Y2 Y3 CONSTANT HIGHCOST AGE AGE2 SEX TIMEH PIECE1H
     PIECE2H HOURS COND SHIFTW WAGET WAGEP1 WAGEP2 SHIFTD
     CONDD TOTWAGE REGGWAGE NOWORKERS SHAREMEN AVAGE
     WAGEG1 WAGEG2 WAGEG3 WAGEG12 SHIFTS0 SHIFTS1 SHIFT2 SHIFT3
     TAM23 YLITYO SUNTYO UUSIMAA A01 A02 A03 A10 A11 A12 A13
     A20 A21 A22 A23 A30 A31 A32 A33 A34 A41 A42 A50 A60 A61 A62 A63
     A64 A65 A66 A70 A71 A72 A80};
OBS=NROW(X);
PAR=2#(NCOL(X));
VARNAME=NAMES13(|,IND2|)||NAMES13(|1,IND2|);
PRINT 'ACCURACY REQUIREMENT:STEP LENGTH PROPORTION:NO OF OBS
& PARAMETERS';
PRINT '*********************************************************';
PRT=ACC1||ACC2||ALPHA||OBS||PAR;
PRINT PRT (| COLNAME=NAMES9 |);
FREE PRT NAMES9;
PRINT B;
NIT=1;
BOLD=B;
LINK LIKEF;
MAR4: LOLD=LL; BOLD=B;
   LINK LIKED;
   IF SUPRESIT=0 THEN DO;
   LOGLIK =NIT||LL;
   PARAMS =B`||DL;
   IF NIT=1 THEN DO;
    PRINT '*****************';
    PRINT 'ITERATION MONITOR';
    PRINT '*****************'; END;
    PRINT LOGLIK (| COLNAME=NAMES3 |);
    PRINT PARAMS (| COLNAME=NAMES4 |);
```

```
     FREE LOGLIK PARAMS; END;
     NLS=1;
     FAC = DL`*INV(CL);
MAR3: B=BOLD-ALPHA#FAC;
    IF NLS>1 & SUPRESLS=0 THEN DO;
    NLS1=NLS-1;
    IF NLS=2 THEN DO;
    PRINT 'LINE SEARCH SUBITERATION';
     PRINT '*************************'; END;
    LOGLIK =NLS1||LOLD||LL||ALPHA;
    PARAMS =BOLD//B;
    PRINT LOGLIK (| COLNAME=NAMES1 |);
    PRINT 'PARAMETER VALUES';
    PRINT PARAMS (| ROWNAME=NAMES2 |);
    FREE LOGLIK PARAMS; END;
    LINK LIKEF;
    IF LL > LOLD THEN GOTO MAR1;
    NLS=NLS+1;
    IF NLS < LLS THEN GOTO MAR2; FREE LLS;
     PRINT '******************************';
    PRINT '*SORRY - LINE SEARCH FAILURE*';
     PRINT '******************************';
    PRINT BOLD B DL CL FAC LOLD LL NLS NIT;
    GOTO MAR7;
MAR2: ALPHA=ALPHA/2; FREE V L;
    GOTO MAR3;
MAR1: NIT=NIT+1;
    IF ABS((LL-LOLD)/LOLD)<ACC1*ALPHA
    & SQRT(DL(|##,|))<=ACC2 THEN GOTO LEN;
    IF NIT > LIT THEN GOTO MAR5;
    GOTO MAR4;
MAR5: PRINT '***************************';
   PRINT '*ITERATION LIMIT EXCEEDED*';
    PRINT '**************************';
    PRINT BOLD B DL CL FAC LOLD LL NLS NIT; FREE NLS;
    GOTO MAR7;
LEN:  PRINT '************************************************';
    PRINT '*CONGRATULATIONS ACCURACY REQUIREMENT ACHIEVED*';
     PRINT '***********************************************';
    FREE ACC1 ALPHA ACC2 ;
MAR7: LINK LIKED;
    PRINT 'LOG-LIKELIHOOD FUNCTION AT SOLUTION';
     PRINT '***********************************';
    PRINT LL; FREE LL;
    VAR  =INV(-CL);
    SERR =SQRT(VECDIAG(VAR));
    TSTAT=B`/SERR;
    SOLN =B`||SERR||TSTAT||DL; FREE VAR SERR TSTAT;
    PRINT 'PARAMETER VALUES AT SOLUTION';
     PRINT '****************************';
    PRINT SOLN (| COLNAME=NAMES5 ROWNAME=VARNAME |);
    FREE SOLN NAMES5 VARNAME;
    PRINT NIT;
    STOP;
```

```
LIKEF:
IF SIGMA=0 THEN DO;
    BETA1= B(|1,1:(PAR/2)|);
    BETA2= B(|1,(PAR/2+1):PAR|);
    XB1  = X*BETA1`; XB2=X*BETA2`;
    Z1   = EXP(XB1); Z2=EXP(XB2);
    Z    = 1 + Z1 + Z2;
    L    = Y1#XB1 + Y2#XB2 - LOG(Z);
    LL   = L(|+,|); FREE L; END;
IF SIGMA=1 THEN DO;
    W1   = B(|1,1|);
    W2   = B(|1,2|);
    BETA1= B(|1,3:(2+(PAR-2)/2)|);
    BETA2= B(|1,(3+(PAR-2)/2):PAR|);
    XB1  = X*BETA1`;
    XB2  = X*BETA2`;
    E1   = EXP(XB1);
    E2   = EXP(XB2);
    E    = E1 + E2 + 1;
    P1   = E1/E;
    P2   = E2/E;
    P3   = 1/E;
    Z1   = EXP(XB1+W1#(0.5-P1));
    Z2   = EXP(XB2+W2#(0.5-P2));
    Z    = Z1 + Z2 + 1;
    L    = Y1#LOG(Z1) + Y2#LOG(Z2) - LOG(Z);
    LL   = L(|+,|); FREE E1 E2 G XB1 XB2 L; END;
RETURN;
LIKED:
IF SIGMA=0 THEN DO;
    V  = ((Y1 - Z1/Z)#X)`
       //((Y2 - Z2/Z)#X)`;
    DL = V(|,+|);
    CL = V*V`; FREE V;
    CL = -CL; END;
IF SIGMA=1 THEN DO;
    G1 = Z1/Z;
    G2 = Z2/Z;
    V  = ((0.5-P1)#(Y1-G1))`
       //((0.5-P2)#(Y2-G2))`
      //(((1-W1#(P1-P1#P1))#(Y1-G1)+P1#P2#W2#(Y2-G2))#X)`
      //(((1-W2#(P2-P2#P2))#(Y2-G2)+P1#P2#W1#(Y1-G1))#X)`;
    FREE G1 G2 Z1 Z2 Z P1 P2 ;
    DL = V(|,+|);
    CL = V*V`; FREE V1 V2 V3 V4 V;
    CL = -CL; END;
RETURN;
FINISH; RUN;
```

Chapter III

JOB TENURE IN FINNISH INDUSTRY

Abstract

This chapter studies the effect of wages on the job tenure in the Finnish metal and forest industry using microeconomic data. The data come from administrative files of the Confederation of Finnish Industry and Employers. The data cover a period of 11 years starting from the first quarter of 1980 and contain several pieces of information on workers, jobs and plants. According to the results the wage groups of the workers and relative wage within a plant are positively related to the job tenure. Also the duration-dependent effects were estimated. The effect of wages is of considerable importance for persons who have been working for a long time. Also semiparametric models of job tenure were estimated allowing for piece-wise linear hazards for the predefined intervals of job tenure.

1. Introduction

The econometric analysis of labour-market transition data has in recent years become an active area of empirical research. It is known also as a hazard-function approach to duration data analysis, where the transition intensity to a new state is modeled using econometric methods. In these studies the process of state-to-state movements is based on the lengths of certain spells of time. In Finland the length of spells of employment has not previously been the subject of any notable interest in econometric study.

This study analyses the dynamic features of transitions from employment in Finnish industry. Special emphasis is devoted to the effects of wages on the probability of exiting from a firm. We analyse whether the workers having lower wages differ from those having higher wages. In addition, we examine the effects of many other factors which have been stipulated in the labour agreements and which affect the probability of leaving the job.

The empirical analysis is carried out in the competing risk framework. It makes possible to take into account the feature that employment spells may be terminated by different outcomes. The data allow one to make a distinction between the workers who change their jobs within Finnish industry or leave it. The average number of industrial workers in 1980 was 627 000. During the 1980's there was a remarkable decrease in the number of workers, since in 1990 there were only 556 000 workers left. This study sheds some new light on the process of leaving the firm and industry.

Special attention is paid to unobserved heterogeneity and the duration-dependent changes in the hazard function. The procedure of discrete mixing distribution is used to minimize the impact of unobserved heterogeneity. It is also known as a mass point approach. Semiparametric models with piece-wise linear hazards are used to examine the non-monotonic job separation hazards. In these models job tenure is expressed in predefined intervals and separate constant baseline hazards are estimated for each of the intervals.

An exhaustive survey of the literature of the movements from unemployment to employment is found in Devine and Kiefer (1991). Job-matching models of Jovanovic (1979, 1984), Miller (1984), Gottschalk and Maloney (1985) and a search model of Albrecht, Holmlund and Lang (1991) incorporate uncertainty of wages or unobservable job-specific characteristics and constitute a theoretical framework for job-to-job transitions. In addition, there is a huge body of literature on the duration of employment (see Kiefer, 1988b, Björklund and Holmlund, 1989, Lindeboom and Theeuwes, 1990a,b, Brown and Light, 1992, Gritz, 1993 and Becker and Lindsay, 1994).

Belzil (1993) has analysed in a recent study the statistical relationship between accepted job duration and the job-to-job transition strategy using Canadian microeconomic data. He found that jobs preceded by unemployment tend to be shorter than the jobs preceded by employment. For those who have comparative advantages in searching for a job choosing unemployment does not seem to raise the subsequent job duration. If similar reasoning is valid for Finland, we could expect that long spells of employment tend to be followed by job-to-job transitions.

This study is organized as follows. In the next section the theoretical background of the determination of the wage is exposed briefly. The data of this study are presented in section 3. The econometric models and the results of estimations are presented in section 4. The concluding chapter summarizes and discusses the results of the study.

2. Determination of the Wage

2.1. Concepts of Labour Turnover

The aim of the management of a company is to maximize profits, where the wages have a central role. The traditional accounting of companies has not been able to provide enough information to examine the costs of labour turnover. The concepts of labour turnover have been discussed by Anderson and Meyer (1994). The categories of labour turnover can be illustrated using the following classification:

New hires	= job creation + new hires at existing positions
Total accessions	= Recalls + new hires
Permanent separations	= job destruction + separations from continuing positions
Total separations	= temporary layoffs + permanent separations
Total permanent turnover	= new hires + permanent separations

The data of this study does not allow investigation of all the concepts of labour turnover. This study concentrates on the total separations, which consists of the permanent separations and layoffs. There is no information on the layoffs in the data. Therefore we study the exiting workers regardless, whether the exiting is due to layoffs, job destruction or separations from continuing positions.

The employers central organizations recognized the large turnover of labour as a serious problem during the 1970's, when there was high demand for labour (see STK, 1975 and STK and LTK, 1978). The reports of the employers' organizations concentrated on how a firm can estimate the costs of labour turnover on a firm level and how the management of firms can reduce the costs. Usually the turnover of labour increased during periods of high demand for labour and during sluggish demand it decreased. There is, however, labour turnover also during periods of weak demand for labour. In some particular firms or personnel groups the labour turnover can be extremely large.

The reasons for the labour turnover cannot be due only to the firm's own decisions. For example, the other firms can compete for the same workers by offering better salaries and working conditions. There are also many reasons which are related to the workers' own personal situation. For example, university studies, change of spouses' work and home and other family relations. The firms have a minor possibility to affect these decisions.

The costs of labour turnover can be very different between the companies. The types of costs and their importance can vary due to the region, branch, business cycle, occupation, education and required level of skill. The following list summarises the costs of labour turnover by the phases of job tenure:

1 Costs of vacancies
- 1.1 use of temporary workers
- 1.2 extra payment of over-time work
- 1.3 vacancy notices
- 1.4 other cost of vacancies

2 Costs of hiring
- 2.1 planning of hiring
- 2.2 search of workers
- 2.3 interviews and tests
- 2.4 health tests
- 2.5 costs of accommodation
- 2.6 material of hiring
- 2.7 other hiring costs

3 Training costs
- 3.1 planning of training
- 3.2 familiarizing
- 3.3 practising
- 3.4 training
- 3.5 training material
- 3.6 other training costs

4 Costs of job placement and learning
   4.1 extra management
   4.2 low effectiveness
   4.3 mistakes in production and service
   4.4 extra use of material
   4.5 extra repair of machines
   4.6 delay in production
   4.7 increase of accidents
   4.8 other costs (e.g. lost customers, other extra arrangements)

5 Costs related to job termination
   5.1 reduced effectiveness during the last days
   5.2 harmful effect on the work of colleagues
   5.3 training courses during the last few months
   5.4 extra routines related to job termination
   5.5 redundancy payment
   5.6 advance salaries that are not returned
   5.7 other costs related to job termination

The list is not exhaustive. It gives only an idea how diverse the costs of labour turnover can be. Also many costs of the management and workers can be seen as costs of labour turnover. From the point of workers that have left the firms there are also costs. For example, the workers may have lower income during a spell of unemployment. They may have extra costs related to the change of jobs, training and possibly lower wages in the new jobs.

There have been many measures in order to reduce the superfluous labour turnover. This study tries to find out how the management of a company can reduce the unnecessary labour turnover. The wage issues are naturally the most important, because the wages and salaries are the largest costs in the most Finnish companies. Also the career of the worker is an important issue in this study. Unjustified promotions may cause dissatisfaction among the fellow workers. Dissatisfaction may commonly be a reason for a person to terminate a job. Also it is well known that many workers leave the firm in order to take a better job in another and possibly competing company. The management training emphasises the open personnel administration. These theories point out that the principles of the personnel policy should be well known within the company.

2.2. An Economic Model of Labour Turnover

This section presents and discusses a simplified version of the model of labour turnover, which is a model of job search by Stiglitz (1985). It is one of the efficiency wage models (see Krueger and Summers, 1988). An important characteristic of the model of labour turnover is that a person with long job tenure is more valuable to the firm than a newcomer. The reason is that there are extra costs of labour at the beginning and end of an employment spell. In some cases it may be more profitable for a firm to pay high efficiency wages in order to reduce the costs of labour turnover.

According to the basic assumptions the workers are continually searching for a higher paid job. Firms are assumed to pay the fixed training costs T for each entrant when they are entering the firm. The interest rate for the training costs is denoted by r. The workers quit when they find a better paid job. The workers leave the ranks of the workers at the rate of q(w). The quit function is assumed to depend on the present wage of the worker w. The workers are replaced by an equal number of new workers. The quit function acts like the depreciation factor on the human capital of the firm.

The production is characterised by the training costs, which are creating a flow of output per worker $f(T)$. The constant returns-to-scale property of the technology is assumed. The wage is the only decision variable of the firm. It is chosen to maximize the profits of the firm, which can be written as follows

$$(1) \quad \mathrm{P} = f(T) - \mathrm{w} - [\mathrm{q}(\mathrm{w}) + \mathrm{r}]T.$$

Since the free entry and constant returns-to-scale property of the technology is assumed, the zero-profit condition of firms is natural. Technically it is obtained by setting P = 0 in (1). The zero-profit condition is, however, a simplification which can be relaxed if deemed necessary. As an implication the market clearing wage can be written as being equal to the production minus the training costs term. Clearly the wage is an increasing function of the production and a decreasing function of the quit rate and interest rate.

Implicitly the model describes the dynamic process of labour turnover. Let us assume that employed workers are identical and have the same search parameters. If for some exogenous reason the productivity of the workers decreases, their wage level will also decrease sooner or later. The decrease of the productivity may depend on the change of technology, motivation or health of the workers. In practice the decrease of wages takes place in terms of real wages. The worker does not get any raise in an inflation economy.

As a consequence of the wage dispersion the low-wage group will have a higher probability of leaving the firm. The workers sort themselves between employment and unemployment solely according to the opportunity cost of choosing unemployment. Then the model gives a prediction that low-wage workers would enter unemployment through quitting a job and leaving industry. In addition, one could expect that the low wage workers would seek better paid jobs and the job-to-job transitions would tend to be followed by higher wages.

The quit rate function is assumed to be a decreasing convex function. Stiglitz (1985) gives arguments why the quit rate function should have the given shape. In order to analyse the effect of the training costs, let the subscripts denote the derivatives. Then the implicit-function rule of differentiation gives

(2) $w_T = -P_{wT}/P_{ww} > 0,$

since $P_{wT} = -q_w > 0$ and $-P_{ww} = q_{ww}T > 0$. Hence, the sign of w_T is determined by the sign of P_{wT}, which is positive. Consequently, the wage is an increasing function of the training costs.

Setting $P = 0$ and differentiating with respect to w gives the optimal condition of the wages. It can be written as follows

(3) $q_w(w) = -1/T.$

The quit rate is a convex decreasing function. The tangency of the quit rate function with the straight iso-cost curve with slope $-1/T$ gives the optimal wage.

The reasons for quitting a firm can be classified into two categories. The workers quit the labour force or become voluntarily unemployed with probability $\mu(w)$ or alternatively they find better paid jobs. It is assumed that $\partial\mu/\partial w < 0$. For some workers an intervening spell of unemployment is observed immediately after they quit their job. For others consecutive employment is observed, since they quit their job in order to accept immediately a new one.

The probability of changing jobs depends on the number of searches during the search period s and on the unknown wage offers. Wage offers are characterized by the distribution function F(w). The quit rate function can be written as follows

$$(4) \quad q(w) = \mu(w) + s[1 - F(w)].$$

The probability that a worker finds a higher paid job is a product of the search activity s and the probability of finding an acceptable offer [1 - F(w)]. According to equation (4) the workers leave the ranks of the workers exponentially at the rate of q(w). The exponential distribution implies that a worker's expected tenure is $E(t) = 1/q(w)$, where q(w) is the quit rate during each period.[5]

Empirical study based on the microeconomic data from the United States has shown that the labour turnover has a cyclical variation. The quit rate is low during a period of rapid economic growth, but on the other hand the hiring of new workers is low during the high unemployment (see Anderson and Meyer, 1994).

---

5 Integrating by parts the remaining expected value of job tenure for any distribution can be written as follows $E(s) = \int_s^\infty t f(t)dt = sS(s) + \int_s^\infty S(t)dt$, where $f(t)$ is the density and $S(t)$ is the survivor function. For a worker entering a firm the expected value of job tenure $E(t) = \int_0^\infty S(t)dt$. In a case of exponential distribution $E(t) = \int_0^\infty \exp(-tq)dt = 1/q$.

Job mobility induces expenditures on training for the recruiting firms. The optimal level of wages depends on the training costs. Lowering the relative wage of workers increases the quit rate. Therefore firms may be reluctant to lower the wage. Even though the workers are willing to work for less, they may consider it a temporary phase as they begin more actively to search for a new job.

Imperfect information on wages means that the firms can exploit the workers by using for some degree their monopoly power. They can keep the workers some time even though they pay less than the market clearing wage. Sooner or later the firms, however, lose the low paid workers to other firms. To some extent wage differentials reflect the exercise of monopoly power of firms.

External effects may affect the quit rate of a firm. If another firm increases the wage level in order to reduce its turnover costs, it increases the quit rate of the other firms. This finding raises an interesting prediction. The wage levels in the subsequent job of the worker are higher than in the previous jobs if the argument of the wage gain is relevant.

3. Description of the Data on Job Tenure

3.1. Development of Employment in Finnish Industry

Figure 1 illustrates the number of employed workers in the total economy, manufacturing, metal and forest industries in 1980 - 1994. The examination is based on the figures produced by Statistics Finland. It can be seen that there has been remarkable changes in the structure of the labour market. The number of jobs in industry has decreased strongly. This study aims to investigate the reasons for decreasing employment in Finnish industry using microeconomic data. There are remarkable differences between the development of employment between the industries. Especially the number of jobs in the clothing and textile industry has been decreasing remarkably as a consequence of the increasing price competition.

In 1980 the number of employed persons in Finland was 2.328 million according to Statistics Finland. During the next ten years the increase was 139 000 workers, which corresponds to an increase of 6 per cent. The number of employed workers started strongly to decrease in the beginning of the 1990's. From the peak of 1989 to 1994 the number of workers decreased by 446 000 persons. From 1980 to 1994 the employment decreased by 304 000 workers, which corresponds to a decrease of 13 per cent.

The development of the employment in Finnish manufacturing was contrary to the development of the employment in the total economy. In 1980 there were on average 627 000 workers in manufacturing. During the next ten years the decrease was 71 000 persons, which corresponds to a decrease of 11 per cent. The decrease of the number of jobs was even stronger in the beginning of the 1990's. From 1990 to 1994 about 130 jobs were lost, which was 23 per cent of the jobs. Starting from 1980 to 1994 the number of jobs decreased by 201 000, which corresponds to 32 per cent.

In the metal and mining industry the decrease of the number of employed workers has been as strong as in manufacturing during the 1980's and 1990's. In 1980 there were 212 000 jobs in the metal and mining industry. Ten years later there were 195 000 jobs and in 1993 only 146 000 jobs left. The number of jobs started to increase slightly in 1994. During the whole period of study 1980 - 1994 the number of jobs decreased by 56 000, which corresponds to 26 per cent of the jobs.

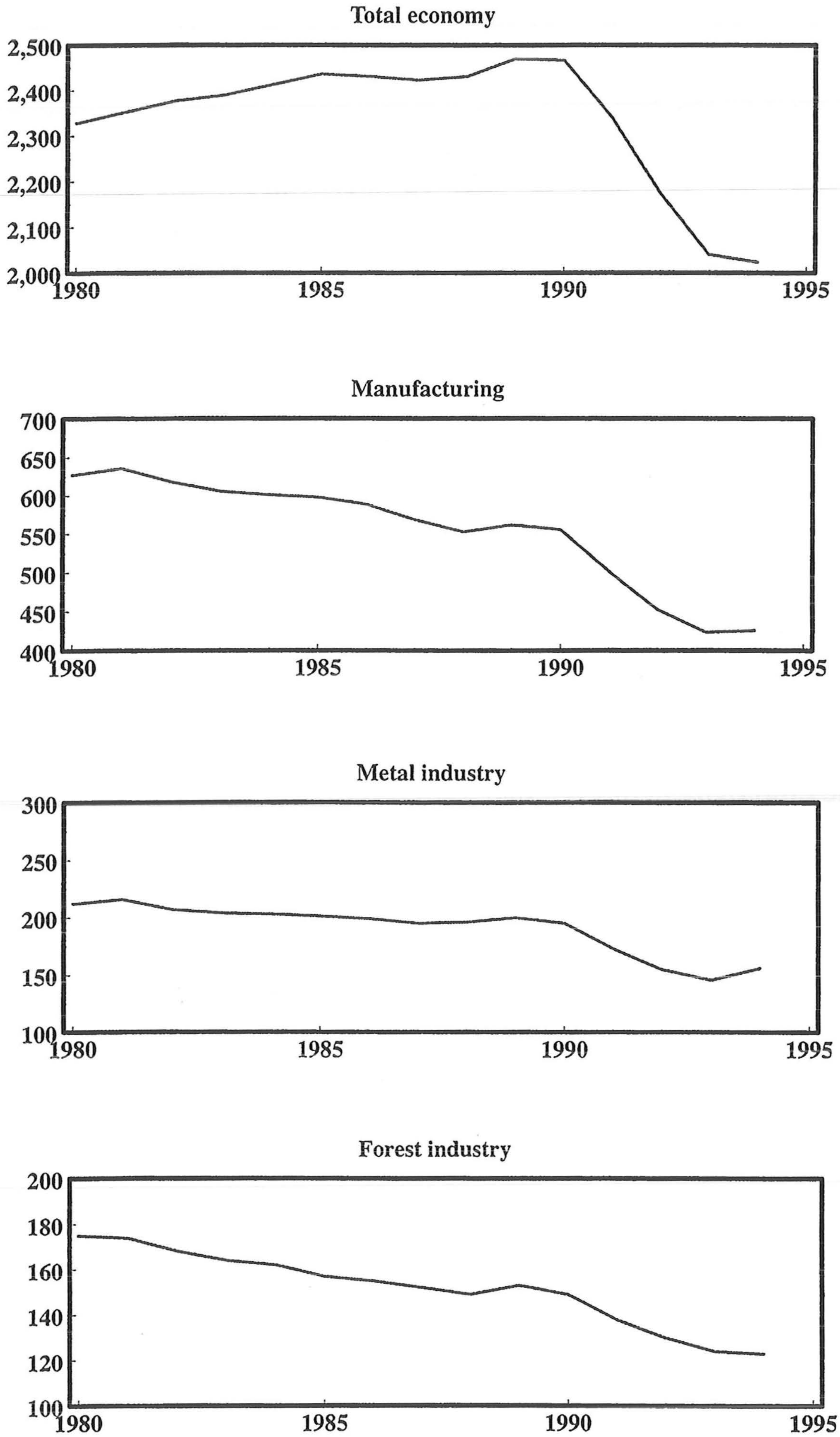
The decrease in the number of jobs has been similar in the wood and paper industries as in manufacturing. In 1980 there were 175 000 jobs. In 1990 there were 149 000 jobs and in 1994 only 123 000 jobs. The number of employed workers decreased in 1980 - 1994 by 52 000, which corresponds to 30 per cent of the workers.

The relatively weak exports of manufacturing products decreased the demand for labour during the 1980's. The central bank policy kept the price competitiveness of the exporting firms weak. There were also other structural changes in the Finnish economy. One of them was the sluggish exports to the Soviet Union. The weak increase of the western demand could not compensate for the loss in the Soviet trade.

New jobs in the public sector increased the employment in the total economy. The new ambitious schemes of social security and public services led also to the increase of public expenditure and tight taxation. The enlargement of the public sector has increased the indirect labour costs, which in turn has decreased the demand for labour. The increase in the public employment has not had a solid foundation.

There have been changes which are clearly related to the structure of the statistics. The splitting of industrial firms into pure industrial firms and, on the other hand, service firms has decreased the number of jobs in industry, because the service jobs have been classified in the service sector. For example, the new companies of technology, cleaning and financing have kept the number of workers unchanged in the plants, even though the number of jobs has decreased within industry. One of the main ideas in the new business thinking has been to simplify the structure of the administration of the firms by concentrating on the core business.

Figure 1. **Number of employed workers in the total economy, total manufacturing and metal and forest industries**



3.2. Flow and Stock Sampling

In this section we shall be concerned with the sampling of individuals and the deduction of the likelihood function appropriate to the type of data collected. It is important to note that the sampling scheme modifies the distribution of data, which must be taken into account when constructing the likelihood function.

Lancaster (1990, 160-161) points out that there are two ways of sampling which are the most fundamental for the econometrician:

1. The set of people who occupy a particular state at a particular time can be randomly sampled. This is called *stock sampling*.

2. The people entering or leaving a given state over an interval of time can be randomly sampled. This is called *flow sampling*.

The distribution of completed employment spells collected by sampling the people employed at a moment of time is generally different from the distribution obtained from a random sample of persons leaving employment. The stock and flow sampling are equal only when the spells have an exponential distribution.

There are also other ways of sampling that are often used for purposes unconnected with the needs of the researcher. For example, the whole population can be randomly sampled regardless of the state they currently occupy. Sometimes the whole labour force is sampled regardless whether persons are working, unemployed or outside the labour force. These non-standard sampling schemes are usually seen to arise as a byproduct of the some other purpose of data collection. The workers are in many cases observed over a fixed interval (see Ondrich, 1985 and Lancaster, 1990, 183-185).

Figure 2 illustrates the sampling from the stock of workers. Let us consider the elapsed duration T_b and the remaining duration T_f, which are random variables with realisations t_b and t_f. If we do not sample entrants to a state but instead sample occupants of a state at t_0, we may observe the backwards or forwards recurrence times, t_b and t_f respectively. For example, in many countries the government statistical services collect and publish survey data which are based on the sample of persons who are unemployed at the end of the month. For each employed worker there is retrospective data on the job tenure until the date of interview, which is sometimes called the elapsed duration.

The probability that a person is observed at t_0 is expressed by the survivor function $S(t_b)$ conditional that the person became employed. The probability that the person entered employment t_b weeks ago is $1/E(T)$. The probability density function of t_b is a product of these two probabilities. The likelihood contribution of completed durations can then be written as follows (see Flinn and Heckman, 1982 and Lancaster, 1990)

$$(5) \quad f(t_b) = S(t_b)/E(T).$$

It should be pointed out that the equation holds only in the stationary state and even relatively minor departures from stationary inflows can have large consequences for the estimates (Kiefer and Neumann, 1989, 207).

For example, in the multi-wave panel data the forward recurrence time can be checked at the interviews. Now suppose complete durations $T_{bf} = T_b + T_f$ are observed. The conditional density of T_f given $T_b = t_b$ can be written as follows

$$(6) \quad f(t_f|t_b) = f(t_b+t_f)/S(t_b).$$

It is the probability of a total duration of t_b+t_f given that it exceeds t_b. Because the marginal density of t_b is $S(t_b)/E(T)$ the joint distribution of T_f and T_b can be written as follows

$$(7) \quad f(t_b, t_f) = \frac{f(t_b + t_f)}{S(t_b)} \; \frac{S(t_b)}{E(T)}$$

$$= \frac{f(t_b+t_f)}{E(T)}.$$

A marginal density of the remaining duration t_f is obtained by integrating t_f out of (7) as follows

$$(8)\quad f(t_f) = \int_0^{\infty} \frac{f(t_b, t_f)}{E(T)}\, dt_f$$

$$= \frac{S(t_f)}{E(T)}.$$

From this it follows directly that T_b and T_f have identical distributions in a stationary economic environment and that, on average, spells will be observed halfway through their duration. This is an important result for the construction of the likelihood function. The likelihood functions are identical whether the individuals are followed backwards or forwards. If we are interested in the termination of employment spells in a specific year, the backward follow-up may offer a better sampling plan than the forward follow-up.

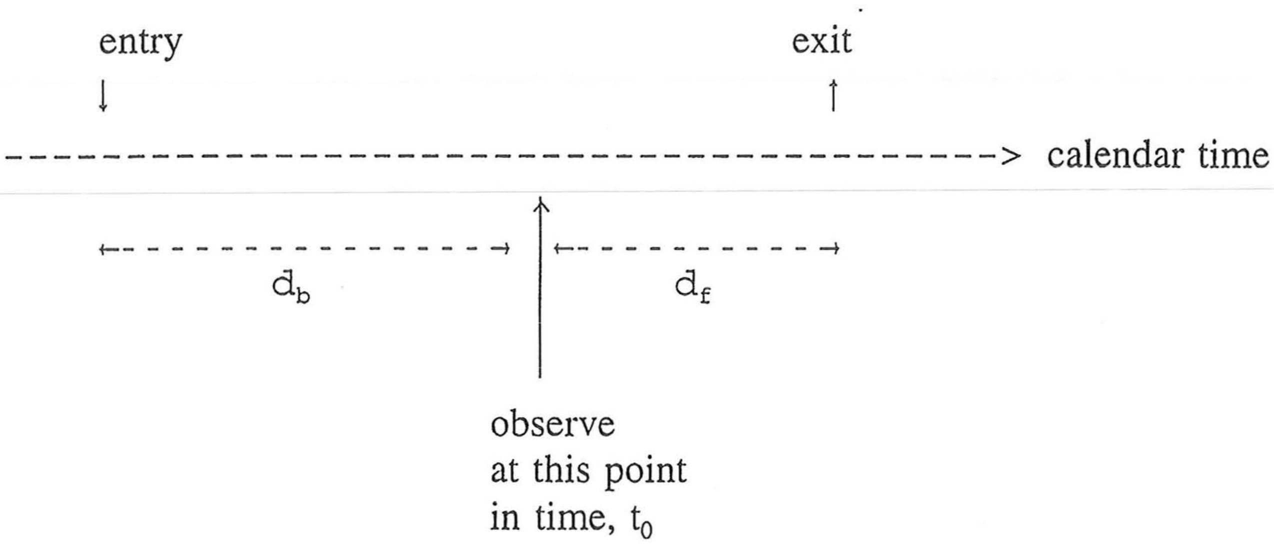
To get the marginal distribution of T_{bf} we integrate the joint distribution of T_b and T_f with respect to t_f over the range $(0, t_{bf})$ giving

$$(9)\quad f_{bf}(t_{bf}) = t_{bf} f(t_{bf})/E(T).$$

This is often called length-biased sampling of complete durations, because the probability that an individual is sampled is proportional to the duration.

Taking the expected value of t_{bf} with respect to $f_{bf}(t_{bf})$ it follows directly that $E(T_{bf}) = E(T^2)/E(T) = E(T)[1 + Var(T)/E(T)^2]$ (see Heckman and Singer, 1984b, 100). The expected duration from the stock sample is greater than the expected duration from the flow sample if the variance of job tenure is positive, which is true in empirical data.

Figure 2. Sampling from the stock of workers



Let us now turn to the flow sampling. In single-cycle sampling schemes the likelihood function depends both upon the model for the transition intensities and the sampling of individuals into the data set. The individuals can be followed backwards or forwards. The durations followed backwards may be recorded as durations beginning when the workers entered a certain state and lasting until the completion of the spell (Kiefer, 1988a). Backward follow-up is found also in clinical trials, which have usually staggered entry. The patients enter over a substantial time period (Cox and Oakes, 1984). An identical likelihood function is obtained either by observing entrants to a state or by observing leavers from a state (see Chesher and Lancaster, 1983 and Lancaster, 1990, 162, 182).

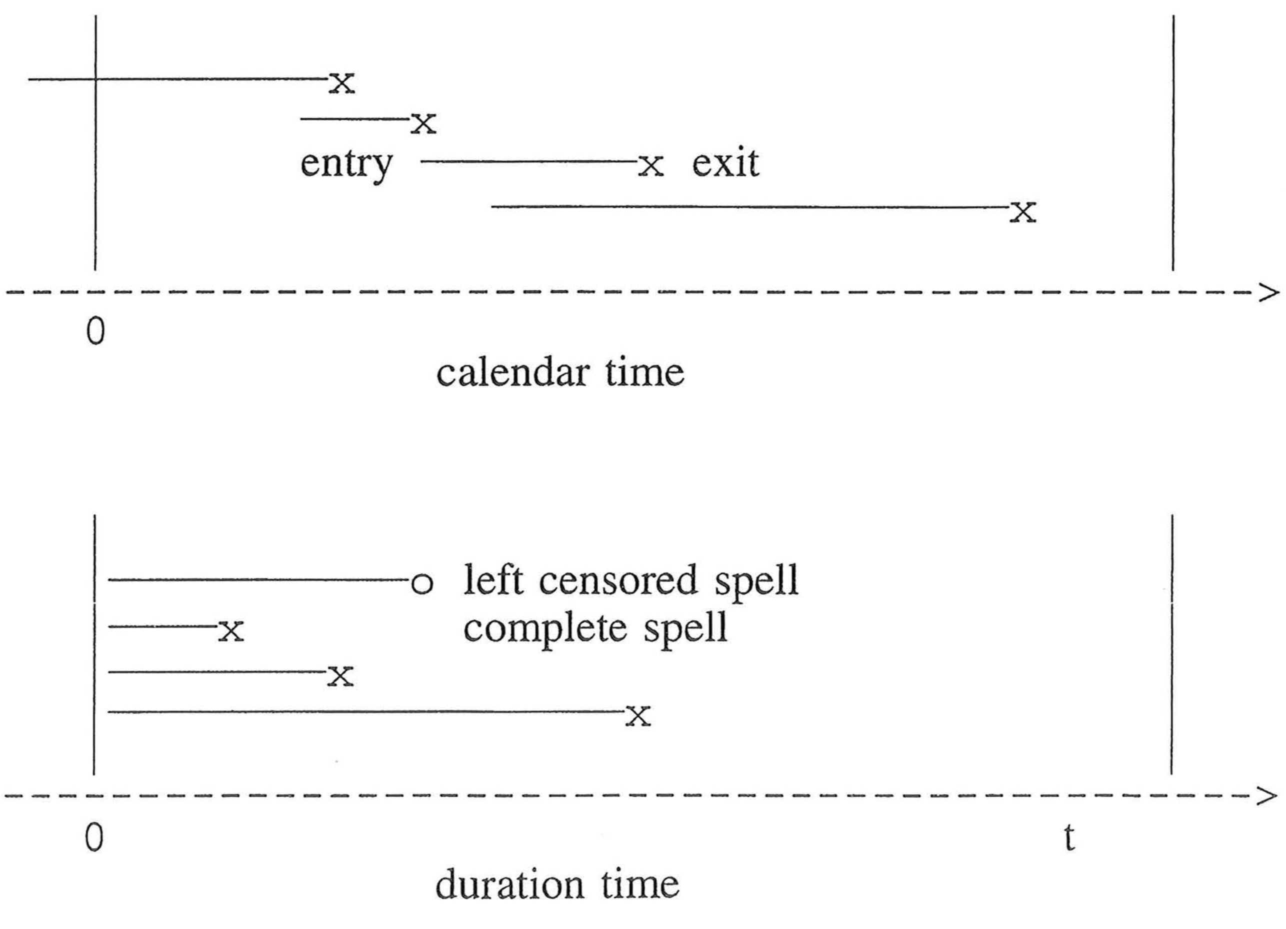
Figure 3 illustrates the sampling from an outflow with staggered entry and backward follow-up. Only the workers whose job terminates during the period of observation were picked for the sample. People may enter before or during the period of observations. The sampling from an outflow is feasible to examine whether the exit distribution varies with the business cycle. The spells that started before the period of observation are left censored and the other observations are complete spells. Alternatively the workers could be sampled from the inflow. In this manner, the duration distribution differs by the time period of job termination.

When the sampling has been made from the flow, the density function is a product of the probability that the person is still employed S(t) and the hazard function h(t), which can be interpreted as the conditional probability of becoming employed during a short interval. Thus the density function can be written as

(10) $f(t) = h(t)S(t)$.

This is the density function of completed durations in the population. The likelihood functions are identical whether the individuals are followed backwards or forwards. The exponential distribution is the only duration distribution for which the likelihood contributions (5) and (10) are identical.

Figure 3. Sampling from a flow with staggered entry and backward follow-up



The distributions of durations measured from stock samples are, in general, quite different from the distributions of durations measured from flow samples. The reason is that longer spells are more likely to be sampled than shorter spells when sampling from the stock of employed persons.

Equations (5), (6), (8), (9) and (10) are the generic forms for the likelihood contributions which can be used in estimations. These distributions have to be parametrized for the estimation. In the semiparametric analysis it is necessary to derive the appropriate discrete-time versions of the likelihood functions. Care is needed with the panel data. Since the discrete-time hazard takes an extreme value distribution form, a likelihood function for the stock sampling should be used with panel data (see Narendranathan and Stewart, 1991).

The data of our empirical study is obtained by sampling workers at the exit of job tenure. There is a staggered entry, because workers are selected during a predetermined period of follow-up. The individuals are followed backwards until they became employed.

3.3. Source, Structure and Descriptive Statistics of the Data

The investigation is based on data from the administrative files of the Confederation of Finnish Industry and Employers (TT). During a research programme conducted by The Research Institute of the Finnish Economy (ETLA) in collaboration with the Labour Institute for the Economic Research (PT) various samples were planned and taken. The cross section and panel data sets have been reported and analysed in various studies (Kettunen and Marjanen, 1992, Kettunen and Vartiainen, 1993, Kettunen, 1993a,c, 1994a,b and Asplund, 1994).

The research programme on wages is interesting, because the vast data of TT or any other similar data have so far not been available for economic research, except for the study on sex discrimination of wages by Vartia and Kurjenoja (1992). Our study extends the previous investigation by analysing the longitudinal data on the job tenure in Finnish industry.

The sample is based on the outflow of workers from employment. The files enable the researcher to document labour-market states occupied by individuals. The data are representative, because about 80 per cent of the Finnish industrial workers are working in the member firms of TT. The wage information is collected every quarter from all the blue-collar workers in the member firms.

The data are reliable, since they are obtained directly form the accounting figures of the firms. The number of workers is about 300 000 every quarter. The data have been primarily collected for the wage negotiations on the central and union levels. Also quarterly aggregate statistics are published using the data.

The sampling of spells of employment was made from the outflow of workers from the firms. About 55 000 persons left the member firms during 1990. In order to guarantee the random and seasonally representative sample, the workers were sorted into a random order and every 15th worker was picked from the outflow during 1990. This sample contains 3703 individuals who have experienced a transition from a job during 1990.

The workers in the three largest industries of the metal and forest industries were included to the final sample. The forest industry includes the wood and paper industries. A reason for selecting these industries is that the number of wage groups defined in the collective wage agreements is different between the industries. Some of the industries have too few observations in order to draw reasonable statistical conclusions about the effects of the wage groups. The selection of the three industries leaves 2929 workers in the sample.

Some of the workers in the sample have unbelievably high wages. These kinds of cases can occur if the workers have been working during a quarter only a few hours and have got some parts of their earnings afterwards or in advance. The observations where the wage level exceeded FIM 110 were rejected. There were 30 excluded outliers. The final sample includes 2899 observations.

There are two kinds of transitions among the persons who left the firms. It can be observed from the data whether the workers immediately find another job in Finnish industry. Alternative forms of exit from a job may include transitions into non-participation. These alternative observations may include also workers who have found better paid jobs outside industry. Unfortunately we do not have information on the destinations of the persons who have left industry.

Every worker was followed backwards until they became employed in that particular firm. In this study we analyse the single spells of employment for each individual. The job tenure is considered to start if the worker has not obtained any income during the previous quarter. This definition of job tenure does not necessarily correspond to any juridical concept of job tenure. Leave of absence is a reason which enables a worker to keep his job even though he is absent over a long period. In the pension system, for example, the job is considered to start again if the worker has been absent more than a year. Regardless of these differences our definition can be considered reasonable, because there is not a unique definition for job tenure in economic theory.

The follow-up went back to the year 1980. So the longest observed lengths of employment were 11 years in the sample. About 14 per cent of the workers were working during the first quarter of 1980. It cannot be known if the workers were unemployed or employed in other firms in 1979. These workers were lost in the follow-up, because it would have been too expensive to go through hundreds of thousands of observations in order to get additional information for a few hundred workers. These observations are called left censored, since the beginning of the employment is not known to the researcher. The censoring is rather mild, but it has to be taken into account in econometric studies.

The quarterly information on the wages of the workers during the whole employment was compiled from the files of TT. Access to the reliable information on wages recording the sequence of actual wage payments throughout a spell of employment is a substantial advantage of this study. Access to administrative data has been a substantial advantage also in the recent studies of unemployment duration (see Solon, 1985, Katz and Meyer, 1990, Meyer, 1990 and Atkinson and Micklewright, 1991).

The dates of entry into and exit from a job is not known. Therefore the job tenure is calculated using the number of quarters during which the persons have been working. One could suspect whether the job tenure is accurately measured. There are, however, 11 years in the follow-up. That implies 44 different lengths of employment. It has been shown that the parameter estimates of transition models are not generally very sensitive to time aggregation in simple parametric or semi-parametric cases (see Bergström and Edin, 1992). So it can be argued that there is enough variation in the variable of interest.

Table 1 presents the descriptive statistics of the data. The workers who find new jobs within industry have been working in the firm on average 3.9 years, while the persons who do not find new jobs within industry have 2.5 years of experience in their jobs. Because 14 per cent of the observations are censored, these figures do not represent the true job tenures. The notable difference in the job tenures supports the reasoning that job experience is related to the probability of finding new jobs within industry.

Those who move from one job to the next within industry are called movers. According to the descriptive statistics men are slightly overrepresented among the movers. Also the share of men is higher in the plants which the workers leave in order to get a job in industry. The persons who leave industry are called the leavers. The movers are nearly two years older than the leavers. The average age of men in the plant is slightly higher for the workers who relocate to other industrial firms. Women are older than men. The average age of men is 37.2 years in the whole sample whereas the average age of women is 41.3 years. Some plants have only male workers.

The high cost areas of Finland have been designated by the government. The areas include the largest towns, islands and Lapland. According to the collective wage agreements higher wages have to be paid in the high cost area. There are not remarkable differences in the high and low cost areas between the movers and leavers. Neither are there remarkable differences in the county of Uusimaa and the rest of the country.

The share of incentive hours is slightly higher in the firms where the persons leave in order to get a job from industry. This may indicate the strenuous nature of piece-rate work, because exhausted workers may search for another job. In another study (Kettunen, 1994a) it has been shown that the hourly piece-rate wage based on the quantity of output is about 20 per cent lower for the persons who work all the time on a piece-rate basis compared to the persons who work only a small number of hours on a piece-rate basis. The shares of incentive hours based on quality and quantity are not different for the two destinations. The shares of overtime and Sunday hours are not very different between the movers and leavers. Both the share of overtime and Sunday work are on average only around 4-5 per cent of all the working hours in a plant.

The means of the quarterly indicators show that the job-to-job movers change jobs most often during the last quarter of the year (47 per cent of the movers). On the other hand, the persons who leave their industrial jobs leave most often during the third quarter (42 per cent of the leavers). This conclusion is in great measure due to the annual holidays and considerable variation in the Finnish climate. The persons who are filling summer-time jobs or holiday vacancies start their studies or become unemployed when they leave the firm.

The wage groups are defined in the collective wage agreements according the required levels of skill in the job. The wage contacts are made in Finland on the level of trade unions, even though there are agreements on the central level. In practice it is impossible that the wage levels are related to similar kinds of requirements between the firms, even though this can be seen as one purpose of the wage agreements. There are three wage groups in the metal industry and five groups in the wood and paper industries.

The controlled effects of the wage groups on the wages are similar in the wood and paper industries (Kettunen, 1993c). Also the effects of wage groups on the job tenure were very similar. Therefore the wage groups in both the wood and paper industry were given joint indicators.

Most workers of the sample are on the middle levels of the wage groups both in the metal and forest industry. More often the persons on the highest levels of the wage groups move to the other industrial firms and the workers on the lowest levels leave industry. This characteristic of the data is more outstanding in the metal industry than in the forest industry. These findings support the reasoning that those moving from one job to the next in industry are often skilled workers.

The average relative wages of workers have been calculated in relation to the average wage of the plant and industry. The average relative wage of workers in industry has been calculated using quarterly data over the whole spell of employment. Also the average relative wage of each worker is calculated over the whole spell of his employment. The average relative wage in Table 1 is calculated over the individuals. Concerning the average wage level in the plant there are data only on the year 1990. The relative wage in the plant is therefore a relative termination wage of a worker in the plant. There are two wage concepts in the data. The regular wage includes only the earnings based on the ordinary hours of work. The total wage includes also the wage incrementals based on the overtime and Sunday work.

The average relative total wage in industry during the whole spell of employment for the persons who find new industrial jobs is clearly higher than the average relative wage for the workers who do not find new industrial jobs. The average relative total wage of the movers is 1.10 whereas the relative total wage of the leavers is 0.98. The higher wage of the movers is in accordance with the longer spells of employment. More experienced workers are usually better paid. The relative wage of the worker in a plant is clearly lower than the relative wage in industry. Low-wage plants are clearly overrepresented in the sample. The relative total wage of the movers in the plant is 0.96 whereas the corresponding wage for the leavers is 0.92.

These simple descriptive statistics of the data support the argument that wage differences between the workers in a plant create incentives for the workers to leave their employer. The results are in accordance with the prediction of the simple model of on-the-job search. Low-wage workers enter unemployment often by quitting their jobs and leaving industry.

Figure 4 illustrates the relationship between the relative wage and job tenure. The examination has been done separately for the persons who find and who do not find new jobs in industry. The average relative wage has been calculated for each worker having a job tenure of equal length (1, 2, 3, ..., 44 quarters). The average relative wages have been plotted against the job tenures. This procedure smooths the relationship between the variables compared to the traditional scatter plots.

The distribution of job tenure is skewed as the next section of the study points out. There are more short spells than long spells of employment. Therefore it important to look more carefully at the short spells of employment. There is plenty of random variation among the longest spells of employment.

Table 1. Descriptive statistics of the data on job tenure

The whole sample:

Variable	Mean	Std.Dev.	Minimum	Maximum
Job tenure, years	3.35	3.80	0.25	11.00
Sex, 1=male	0.79	0.41	0.00	1.00
Share of men, %	79.87	16.61	6.70	100.00
Age, years	33.10	11.83	15.00	65.00
Average age of men in a firm	37.17	3.28	25.00	47.00
Average age in a firm	38.04	2.76	26.00	47.00
High cost area, 1=yes	0.33	0.47	0.00	1.00
County of Uusimaa, 1=yes	0.16	0.37	0.00	1.00
Share of incentive hours[1]	22.09	27.12	0.00	100.00
Share of incentive hours[2]	27.69	34.15	0.00	100.00
Share of overtime hours, %	3.71	2.53	0.00	17.50
Share of Sunday hours, %	4.44	4.38	0.00	18.10
Quarter, 1=yes: 1	0.20	0.40	0.00	1.00
2	0.15	0.36	0.00	1.00
3	0.29	0.46	0.00	1.00
4	0.35	0.48	0.00	1.00
Wage group, metal, 1=yes: 1	0.18	0.38	0.00	1.00
2	0.27	0.44	0.00	1.00
(low) 3	0.12	0.32	0.00	1.00
Wage group, forest, 1=yes: 1	0.10	0.29	0.00	1.00
2	0.10	0.31	0.00	1.00
3	0.11	0.31	0.00	1.00
4	0.07	0.25	0.00	1.00
(high) 5	0.06	0.23	0.00	1.00
Relative regular wage in industry	1.04	0.23	0.53	2.08
Relative total wage in industry	1.05	0.26	0.50	2.28
Relative regular wage in a plant	0.95	0.16	0.46	2.51
Relative total wage in a plant	0.95	0.18	0.40	2.36

The number of observations is 2899.

The workers who find new jobs in Finnish industry:

Variable		Mean	Std.Dev.	Minimum	Maximum
Job tenure, years		3.92	3.90	0.25	11.00
Sex, 1=male		0.82	0.39	0.00	1.00
Share of men, %		81.21	15.16	13.30	100.00
Age, years		33.83	11.27	16.00	64.00
Average age of men in a firm		37.44	3.10	25.00	47.00
Average age in a firm		38.22	2.69	26.00	47.00
High cost area, 1=yes		0.35	0.48	0.00	1.00
County of Uusimaa, 1=yes		0.14	0.35	0.00	1.00
Share of incentive hours[1]		23.86	28.34	0.00	100.00
Share of incentive hours[2]		27.26	33.45	0.00	100.00
Share of overtime hours, %		3.67	2.41	0.00	17.50
Share of Sunday hours, %		4.70	4.52	0.00	18.10
Quarter, 1=yes: 1		0.20	0.40	0.00	1.00
2		0.12	0.32	0.00	1.00
3		0.21	0.40	0.00	1.00
4		0.47	0.50	0.00	1.00
Wage group, metal, 1=yes:	1	0.20	0.40	0.00	1.00
	2	0.27	0.45	0.00	1.00
	(low) 3	0.09	0.28	0.00	1.00
Wage group, forest, 1=yes:	1	0.08	0.27	0.00	1.00
	2	0.10	0.29	0.00	1.00
	3	0.11	0.32	0.00	1.00
	4	0.08	0.27	0.00	1.00
	(high) 5	0.07	0.25	0.00	1.00
Relative regular wage in industry		1.08	0.23	0.54	2.03
Relative total wage in industry		1.10	0.26	0.51	2.28
Relative regular wage in a plant		0.96	0.14	0.50	2.23
Relative total wage in a plant		0.96	0.17	0.40	2.21

The number of observations is 1707.

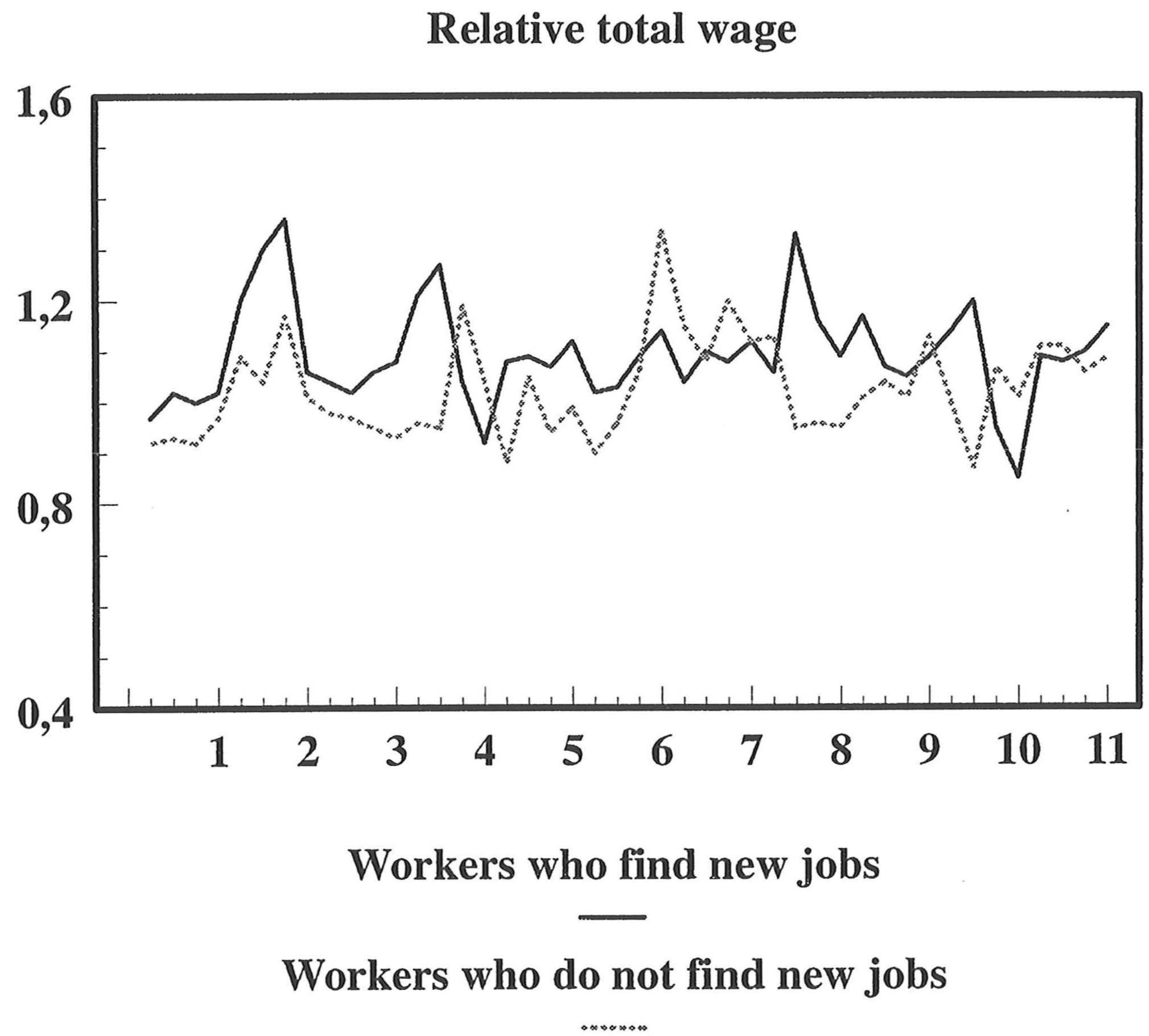
The workers who do not find new jobs in Finnish industry:

Variable		Mean	Std.Dev.	Minimum	Maximum
Job tenure, years		2.54	3.50	0.25	11.00
Sex, 1=male		0.76	0.43	0.00	1.00
Share of men, %		77.97	18.33	6.70	100.00
Age, years		32.07	12.52	15.00	65.00
Average age of men in a firm		36.78	3.48	25.00	47.00
Average age in a firm		37.79	2.83	26.00	47.00
High cost area, 1=yes		0.31	0.46	0.00	1.00
County of Uusimaa, 1=yes		0.19	0.39	0.00	1.00
Share of incentive hours[1]		19.57	25.08	0.00	99.10
Share of incentive hours[2]		28.30	35.16	0.00	100.00
Share of overtime hours, %		3.77	2.69	0.00	17.50
Share of Sunday hours, %		4.07	4.15	0.00	18.10
Quarter, 1=yes: 1		0.21	0.41	0.00	1.00
2		0.19	0.40	0.00	1.00
3		0.42	0.49	0.00	1.00
4		0.18	0.39	0.00	1.00
Wage group, metal, 1=yes:	1	0.15	0.36	0.00	1.00
	2	0.25	0.44	0.00	1.00
(low)	3	0.16	0.36	0.00	1.00
Wage group, forest, 1=yes:	1	0.12	0.32	0.00	1.00
	2	0.11	0.32	0.00	1.00
	3	0.11	0.31	0.00	1.00
	4	0.05	0.22	0.00	1.00
(high)	5	0.05	0.21	0.00	1.00
Relative regular wage in industry		0.98	0.20	0.53	2.08
Relative total wage in industry		0.98	0.23	0.50	2.07
Relative regular wage in a plant		0.93	0.18	0.46	2.51
Relative total wage in a plant		0.92	0.19	0.42	2.36

The number of observations is 1192.

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).

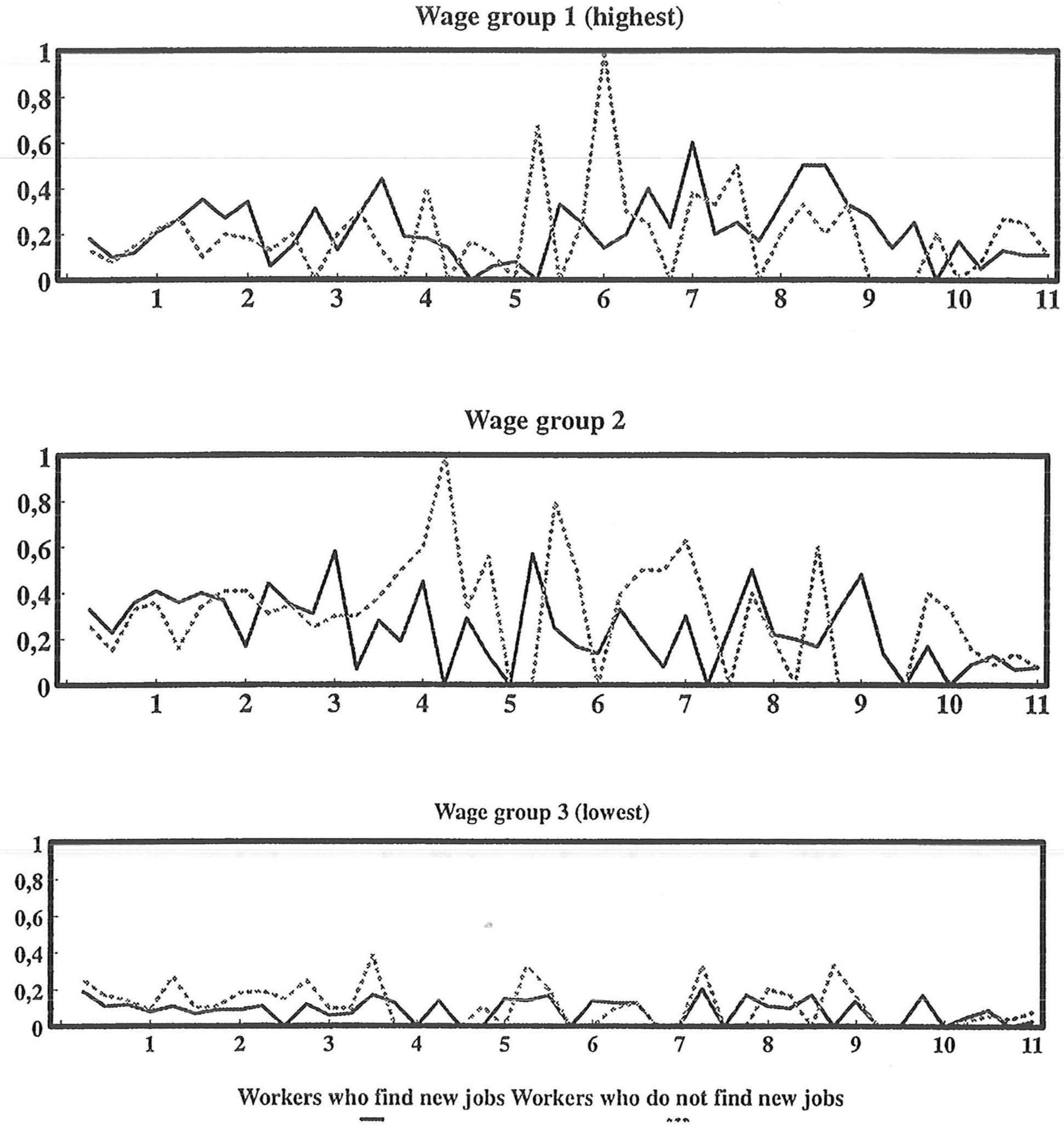
Figure 4. **Average relative total wage by job tenure**



There is not a very clear relationship between the relative wage and job tenure. This interpretation is, however, based on few outliers with large random variation. The basic trend seems to be slightly increasing, which means that the persons with long spells of employment have higher wages than the others. It can also be seen that the relative wage of the persons who find new industrial jobs is during the first three years clearly higher than the relative wage of the persons who leave industry.

Figure 5 illustrates the relationship between the wage groups and job tenure. In the lowest wage group of the metal industry (wage group 3) there are rather few terminations of employment. In the third wage group the jobs terminate most often during the first few years. There is no remarkable difference between the workers who leave and do not leave industry.

Figure 5. Distribution of wage groups by job tenure in the metal industry



In the second wage group of the metal industry the persons who leave industry have a decreasing trend, because there are rather many persons who have been working less than three years. There is not a clear difference between the workers who leave and remain in the industry.

In the first wage group of the metal industry there are relatively many spells of employment which terminate at 5-9 years. We cannot, however, make any strong conclusions about these investigations, but according to these figures the persons with long spells of employment tend to have higher wages than the others.

Figure 6 illustrates the relationship between the wage groups and job tenure in the forest industry. In the forest industry, which consists of the wood and paper industries, the lowest wage group is denoted as one and the highest wage group is denoted as five.

It can be seen that in the two lowest groups there are relatively many short spells of employment. In the third wage group there is no clear trend. In the fourth and fifth wage group there are relatively few employment spells that terminate during the first three years. Typical employment spells are long in the two highest wage groups. There are no remarkable differences between the workers who find new jobs in industry and who leave industry.

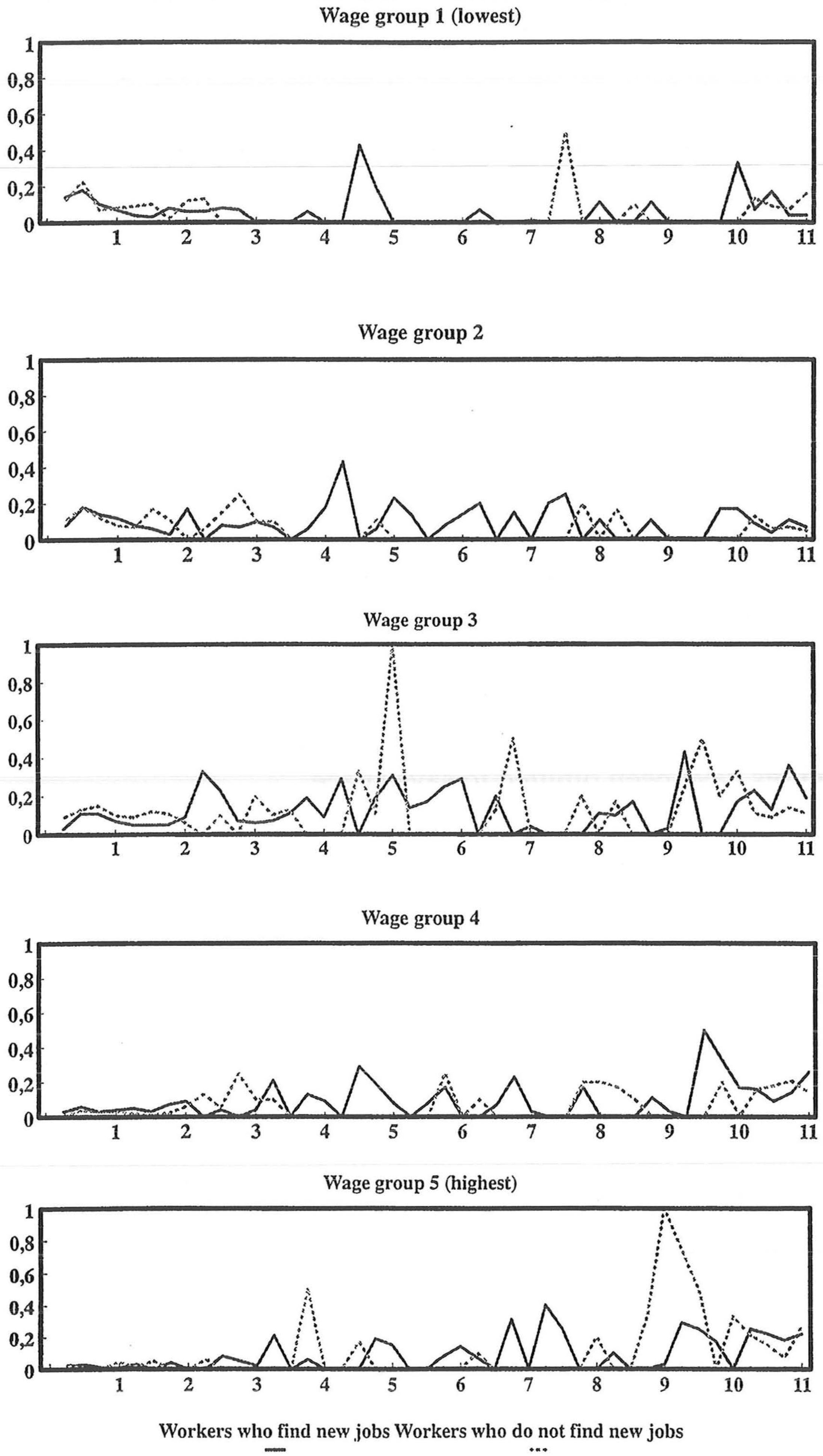
Also many other explanatory variables were plotted against the job tenure (Kettunen, 1996). The age of the worker clearly has a positive relationship with the job tenure in both of the destinations. The other explanatory variables have less distinctive duration-dependent trends. These variables have, however, less importance in this context. Therefore the figures have been omitted to save space.

3.4. Nonparametric Estimates of Job Tenure

It is useful to describe the data of job tenure using a simple nonparametric actuarial method. The life table method introduced by Cutler and Ederer (1958) is used to evaluate the distribution of job tenure. The method is well known and rather widely used in the statistical packages of transition data. Therefore only the main characteristics of the life table method are summarized briefly.

The lengths of employment are divided into intervals by the researcher. The midpoints of the intervals are used to locate the hazard, density and survivor functions. It should be pointed out that the results of this investigation depend to a large degree on the chosen intervals.

Figure 6. Distribution of wage groups by job tenure in the forest industry



If the persons are working during the first quarter of 1980, it is not known when the persons started to work. These observations are censored. Censoring is taken into account in the estimations. In small cohorts there may constitute only a few observations in the later intervals. Then the estimated variances are not good approximations of the true variance. Therefore it is reasonable to use larger intervals for the longer spells. Because the actuarial method is well known, the full description of the procedure is omitted here to save space.

The conditional proportion of exiting is the ratio of workers who leave the cohort during an interval and the risk set. The risk set in the life table is the estimated number of workers who are working during the interval. It is assumed that the censored observations are uniformly distributed over the interval. Hence the number of censored observations is halved in order to take them into account in the risk set.

The value of the survivor function at the beginning of an interval can be calculated by multiplying the previous conditional proportions of staying over the intervals in the risk set. The estimate of the survivor function at the midpoint of an interval is an average of the survivor functions at the ends of the interval. The survivor function is equal to one minus the distribution function of job tenure.

The density function is calculated as a difference of the survivor functions at the ends of the interval divided by the length of the interval. Consequently, the definition of the survivor function implies the density function of job tenure.

The hazard function is the ratio of the density and survivor functions at the midpoint of an interval. Consequently, the hazard function of job tenure has been calculated for a unit of interval (year). The hazard function is sometimes called the instantaneous or conditional probability of exiting a risk set. It is a rate of two probabilities but not, however, a proper density, because its value is not necessarily less than one.

Tables 2-4 present the results of estimations. The tables have been calculated separately for the whole sample, workers who find new industrial jobs and workers who do not find new jobs in industry. There is a remarkable difference between the two categories of the data. The hazard function of the workers who find new industrial jobs is clearly lower than the hazard function of the persons who leave industry. This phenomenon is especially pronounced during the first 1.5 years of employment. Starting from the second year the hazard functions of the two groups are rather similar.

The labour turnover is rather strong in Finnish industry, because 46 per cent of the workers leave their jobs during the first year and 68 per cent of them leave their jobs during the first three years. About 35 per cent of the workers who change their jobs within industry leave their jobs within the first year and 62 per cent of them leave their jobs during the first three years. Correspondingly, 62 per cent of the workers who do not find new jobs within industry leave their jobs during the first year and 78 per cent of them leave their jobs during the first three years. These figures indicate that the labour turnover is clearly higher among the persons who leave industry.

The descriptive statistics support the argument that more experienced and skilled workers tend to change their jobs within industry and less skilled workers leave industry. This is, however, only a preliminary outcome of the investigation of the data, which needs more rigorous analysis. In order to be able to better evaluate the nature of the many simultaneously affecting factors, a variety of variables must be controlled for. This will be done in the later sections of this study.

It can be seen that the first interval has the highest value of the hazard function, but also the later few intervals have high values. One reason for the short spells of employment is that the persons who are filling the summer-time or holiday vacancies leave the firms during the third quarter of the year.

The second reason for the short spells of employment is maternity leave. It is normally about 11 months in Finland. If the newcomer is filling a vacancy of a worker who is on maternity leave, the newcomer can expect a termination of the employment. Nowadays the period of maternity leave can be extended upto three years regarding the birth of each child, because the state started to pay a special benefit for the care of children in the beginning of the 1990's.

The third reason is that the temporary contract of employment cannot renewed. Otherwise the worker has a permanent job, which may be expensive to the employer, because the job is terminable only if the employer gives two month's notice. Unfortunately we do not have information on holiday vacancies, maternity leaves or temporary contracts in the data.

The fourth reason for the short spells of employment is that there is a test period of three months for every worker. If it turns out that the probationer does not fulfil the standards of the firm, the worker is dismissed after the first three months. A period of three months has been continued often in two quarters. Since the dates of entry and exit are not known in the data, it is therefore classified as continuing two quarters.

In addition, it can be argued that the data probably reflect the fundamental features of industrial relations. Short spells of employment are typical for the assisting personnel. In addition, short spells may be related to the temporarily increased demand for the products of the firm. That may lead to recruiting of personnel with short contracts.

Figure 7 illustrates the hazard functions of the job tenure using slightly shorter intervals than in Tables 2-4. The intervals of one quarter were used up to four years. Thereafter half-year intervals were used. There is weak evidence about the seasonal effects. The workers who find new jobs have low values of the hazard function at 1, 2 and 3 years of employment. This reflects the seasonal demand for labour.

If there is enough work to be done in a company and hence possibilities to earn well, the workers are probably not seeking actively new job opportunities in other companies. In addition, the variation of the hazard function may reflect the typical increases of the wages at 1, 2 and 3 years. They are based on the accumulating seniority of the workers. According to economic theory wage increases decrease the labour turnover. There seems to be also evidence that the workers who leave industry have higher values of the hazard function over the short spells of employment.

Table 2. Life table of job tenure for the workers in Finnish industry

Interval in years (lower, upper]	Exiting	Conditional proportion exiting	Censored	Risk set	Density	Cum. survival	Hazard
					Std.errors in parentheses		
0 -	913	0.315	0	2899	0.525 (0.014)	1.000 (0.000)	0.623 (0.020)
0.5 -	416	0.209	0	1986	0.287 (0.013)	0.685 (0.008)	0.468 (0.023)
1 -	256	0.163	0	1570	0.177 (0.011)	0.542 (0.009)	0.355 (0.022)
1.5 -	212	0.161	0	1314	0.146 (0.010)	0.453 (0.009)	0.351 (0.024)
2 -	80	0.073	0	1102	0.055 (0.006)	0.380 (0.009)	0.151 (0.017)
2.5 -	104	0.102	0	1022	0.072 (0.007)	0.353 (0.009)	0.214 (0.021)
3 -	84	0.092	0	918	0.029 (0.003)	0.317 (0.009)	0.096 (0.010)
4 -	60	0.072	0	834	0.021 (0.003)	0.288 (0.008)	0.074 (0.010)
5 -	51	0.066	0	774	0.018 (0.002)	0.267 (0.008)	0.068 (0.010)
6 -	141	0.195	0	723	0.049 (0.004)	0.249 (0.008)	0.216 (0.018)
7 -	39	0.067	0	582	0.014 (0.002)	0.201 (0.007)	0.069 (0.011)
8 -	83	0.153	0	543	0.029 (0.003)	0.187 (0.007)	0.166 (0.018)
9 -	33	0.072	0	460	0.011 (0.002)	0.159 (0.007)	0.074 (0.013)
10 -	29	0.127	398	228	.	0.147 (0.007)	.

Total 2899, Complete spells 2501, Censored 398 (14 %).

Table 3. Life table of job tenure for the workers who find new jobs in Finnish industry

Interval in years (lower, upper]	Exiting	Conditional proportion exiting	Censored	Risk set	Density	Cum. survival	Hazard
					Std.errors in parentheses		
0 -	381	0.223	0	1707	0.372 (0.017)	1.000 (0.000)	0.419 (0.021)
0.5 -	219	0.165	0	1326	0.267 (0.016)	0.777 (0.012)	0.360 (0.024)
1 -	171	0.155	0	1107	0.200 (0.015)	0.649 (0.012)	0.335 (0.026)
1.5 -	151	0.161	0	936	0.177 (0.014)	0.548 (0.012)	0.351 (0.028)
2 -	44	0.056	0	785	0.052 (0.008)	0.560 (0.012)	0.115 (0.017)
2.5 -	90	0.122	0	741	0.105 (0.011)	0.434 (0.012)	0.259 (0.027)
3 -	59	0.091	0	651	0.035 (0.004)	0.381 (0.012)	0.095 (0.012)
4 -	43	0.073	0	592	0.025 (0.004)	0.347 (0.011)	0.075 (0.011)
5 -	38	0.069	0	549	0.022 (0.004)	0.322 (0.011)	0.072 (0.012)
6 -	113	0.221	0	511	0.066 (0.006)	0.299 (0.010)	0.249 (0.023)
7 -	24	0.060	0	398	0.014 (0.003)	0.233 (0.010)	0.062 (0.013)
8 -	60	0.160	0	374	0.035 (0.004)	0.219 (0.009)	0.174 (0.022)
9 -	23	0.073	0	314	0.014 (0.003)	0.184 (0.009)	0.076 (0.016)
10 -	25	0.158	266	158	.	0.171 (0.009)	.

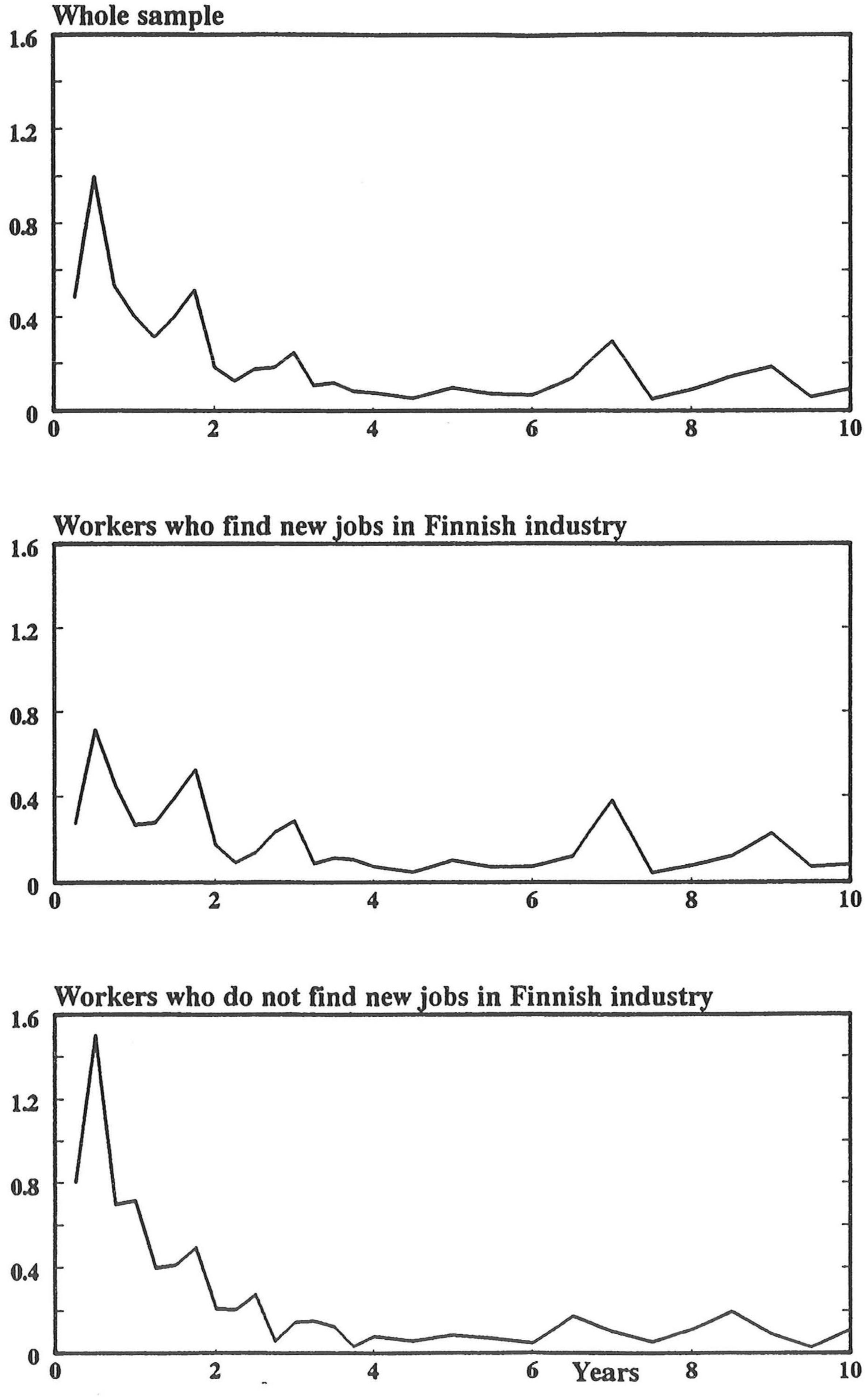
Total 1707, Complete spells 1441, Censored 266 (16 %).

Table 4. Life table of job tenure for the workers who do not find new jobs in Finnish industry

Interval in years (lower, upper]	Exiting	Conditional proportion exiting	Censored	Risk set	Density	Cum. survival	Hazard
					Std.errors in parentheses		
0 -	532	0.446	0	1192	0.744	1.000	0.957
					(0.024)	(0.000)	(0.040)
0.5 -	197	0.299	0	660	0.331	0.554	0.702
					(0.022)	(0.014)	(0.049)
1 -	85	0.184	0	463	0.143	0.388	0.404
					(0.015)	(0.014)	(0.044)
1.5 -	61	0.161	0	398	0.102	0.317	0.351
					(0.013)	(0.013)	(0.045)
2 -	36	0.114	0	317	0.060	0.266	0.241
					(0.010)	(0.012)	(0.040)
2.5 -	14	0.050	0	281	0.024	0.236	0.102
					(0.006)	(0.012)	(0.027)
3 -	25	0.094	0	267	0.021	0.224	0.098
					(0.004)	(0.012)	(0.019)
4 -	17	0.070	0	242	0.014	0.203	0.073
					(0.004)	(0.011)	(0.018)
5 -	13	0.058	0	225	0.011	0.189	0.059
					(0.004)	(0.011)	(0.016)
6 -	28	0.132	0	212	0.024	0.178	0.141
					(0.003)	(0.011)	(0.027)
7 -	15	0.082	0	184	0.013	0.154	0.085
					(0.004)	(0.010)	(0.022)
8 -	23	0.136	0	169	0.019	0.142	0.146
					(0.004)	(0.010)	(0.030)
9 -	10	0.068	0	146	0.008	0.123	0.071
					(0.003)	(0.010)	(0.022)
10 -	4	0.057	132	70	.	0.114	.
						(0.009)	

Total 1192, Complete spells 1060, Censored 132 (11 %).

Figure 7. Nonparametric hazard functions of job tenure



3.5. Wage Profiles

This section of the study is concerned with the development of the wages of workers during the job tenure. The form of the wage development during the job tenure is called a wage profile.

Figure 8 illustrates the wage levels in 1990 prices for the persons who are leaving their jobs in 1990. The wage index of manufacturing is used as a deflator in order to eliminate the nominal and real increase of wages. Therefore the wages are expressed in terms of the wage level of 1990.

Figure 9 illustrates the sequence of relative wages of the workers compared to the wages of all the workers who are working in each quarter of the year. The aggregate wage level in industry have been used in these calculations. These figures are drawn for the four overlapping cohorts of workers who exit their jobs during the quarters of 1990.

Figures 8 and 9 have been drawn for two wage concepts which are the regular and total wage. The total wage includes the incrementals based on the overtime and Sunday work. The persons who have found new industrial jobs have also obtained on average more wage incrementals. This finding can be used as an argument that the larger wage concept including wage incrementals is relevant in econometric studies.

A general remark is that the wage of the cohorts of all the workers are typically 3-10 per cent higher than the wage of the persons who are working. Only the cohorts of the workers who do not find new jobs in industry have lower average wages than the stock of the workers. Very strong conclusions cannot be drawn about these figures, since many explanatory variables may affect these graphs. In the next sections of this study many other variables are included in order to obtain independent effects of explanatory variables. For example, older workers who are well paid may be overrepresented in the group having long spells of employment.

Another remark about Figures 8 and 9 is that the average wage of the cohorts are decreasing during the five last years in a firm. If the relative wage of a worker decreases due to an exogenous reason, one might expect according to the economic theories that the worker will initiate on-the-job search. The decreasing average wage of the cohorts easily leads, however, to incorrect conclusions, because the distribution of job tenure strongly affects the average wage. Short spells of employment with low wages strongly affect the decreasing average wage of the cohorts. This can be concluded from the data analysis of wage profiles.

Figure 10 illustrates relative wage profiles of workers over their whole spells of employment. Usually wage profiles are derived from the studies of cross-section data, where the age of the workers is used as an explanatory variable. Then the effect of age can be estimated at the time of the cross section. The persons with different ages cannot, however, be used to derive proper wage profiles.

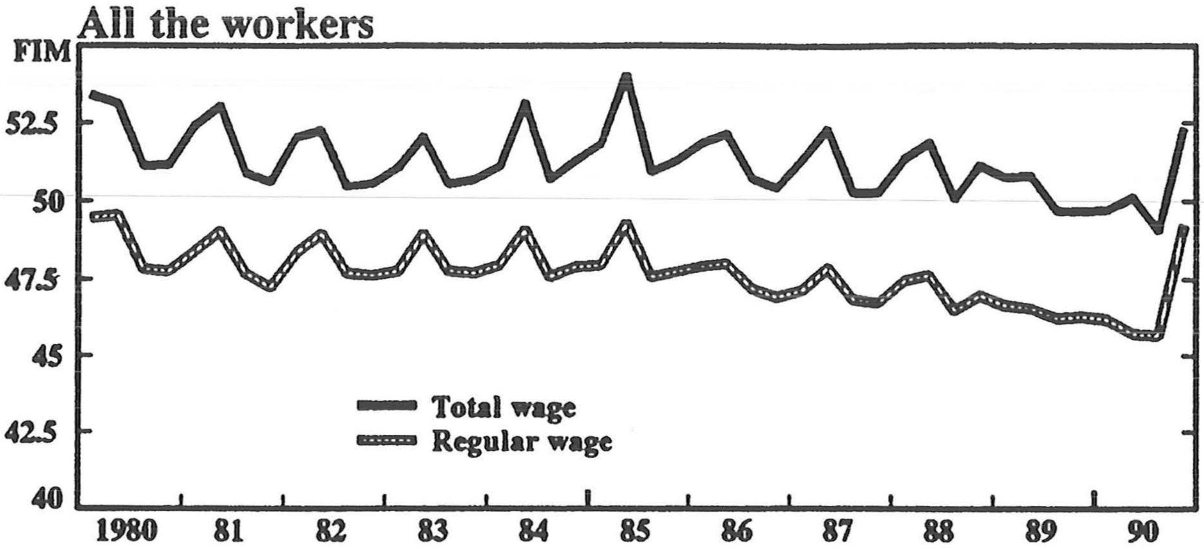
In our case the average wage profiles have been calculated for a group of persons who have experienced equal lengths of employment. Using these selected groups it is possible to examine the proper development of wages of the identical persons. To our knowledge this kind of information on the wage profiles has so far been unknown in Finland.

In the economic literature it is often said that the workers are 'low paid' at the beginning of job tenure and 'overpaid' at the end of it. An increasing wage profile may be a reason for dissatisfaction at the beginning of job tenure, which spurs workers to change their jobs. The existence of vacancies is of course a prerequisite for changing jobs. The new jobs possibly have a constant wage profile. An increasing wage profile may spur the workers to stay in their jobs if the job security is good. For example, many jobs in the public sector are often quite secure.

The wage profiles have been calculated for the job tenures of 1-7 years. In consecutive order the sample sizes are 76, 35, 48, 70, 91, 17, 10 and 8 workers, respectively. The sample sizes are generally decreasing, because most spells of employment are short. Therefore there is more random variation in the groups of longer spells.

It can be seen that the wage profiles are increasing for the short spells of four years or less. The wage profiles are constant for the spells of five years or more. The workers with longer spells have on average higher wages than the workers who have short spells of employment. The wage differentials are rather small between the short- and long-term workers.

Figure 8. Sequence of wages of the workers who left their jobs during 1990



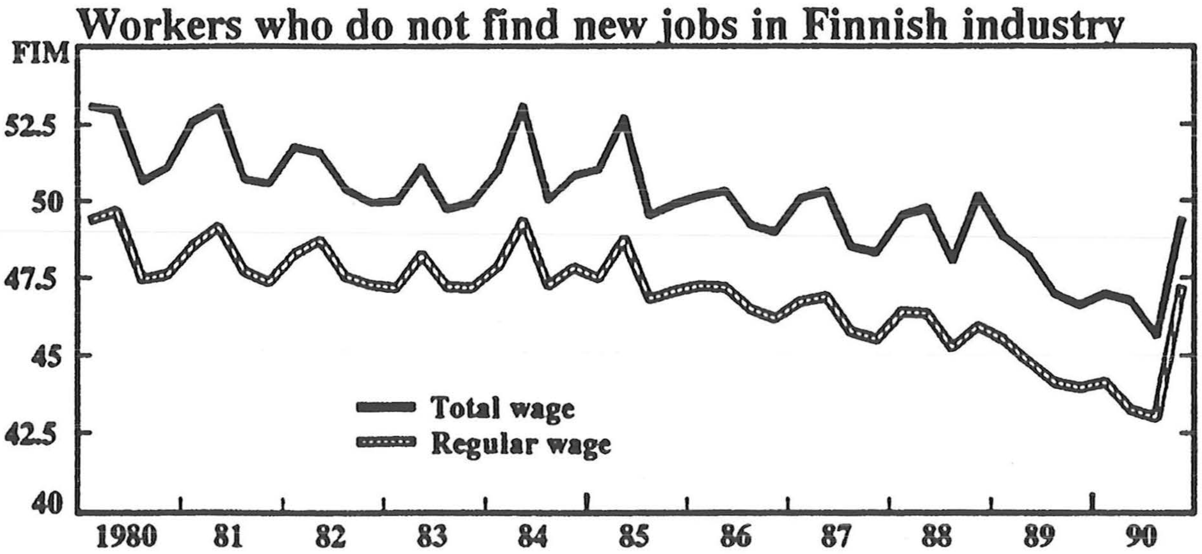


Figure 9. Sequence of relative wages of the workers who left their jobs during 1990

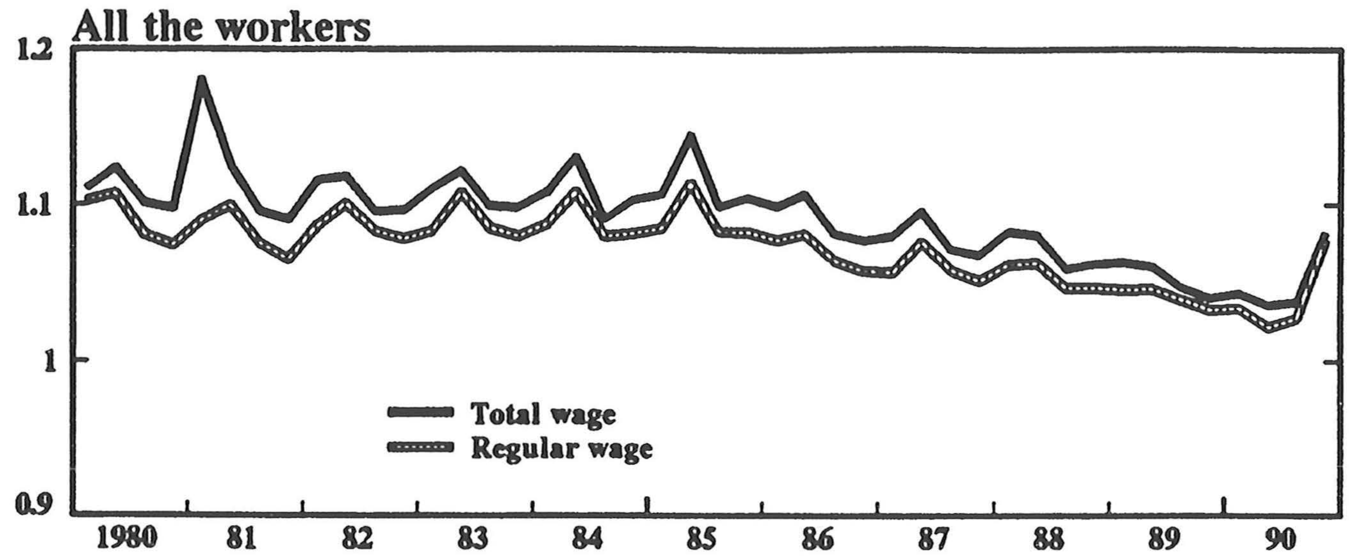


Figure 10. Wage profiles of the relative wages by job tenure

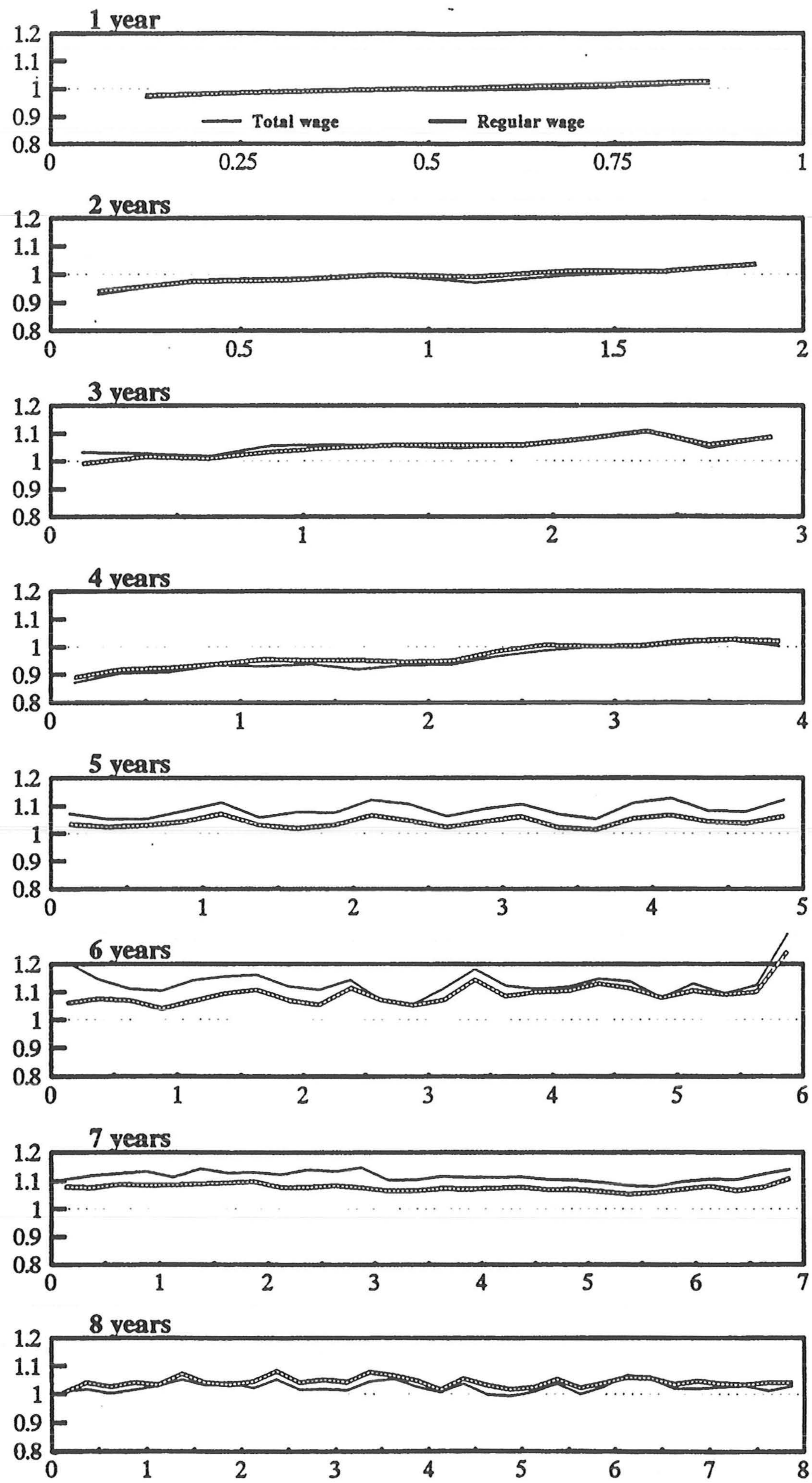
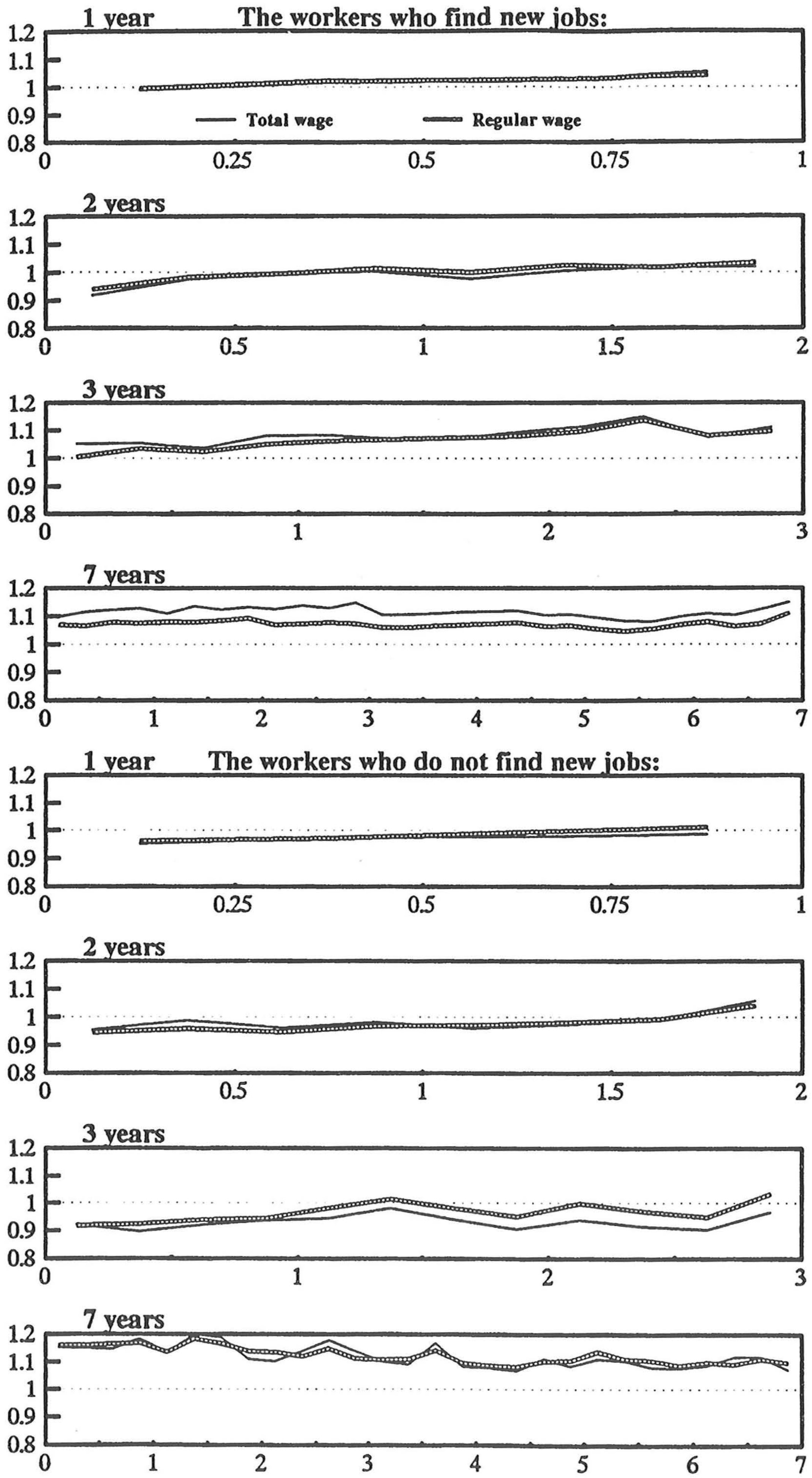


Figure 11. **Wage profiles of the relative wages by the persons who find and who do not find new jobs in Finnish industry**



The regular starting wage of the persons who enter a firm has been equal or higher than the average regular wage of the stock of the workers in 1982 - 1985. The starting wage is important from the point of becoming employed. In the recent discussion on economic policy the starting wage has been argued to have on important role in reducing unemployment. In order to increase the probability of becoming employed the stating wage should be low. In 1986 - 1989 the starting wages were lower than the average wage level. On the other hand, a low starting wage may, however, be a reason for an increasing wage profile. A low wage drifts within a few years towards the average wage level. A low starting wage is according to the figures correlated also to the faster turnover of labour.

Figure 11 illustrates the wage profiles for the workers who find and who do not find new jobs in industry when they exit a firm. The wage profiles have been calculated for 1, 2, 3 and 7 years. There are 76, 35, 48 and 70 observations for the workers who find new jobs and 91, 17, 10 and 8 observations for the rest of the workers, respectively. According to the figures the wage profiles are increasing for the short spells of employment in both of the destinations. It turns out also that the relative wage level is clearly lower for the short-term employed persons who leave industry than for the persons who find new industrial jobs.

3.6. Wage Level of the Subsequent Job

The wage level of the subsequent job is interesting from the point of on-the-job search. Better earnings opportunities in other firms may attract the workers to initiate a job search. There may, however, be other reasons for the termination of an employment than a search. Therefore the means of the wages in the subsequent jobs cannot necessarily be used in order to give strong support to the wage gains implied by the search theory.

Table 5 illustrates the descriptive statistics of the levels of the termination and starting wages. The average wage levels have been calculated for the last quarter of an old job and for the first quarter of a new job. According to the data the persons who find new industrial jobs get on average only one per cent higher total wages during the next quarter in a new job. As the average growth rate of the wages from quarter to quarter during 1990 was two per cent, it can be concluded that on average the persons do not benefit from changing their jobs. These average figures of the data do not support the theory of search for a better paid job.

Table 5. **Descriptive statistics of the termination and starting wages of the workers who find and who do not find new jobs within industry**

Variable	Obs.	Mean	Std.Dev.	Minimum	Maximum
Termination wage of the whole sample:					
Regular hourly wage	2899	45.63	9.30	23.00	104.88
Total hourly wage	2899	48.79	11.38	23.50	107.70
The workers who find new jobs:					
Termination wage					
Regular hourly wage	1707	47.36	9.07	23.50	104.88
Total hourly wage	1707	50.91	11.18	23.50	104.88
Starting wage					
Regular hourly wage	1707	47.74	8.40	23.62	99.63
Total hourly wage	1707	51.42	11.15	23.62	118.03
Termination wage of the workers who do not find new jobs:					
Regular hourly wage	1192	43.17	9.08	23.00	100.75
Total hourly wage	1192	45.75	10.99	23.50	107.70

The regular wage is based on ordinary working hours. The total wage includes the incrementals based on overtime and Sunday work.

The persons who find new industrial jobs usually have higher wages in their previous jobs than the workers who leave industry. This can be seen as evidence for the discouragement of the workers. If the persons realize that they cannot obtain better paid jobs within industry, they leave the industrial firms. The opportunity cost of choosing unemployment is lower for a person who has a low wage. Therefore these figures can be seen in that respect as evidence for a search theory.

According to a Swedish study a majority of job leavers report that they have received higher pay on the new job (Björklund and Holmlund, 1989). The excess wage growth for job leavers is 7-8 per cent. On the other hand, a minority of job losers reported that they have received higher pay. Unfortunately there is no information on the voluntary leavers and job losers in our data.

Topel and Ward (1992) studied the job mobility and the careers of young men using longitudinal data from the United States. It turned out that during the first ten years in the labour market a typical worker will hold about two thirds of his jobs in his total career. The wage gains at job changes account for at least a third of early-career wage growth. Job changing is a critical component of workers' movement toward the stable employment relations of mature careers. Also Farber (1994) found that mobility is strongly positively related to the frequency of job change prior to the start of a job. Mobility is more strongly related to a job change in the most recent year prior to the start of the current job than any previous job changes.

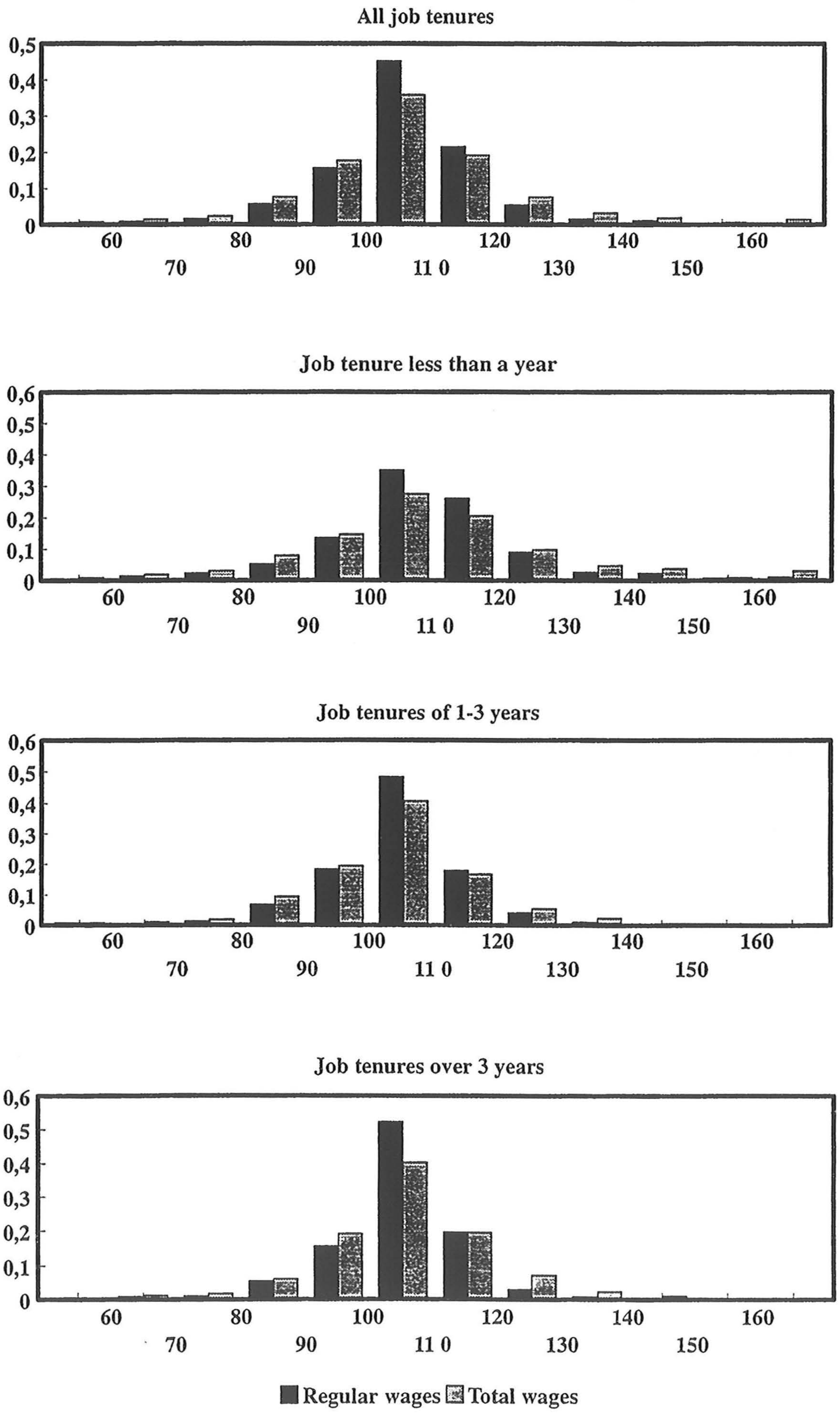
Figure 12 illustrates the distribution of the changes of relative wages by the job tenure for the persons who change their jobs within industry. The change of wages has been calculated separately for the regular wage and total wage. It can be seen that the distributions of the changes of these two wages are slightly different from each other. The regular wage of the workers usually changes less than the total wage. The wage incrementals based on the overtime and Sunday work are the reasons for the difference between the regular and total wage. The regular wage in the new job is typically close to the regular wage in the previous job or slightly higher.

It can be concluded from the changes of regular wages that the wage level of most workers does not change very much when the workers change their jobs. The regular wage remains within the band of 5 per cent in 45 per cent of the cases. The change of the wage is less than 15 per cent in 85 per cent of the cases.

The workers have got in a new job clearly higher wages than in the previous job if their previous job tenure has been short. If the job tenure has been less than one year, the regular wage remains within the band of 5 per cent in 42 per cent of the cases and changes less than 15 per cent in 75 per cent of the cases.

If the job tenure has been 1-3 years the change of regular wages is clearly less than in the short job tenures. The wage remains within the band of 5 per cent in 48 per cent of the cases and changes less than 15 per cent in 85 per cent of the cases.

Figure 12. **Distributions of the changes of relative wages by job tenure for the persons who change their jobs within industry**



If the job tenure has been longer than 3 years the change of jobs rather seldom imposes a large change of the wage. The regular wage remains within a band of 5 per cent in 52 per cent of the cases and changes less than 15 per cent in 87 per cent of the cases. There is a similar amount of observations in the lower and upper tails of the distribution of the changes of relative wages.

Table 6 depicts the characteristics of the workers that have changed their jobs within industry. The information has been classified by the change of regular wage in three groups according to whether the wages have decreased, remained unchanged or increased. The changes that remain within the band of 10 per cent have been classified as unchanged wages in the table. About 13 per cent of the workers have lower wages in the new job. There have not been any remarkable wage changes in 68 per cent of the cases. Only 18 per cent of the workers have succeeded to obtain better paid jobs.

It is interesting to know the characteristics of the workers whose income decreases when they change their jobs within industry. The wage level decreases quite often for the persons who have long job tenures. The wages of men decrease more often than the wages of women. The wages decrease quite often if the workers change their jobs during the third and fourth quarter of the year. The workers in the highest wage group in the metal industry (wage group 1) often incur wage decreases. The workers that have wage decreases usually have a rather high wage in their previous jobs.

What are the characteristics of workers whose income increases when they change their jobs within industry? These workers have been working a relatively short time in their jobs. They are younger than others. They have been working in rural areas, villages or small towns (low cost area). They have been working more seldom than others in an incentive work based on quantity. The wages increase often if the workers change their jobs during the third quarter of the year. During the fourth quarter the wages remain quite often unchanged. The workers who have been working in the lowest wage group in the metal and forest industries have gained from the change of jobs.

Table 7 presents the characteristics of the workers who change their jobs within industry. This time the workers have been classified using the

Table 6. **Characteristics of workers who change their jobs within industry by the change of the regular wage**

Variable		Income in the new job / Income in the previous job	
	< 0.9	0.9-1.1	1.1 <
Job tenure, years	3.52	4.33	2.68
Sex, 1=male	0.87	0.81	0.80
Share of men	0.83	0.82	0.79
Age, years	33.73	35.31	28.42
Average age of men in a firm	37.82	37.52	36.86
Average age in a firm	38.52	38.25	37.89
High cost area, 1=yes	0.42	0.35	0.29
County of Uusimaa, 1=yes	0.10	0.15	0.14
Share of incentive hours[1]	0.33	0.25	0.14
Share of incentive hours[2]	0.23	0.27	0.31
Share of overtime hours, %	3.79	3.57	3.95
Share of Sunday hours, %	4.10	4.55	5.66
Quarter, 1=yes: 1	0.19	0.19	0.23
2	0.13	0.11	0.14
3	0.24	0.14	0.42
4	0.44	0.55	0.31
Wage group, metal, 1=yes: 1	0.30	0.21	0.10
2	0.27	0.29	0.23
(low) 3	0.09	0.08	0.12
Wage group, forest, 1=yes: 1	0.09	0.06	0.16
2	0.07	0.09	0.13
3	0.08	0.11	0.15
4	0.06	0.09	0.07
(high) 5	0.05	0.08	0.04
Relative regular wage in industry	1.15	1.09	0.98
Relative total wage in industry	1.17	1.12	1.00
Relative regular wage in a plant	1.06	0.96	0.90
Relative total wage in a plant	1.05	0.97	0.89
The number of observations	222	1170	315

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).

Table 7. Characteristics of workers who change their jobs within industry by the change of the total wage

Variable		Income in the new job / Income in the previous job	
	< 0.9	0.9-1.1	1.1 <
Job tenure, years	3.47	4.24	3.48
Sex, 1=male	0.86	0.80	0.82
Share of men	0.83	0.81	0.80
Age, years	34.36	35.02	30.54
Average age of men in a firm	37.84	37.44	37.15
Average age in a firm	38.46	38.17	38.15
High cost area, 1=yes	0.38	0.37	0.28
County of Uusimaa, 1=yes	0.14	0.14	0.14
Share of incentive hours[1]	0.33	0.24	0.16
Share of incentive hours[2]	0.22	0.27	0.31
Share of overtime hours, %	4.25	3.50	3.65
Share of Sunday hours, %	4.17	4.38	5.88
Quarter, 1=yes: 1	0.20	0.19	0.22
2	0.13	0.11	0.12
3	0.21	0.15	0.33
4	0.45	0.55	0.32
Wage group, metal, 1=yes: 1	0.27	0.22	0.11
2	0.29	0.29	0.22
(low) 3	0.07	0.09	0.10
Wage group, forest, 1=yes: 1	0.08	0.06	0.14
2	0.07	0.10	0.11
3	0.10	0.10	0.15
4	0.06	0.08	0.09
(high) 5	0.07	0.06	0.09
Relative regular wage in industry	1.14	1.09	1.01
Relative total wage in industry	1.18	1.10	1.03
Relative regular wage in a plant	1.03	0.96	0.92
Relative total wage in a plant	1.07	0.96	0.89
The number of observations	306	992	409

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).

total wage instead of the regular wage. The total income has decreased more than 10 per cent in 18 per cent of the cases. The total wages have not had any remarkable changes in 58 per cent of the cases. About 24 per cent of the workers have got a clearly better paid job, where the wage level is at least 10 per cent higher than in their previous job. The changes of total wages are higher than the changes of regular wages. The figures of Table 7 are rather similar to the figures in Table 6.

4. Econometric Models of Job Tenure

4.1. Wages and Employment Decisions

This section studies the effect of wages and the employment decisions. Topel (1986) studied the process of employment and wage dynamics using the data from the United States (Current Population Surveys, 1977-79). He found that wage differences taking the costs of migration into account had an important role in migration to markets offering the greatest present value of future earnings. Wages were found to be sensitive to interarea differences in market conditions. A positive shock to labour demand increases wages. The wages are flexible to transitory changes in local labour market conditions.

The study by Topel (1986) indicates that there is potential endogenity of the wage in the tenure regressions. This is, at least in part, an empirical matter which is not necessarily supported by the Finnish system. Migration is relatively small in Finland compared to the United States. Also the Finnish labour market is strongly regulated by the labour market agreements. Labour unions are powerful, because nearly 95 per cent of the workers are members of labour unions.

There are great interarea differences in unemployment rete, but the wage differentials between the areas are small controlled by other factors (Kettunen, 1993c). On the other hand, the generous unemployment insurance decrease the regional mobility of unemployed workers (Kettunen, 1993b). In the county of Uusimaa the wage level is higher than in the other parts of the country. This is partly due to the collective labour market agreements that stipulate higher wages for that area. The cost push is the argument that is written in the wage contracts.

In this study it was pointed out that the wage profiles of the workers are constant or slightly increasing. The later sections of this study show that increasing the wage group is not an economically reasonable way to decrease the costs of labour turnover, because the cost of raising wage has generally larger effects than the reduced costs of labour turnover. These arguments support the reasoning that the wages are to a great measure determined by the exogenous factors.

Topel (1993) points out that long-term changes in jobless time are demand driven, because groups with falling wages are also those with rising joblessness. Juhn, Murphy and Topel (1991) asked whether these changes are consistent with a simple market-clearing model of stable labour supply and shifting labour demands across skill groups. They concluded that a market-clearing model is consistent with the facts, at least for long-run changes. In our study the endogenity of wages is less apparent, because most spells of employment are short in the data.

Job changing is a result of a process where workers are sorted into more durable and productive jobs. High-wage jobs tend to survive, which implies higher wages for persons with long job tenures. Another explanation is that more productive workers change jobs less often. In either case the wage does not need to rise as tenure accumulates (see Topel, 1991). There are also other empirical studies that have concluded that the returns to job-specific experience are minor (Abraham and Farber, 1987). Also the wage profiles of our empirical research supports partly this view.

On the other hand, Topel (1991) provides strong evidence that wages rise with job seniority. Persons with longer job tenures typically earn higher wages. He found that 10 years of current job seniority raise the wage of the typical male worker in the United States by over 25 per cent. Senior workers would suffer this amount if their jobs were to end exogenously. This has been interpreted as evidence for many theories of compensation and productivity. For example, Becker's (1964) model predicts that investment in human capital is the reason to rising wages.

The wage is the decision variable of the firm in an economic model, whereas the job termination is based on the decision of the worker. Therefore the wage is usually used as an explanatory variable in the models of job tenure. According to the results by Burdett, Kiefer and Sharma (1985) the wage does not significantly improve the fit in their translation model from employment to unemployment. In the study by Lindeboom and Theeuwes (1990a,b) no wage effects on job tenure were found. They included also an indicator for the insufficient wage. It took a positive coefficient with respect to the probability of the job termination. A rather general result in the empirical studies of job tenure is that high-wage workers are less likely to terminate their employment spells. This kind of results are found by Kiefer (1988b), Brown (1992) and Belzil (1993).

4.2. Competing Risk Models

The econometric approach of this study is to estimate models of job tenure. The models are used to identify the personal, job and labour-market characteristics that are related to the probabilities of finding another industrial job or leaving industry. The fact that there are alternative channels out from a firm is explicitly accounted for. A two-alternative competing risk model with censoring is an obvious candidate for analysing the problem.

In a competing risk framework the destinations are assumed to be mutually exclusive and to exhaust the possible destinations. Let d_j be an indicator taking the value 1 if state j is entered and 0 otherwise. For a random variable T representing the waiting time until a particular event takes place the hazard function of a destination j can be written as follows

$$(11) \quad h_j(t) = \lim_{dt \to 0} \Pr(t \leq T \leq t+dt,\ d_j = 1 | T > t)/dt.$$

$$= f_j(t)/S(t),$$

where $f_j(t)$ and $S(t)$ are the density and survivor functions. The transition intensities $h_j(t)$, $j = 1,\dots,J$, represent instantaneous rates for the worker leaving the firm and enter state j during a small interval (t, dt) given that the person is still working in the firm. In a small interval the probability of the departure to state j is often slightly incorrectly expressed by $h_j(t)dt$. The hazard function $h_j(t)$ or $h_j(t)dt$ are not real probabilities, because $h_j(t)$ is actually a ratio of two probabilities. That does not imply that $h_j(t)$ is a probability, because it is not necessarily true that $h_j \in (0, 1)$.

The cause-specific hazard functions related to the distinct destinations define the total hazard functions for job tenure as follows

$$(12) \quad h(t) = \sum_{j=1}^{J} h_j(t).$$

The total hazard function is of relevance towards writing the integrated hazard

$$(13)\quad I(t) = \int_0^t h(\tau)d\tau$$

$$= \int_0^t \sum_{j=1}^{J} h_j(\tau)d\tau$$

$$= \sum_{j=1}^{J} I_j(t).$$

The survivor function can then be written as follows

$$(14)\quad S(t) = e^{-I(t)} .$$

S(t) is the probability that the person is still working in a firm. Then the probability of exiting to destination j, the density function, can be written as follows

$$(15)\quad f_j(t) = h_j(t)S(t).$$

A complete or censored duration of employment is observed in the data. Let c be a censoring indicator. If $c = 1$, then a complete spell of employment is observed, otherwise $c = 0$.

The contribution of an individual to the likelihood function for a complete spell can be expressed using the density function $f_j(t)$. In the case of censoring the contribution comes via the probability that the duration was at least t units of time. The probability is expressed using the survivor function. The likelihood function can then be written as follows

$$(16)\quad L(\theta) = \prod_{n=1}^{N} \prod_{j=1}^{J} h_j(t)^{cd_j} S(t),$$

where N is the size of the sample. The subscript n denoting the individual has been left out in terms $h_j(t)$, c, $d_j(t)$ and S(t) to simplify the notation.

In order to solve the maximum likelihood estimates of the unknown parameters the sum of individual log-likelihood components is maximized with respect to the parameters. The log-likelihood contribution of an individual n for a failure type j can be written as follows

$$(17)\quad \log L_n(\theta) = cd_j \log h_j(t) - I(t)$$

$$= cd_j \log h_j(t) - I_j(t) - \sum_{k \neq j}^{J} I_k(t).$$

The examination of equation (17) leads to a substantial advantage in estimating the model. It turns out that the log-likelihood contribution can be partitioned into separate terms of cause specific terms (see also Kalbfleich and Prentice, 1980, 168-171 and Lancaster, 1990, 164). Therefore the parameters of a particular cause specific hazard can be estimated separately by treating each time the durations terminated by other reasons as censored.

So far the log-likelihood function (17) of job tenure has been written in a general form. The distribution of job tenure needs usually to be parametrized in order to estimate the model. The correct distribution is not, however, known. Therefore the next section of the study is concerned with the estimation of the discrete mixing distribution.

4.3. Discrete Mixing Distribution

In this section the econometric model of job tenure is studied. Special attention is paid to the effects of unobserved heterogeneity across workers. The mass point approach to the incorporation of the effects of unobserved explanatory variables is applied. A standard way of incorporating unobserved heterogeneity is to assume some parametric distribution for it. The estimates of the structural parameters may, however, be sensitive to the selected parametric form of the distribution.

The procedure of discrete mixing distribution has been derived in order to minimize the impact of distributional assumptions in the econometric models of duration data. Since the earlier work by Kiefer and Wolfowitz (1956) the properties of the mixing distribution have been studied by Simar (1976), Laird (1978), Lindsay (1983a,b) and Heckman and Singer (1984a,b). Furthermore, there exists a wide set of applications. Davies and Crouchley (1984), Dunn, Reader and Wrigley (1987), Davies (1987) and Card and Sullivan (1988) have applications in the context of discrete choice models. Brännäs (1986a,b), Trussell and Richards (1987) and Ham and Rea (1987) have applied the method in the context of duration models.

The Weibull distribution has been widely used in the applications of job tenure (see Ondrich, 1985, Lindeboom and Theeuwes, 1990a,b and Lilja, 1990). Assuming a parametric Weibull distribution the mixing likelihood contribution for a destination j can be written as follows

$$(18) \quad f_Q = \sum_{i=1}^{m} p_i h_i(t)^c e^{-I_i(t)} \ ,$$

where $h_i(t) = \alpha t^{\alpha-1} e^{u_i + x\beta}$ and $I_i(t) = t^{\alpha} e^{u_i + x\beta}$ are the hazard functions and integrated hazards for the different unobserved groups, i = 1,...,m, where m is the number of points of support of the discrete mixing distribution Q. The subscript j has been left out to simplify the notation. The indicator c = 1 if a complete spell and a destination j is observed, otherwise c = 0.

The constant of the basic Weibull model is split into the location parameters u_i and each location parameter is given a probability p_i. Hence, the discrete mixing distribution is consistently estimated with the structural parameters. For the probabilities p_i it is required that $p_i \in (0, 1)$ and that $\Sigma\, p_i = 1$. These requirements are satisfied using a multinominal logit type of formula

$$(19) \quad p_i = \frac{e^{g_i}}{1 + \sum_{k=1}^{m-1} e^{g_k}} \ , \quad i = 1,...,m-1,$$

where g_k, k = 1,...,m-1, are the parameters to be estimated. The logit formula implies that $p_m = 1 - p_1 - p_2 - ... - p_{m-1}$. The parameters g_k do not have an interesting economic interpretation. They work only as a device in order to obtain the probabilities p_i.

The standard errors of the probabilities p_i are approximated by the well-known delta method. The first order Taylor series expansion gives

$$(20) \quad p_i(\hat{g}) = p_i(g) + (\hat{g} - g)' \frac{\partial p_i}{\partial g},$$

where $g = (g_1 \ldots g_{m-1})$. The variance can then be approximated by

$$(21) \quad \mathrm{Var}[p_i(\hat{g})] = \frac{\partial \hat{p}_i{}'}{\partial \hat{g}} \mathrm{Var}(\hat{g}) \frac{\partial \hat{p}_i}{\partial \hat{g}} \ .$$

The procedure for estimating a discrete mixing distribution is to increase the number of mass points until the influence of unobserved variables disappears. The stopping rule is found by Lindsay (1983a). Following Lindsay (1983a) and Heckman and Singer (1984a) it can be seen that the log-likelihood function $L(\theta)$ is differentiable. The Gateaux derivative of the functional L is taken at L_{Q_i} with i mass points towards $L_{Q_{i+1}}$, which can be written as follows

$$(22) \quad D(u;Q) = \lim_{p \to 0} \{L[(1-p)f_{Q_i} + pf_{Q_{i+1}}] - L(f_{Q_i})\}/p$$

$$= \sum_{n=1}^{N} [(f_{Q_{i+1}} - f_{Q_i})/f_{Q_i}]$$

$$= \sum_{n=1}^{N} f_{Q_{i+1}} / f_{Q_i} - N \ .$$

The number of points of support is increased until $D(u;Q) \leq 0$. Then the procedure is stopped and the semi-parametric maximum likelihood estimator is obtained (see also Brännäs and Rosenqvist, 1988). A simple first order check for a global maximum is to verify that the second derivative $D''(u^*; Q) \leq 0$ at the support points of measure Q. The maximum likelihood algorithms can be used to estimate the unknown parameters when the number of mass points are fixed. In our case the Berndt, Hall, Hall and Hausman (1974) algorithm is used to estimate the unknown parameters.

According to the descriptive statistics the characteristics of the two destinations are in many respects different. It is not, however, possible to draw strong conclusions from these simple statistics. Also the explanatory variables may have different effects on the probability of exiting the firm. In order to evaluate the independent effects of explanatory variables, a variety of factors must be controlled for in the two different destinations.

Table 8 presents the results of the estimations. The estimation has been done in a competing risk framework separately to both of the destinations following the mass point approach of incorporating unobserved heterogeneity to the model. The number of observations is 2899 and the explanatory variables are the same in both of the groups. The data of the models differ only with respect to the indicators of the destinations.

Two points of support of the discrete mixing distribution are enough to rectify the effect of unobserved heterogeneity in the model for the persons who find new jobs. Unobserved heterogeneity split the observations into two groups having 32 and 68 per cent of the observations. It is not, however, possible to identify these observations from the data set. Correspondingly, in the model of the persons who do not find new jobs three points of support are needed. They take the probabilities of 37, 30 and 33 per cent. Accordingly this group consists of more heterogenous workers.

According to the results the sex of the workers or the share of men in a firm do not have statistically significant effects on the probability of leaving a firm. Similar results were obtained in both of the destinations.

The age of the workers has a negative effect on both of the destinations. Older persons have longer spells of employment. The effect of age was studied also using the age squared and indicators for the age groups. These estimations show, however, a linear increasing effect of age. Therefore the age was included as a continuous explanatory variable.

The average age of the workers in a plant takes a negative coefficient. It indicates that the turnover of the labour force is small in the firms where the average age is high. It is, however, surprising that the average age of men has a positive effect for the workers who find new industrial jobs.

The high cost area is positively related to the exit rate for the persons who find new jobs. The high cost area is situated mainly in the southern part of the country. The islands and Lapland are also high cost areas, but there are rather few industrial jobs available. In the southern part of the country there are plenty of jobs available. That can be a reason for shorter job tenures. In the county of Uusimaa the labour turnover is high for the persons who leave industry. There are usually plenty of vacancies in Uusimaa. Most of them are not in the metal and forest industry.

The incentive hours based on quality and quantity are negatively related to the exit rate for the persons who find new industrial jobs. The incentive work is better paid, but it is more effective. Another study shows that the incentive work is given to the skilled persons (Kettunen, 1994a). Therefore one reason for the negative signs of the coefficients of incentive work is that experience and a rather long job tenure is required until the person is accepted into incentive work schemes.

The share of overtime hours is positively related to the exit rate. A laborious job may exhaust the workers and therefore increase the exit rate. The share of Sunday hours is negatively related to the exit rate for the persons who do not find new jobs.

The quarterly indicators are included in the model in order to take the non-stationarity of the economic environment into account. The job-to-job transitions are frequent during the third quarter. The exit rate from industry is high during the second and third quarter. One reason is that there are short job tenures during the summer when the ordinary staff has their summer holiday. For example, students often fill short summer-time or holiday vacancies. During the last quarter the turnover of labour is low. These findings are in line with the re-employment probabilities of unemployed workers (Kettunen, 1993b).

The wage group has been defined in the labour market agreements using the respective job requirements. In the metal industry the lowest wage group is denoted by the number three and in the forest industry it is denoted by the number one. The reference group in the models is the wage group number three of the metal industry. It turns out that the wage groups with high requirements are negatively related to the exit rate. A wage group of a worker has been considered as an organizational position (see Lilja, 1995). The wage groups do not determine the wage level alone, because there are many other important factors. In practice the wage groups indicate only the minimum wage of the workers. The coefficients of the indicators are similar in both of the destinations. These findings support the argument that highly skilled labour cannot be replaced easily and therefore they are better paid. The promotion of a worker spurs workers to remain in their jobs.

In order to reduce the unnecessary turnover of labour the specification of the criteria of promotion turns out to be important. The possibility to make a career seems to be a significant factor in reducing labour turnover. On the other hand, the unspecified and unfair criteria may cause dissatisfaction and unnecessary labour turnover. This is an important piece of information for the management of the companies.

The relative wage represents the average relative wage of the worker during the whole spell of employment. The relative wage of the worker is calculated in relation to the average wage of industrial workers. The relative wage is negatively related to the exit rate for the persons who do not find new jobs within industry. This is a result which was expected by the economic theory. A low wage increases incentives to seek another job or go back to school.

It is little bit surprising that the relative wage is positively related to the exit rate for the persons who leave the firm in order to get another industrial job. These persons have on average higher wages than the persons who leave industry. Those moving from one job to the next within industry have on average one per cent higher starting wage in the new jobs than their wage was during the last quarter of their previous job. If these persons are highly qualified, the employer tries to keep some of these persons by offering an increasing wage profile and paying more than to others. Then we will find a positive relationship between the wage and the exit rate. This finding needs, however, a more rigorous analysis, which is done in the next section of this study.

Also the models using the deflated average wage levels during the whole spell of employment were estimated. The models with the wage levels gave, however, similar kinds of results as the relative wages. The relative wages were used, because they led to higher values of the log-likelihood functions. Therefore the results based on the wage levels have been omitted to save space.

Table 8. Results of estimations of the models of job tenure

(A) The persons who find new jobs in industry
(B) The persons who do not find new jobs in industry

		(A)	(B)
Shape parameter		1.505	1.330
		(0.065)	(0.075)
Sex, 1=male		-0.099	0.009
		(0.103)	(0.134)
Share of men		-0.059	0.456
		(0.355)	(0.461)
Age, 10 years		-1.015	-0.613
		(0.051)	(0.046)
Average age of men, 10 years		1.221	0.381
		(0.379)	(0.481)
Average age of workers, 10 years		-2.180	-0.871
		(0.433)	(0.542)
High cost area, 1=yes		0.194	-0.188
		(0.085)	(0.116)
County of Uusimaa, 1=yes		0.037	0.541
		(0.095)	(0.130)
Share of incentive hours[1]		0.010	-0.248
		(0.161)	(0.224)
Share of incentive hours[2]		-0.319	-0.087
		(0.127)	(0.159)
Share of overtime hours		8.498	9.497
		(1.367)	(1.958)
Share of Sunday hours		-0.666	-4.183
		(1.162)	(1.647)
Quarter 2, 1=yes		-0.216	0.388
		(0.115)	(0.138)
Quarter 3, 1=yes		0.101	0.881
		(0.096)	(0.131)
Quarter 4, 1=yes		-0.046	-1.101
		(0.096)	(0.138)
Wage group, metal, 1=yes:	1	-0.538	-0.535
		(0.140)	(0.194)
	2	-0.255	-0.537
		(0.122)	(0.167)
(reference group, low)	3		
Wage group, forest, 1=yes:	1	0.020	0.010
		(0.182)	(0.225)
	2	-0.232	-0.160
		(0.158)	(0.209)
	3	-0.728	-0.362
		(0.159)	(0.207)
	4	-1.265	-1.494
		(0.196)	(0.259)
(high)	5	-1.634	-1.640
		(0.219)	(0.281)
Relative wage in industry		1.505	-1.492
		(0.065)	(0.217)

p_1	0.315	0.375
	(0.040)	(0.078)
p_2	0.685	0.296
	(0.040)	(0.133)
p_3		0.329
		(0.211)
Log likelihood	-3474.7	-2504.0

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).

The data include also information on the average wage of the plant in 1990. Unfortunately the data do not include the average wage of the plant over the whole period of study. The plant data can be used in order to calculate the relative wages of the workers within the plant. The average wage of the plant can be remarkably different from the average wage of industry. These differences can be reasons for workers to search for better jobs.

Table 9 presents the results based on the relative wages within the plants. The other structural parameters are only slightly different from the previous estimates in Table 8. Therefore we pay no specific attention to them. Also the log-likelihood functions are quite near the previous values. The number of mass-points are the same as in the previous models.

It turns out that the relative wage of the worker is negatively related to the exit rate in both of the destinations. According to the evidence the relative wage within a plant has a statistically significant effect on the exit rate. The relative wage within the plant is more important than the relative wage within industry. Also the descriptive statistics are in accordance with these estimates, because the relative wages on the plant level are lower than the relative wages on industrial level.

The negative effect of the wage is also in these models larger for the persons who leave industry. The effect of the wages for those moving from one job to the next in industry is negative, statistically significant but rather small compared to the other destination. The small value of the coefficient can to some extent reflect the positive effect caused by the employer who tries to keep these workers in a firm by offering an increasing wage profile.

Table 9. Results of estimations of the models of job tenure using the relative wage within a plant

(A) The persons who find new jobs in industry
(B) The persons who do not find new jobs in industry

		(A)	(B)
Shape parameter		1.459	1.321
		(0.061)	(0.077)
Sex, 1=male		-0.073	0.056
		(0.103)	(0.133)
Share of men		-0.030	-0.062
		(0.352)	(0.452)
Age, 10 years		-0.935	-0.635
		(0.047)	(0.047)
Average age of men, 10 years		1.233	0.387
		(0.366)	(0.476)
Average age of workers, 10 years		-2.090	-1.006
		(0.418)	(0.536)
High cost area, 1=yes		0.235	-0.235
		(0.083)	(0.115)
County of Uusimaa, 1=yes		0.062	0.547
		(0.097)	(0.132)
Share of incentive hours[1]		0.262	-0.452
		(0.162)	(0.220)
Share of incentive hours[2]		-0.175	-0.265
		(0.127)	(0.156)
Share of overtime hours		8.984	8.790
		(1.435)	(1.969)
Share of Sunday hours		-0.605	-6.353
		(1.159)	(1.597)
Quarter 2, 1=yes		-0.276	0.336
		(0.116)	(0.138)
Quarter 3, 1=yes		0.121	0.770
		(0.087)	(0.130)
Quarter 4, 1=yes		-0.068	-1.280
		(0.098)	(0.145)
Wage group, metal, 1=yes:	1	-0.306	-0.551
		(0.138)	(0.190)
	2	-0.126	-0.381
		(0.121)	(0.164)
(reference group, low)	3		
Wage group, forest, 1=yes:	1	0.020	0.069
		(0.177)	(0.220)
	2	-0.137	-0.117
		(0.157)	(0.202)
	3	-0.658	-0.311
		(0.162)	(0.204)
	4	-1.170	-1.403
		(0.191)	(0.257)
(high)	5	-1.475	-1.566
		(0.214)	(0.276)

Relative wage within a plant	-0.370 (0.195)	-1.836 (0.247)
p_1	0.419 (0.041)	0.332 (0.070)
p_2	0.581 (0.041)	0.362 (0.151)
p_3		0.306 (0.223)
Log likelihood	-3489.0	-2500.4

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).

4.4. Effects of Explanatory Variables on the Job Tenure

The previous econometric models are interesting, because they indicate the statistically significant effects of explanatory variables on the job tenure. It can be argued that the study is insufficient, because it does not tell very much about the economic importance of the effects. The size of the effects is studied in this section by simulating the estimated microeconomic models. The effect of an explanatory variable can be statistically significant even though the effect is small and therefore economically unimportant. The economic importance of the explanatory variables is illustrated by way of an example for a fictive and an average person in industry.

For the illustration the expected value of a job duration has to be derived. The survivor function is obtained from the mixing likelihood contribution by setting c = 0. It can be written as follows

$$(23) \qquad S(t) = \sum_{i=1}^{m} p_i e^{-I_i(t)} .$$

Thus the expected value of the job tenure can be written as follows

$$(24) \qquad E(T) = \int_0^\infty \sum_{i=1}^{m} p_i e^{-t^\alpha e^{u_i + x\beta}} dt$$

$$= \sum_{i=1}^{m} p_i e^{-(u_i + x\beta)/\alpha} \, \Gamma(1/\alpha)/\alpha ,$$

where Γ is the gamma function and the integration is done by a change of variables letting $I_i = t^{\alpha}e^{u_i + x\beta}$.

Let the fictive person be a 30-year-old woman. During the first quarter of 1990 she left a plant where the share of men is 50 per cent, the average age is 30 years for the men and women, the share of incentive work is 0.2 and the shares of overtime and Sunday work are 0.02. She is working in the metal industry and the required level of skill in her job was the lowest level (number 3). Her wage was on an average level in a plant. The plant is situated not in the county of Uusimaa and the location is classified not to be in the high cost area.

Table 10 presents the effects of the changes of the explanatory variables on the job tenure. It can be seen that there is a prominent increase in job tenure when the wage group (the required level of skill) increases. The wage groups do not leave very much explanatory power for the relative wage. Also the elderly persons have long durations of employment. Long durations are found from the plants where the average age of workers is high. The persons who leave industry during the last quarter have had long periods of employment.

Table 11 present the effects of explanatory variables on the job tenure for an average person in a sample. This table represents better than the previous table the magnitude of the effects. The characteristics of the workers are fixed at the average values. Thereafter the effect of each explanatory variable on the job tenure is studied by giving it different values as shown in Table 11.

Ten additional years of age increase the job tenure by 3.7 years among the persons who leave industry and 4.6 years among the persons who find new industrial jobs. If the average age of workers increases by ten years, the increase of job tenure is about five years. The average age of men has a negative effect. Therefore if the average age of women increases in a plant, the expected job tenure is long. In the county of Uusimaa the exit from the industry occurs three years earlier than in the other parts of the country. In Uusimaa there are usually plenty of vacancies available.

The incentive work increases the job tenure by 2-4 years among the persons who leave industry compared to the workers on the time-based wage. The incentive wage is usually higher than the time-based wage. This is in accordance with the wage effect, since a high wage usually increases the job tenure.

The share of overtime work decreases the job tenure in both of the destinations. The effect can easily be many years. Overtime work may cause problems in children's day care. Young children decrease the willingness to participate in overtime work. The Sunday work can easily increase the job tenure by many years among the persons who leave industry. In Finland the wage incrementals based on Sunday work are substantial. That is in accordance with the wage effect.

The seasonal variation is notable among the persons who leave industrial jobs. There are plenty of short employment spells which terminate during the second and third quarter of the year. The job tenures that terminate during the second quarter are 2.1 years shorter than the job tenures that terminate during the first quarter. Correspondingly, in the third quarter the job tenures are 4.1 years shorter whereas in the forth quarter the job tenures are extremely long.

Each higher level of wage group increases the job tenure. In the metal industry the increase from the lowest level to the middle level increases the job tenure 2.1 years and the increase from the lowest level to the highest level increases the job tenure 3.3 years among the persons who leave industry.

In the forest industry each higher level of wage group increases the job tenure so that in the highest wage group the job tenure is 7.1 years longer than in the lowest wage group among the workers who change their jobs in industry. The corresponding effect is 11.6 years among the persons who leave industrial jobs.

The relative wage in the plant has a notable effect only among the workers who leave industry. The effects of wages on the job tenure are not linear. For example, a decrease of wages by 20 per cent will decrease the expected value of job tenure by 2.1 years. The increase of wages by 20 per cent increase the job tenure by 2.7 years.

Table 10. Effects of explanatory variables on the expected duration of employment for a person

Change of the explanatory variable (A) The persons who find new jobs (B) The persons who do not find new jobs	Change of the expected duration of employment (A)	 (B)
Gender: female → male	-0.1	-0.2
Share of men: 0.5 → 1.0	-0.0	0.1
Age: 30 → 40 years	2.0*	2.8*
Average age of men: 30 → 40 years	-1.2*	-1.1
Average age: 30 → 40 years	6.9*	5.2
High cost area: no → yes	-0.3*	0.9*
County of Uusimaa: no → yes	-0.1	-1.5*
Share of incentive hours[1]: 0.2 → 0.8	-0.2*	1.0*
Share of incentive hours[2]: 0.2 → 0.8	0.2*	0.6
Share of overtime hours: 0.02 → 0.10	-0.8*	-1.9*
Share of Sunday hours: 0.02 → 0.10	-0.1	2.1*
Quarter: 1 → 2	0.5*	-1.0*
Quarter: 1 → 3	-0.2	-2.0*
Quarter: 1 → 4	0.1	7.4*
Wage group 3 (metal) → 2 (metal)	0.2*	2.3*
Wage group 3 (metal) → 1 (metal)	0.5	6.0*
Wage group 3 (metal) → 1 (forest)	-0.0	-0.2
Wage group 3 (metal) → 2 (forest)	0.2	0.4
Wage group 3 (metal) → 3 (forest)	1.2*	1.2
Wage group 3 (metal) → 4 (forest)	2.7*	8.6*
Wage group 3 (metal) → 5 (forest)	3.8*	10.3*
Relative wage: 1.0 → 0.8	-0.1*	-1.1*
1.0 → 1.2	0.1*	1.4*

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).
* Statistically significant coefficient on the 5 % level.

Table 11. Effects of explanatory variables on the expected duration of employment for an average person in industry

The change of the explanatory variable (A) The persons who find new jobs (B) The persons who do not find new jobs	The change of the expected duration of employment (A)	 (B)
Gender: female → male	-0.3	-0.4
Share of men: 0.5 → 1.0	-0.1	0.2
Age: 30 → 40 years	3.7*	4.6*
Average age of men: 30 → 40 years	-5.6*	-2.6
Average age: 30 → 40 years	5.1*	5.2
High cost area: no → yes	-0.8*	1.5*
County of Uusimaa: no →yes	-0.2	- 3.0*
Share of incentive hours[1]: 0.2 → 0.8	-0.5	2.4*
Share of incentive hours[2]: 0.2 → 0.8	0.4*	1.4
Share of overtime hours: 0.02 → 0.10	-2.2*	-3.8*
Share of Sunday hours: 0.02 → 0.10	-0.2	3.4*
Quarter: 1 → 2	1.1*	-2.1*
Quarter: 1 → 3	-0.4	-4.1*
Quarter: 1 → 4	0.2	15.2*
Wage group 3 (metal) → 2 (metal)	0.4*	2.1*
Wage group 3 (metal) → 1 (metal)	0.9	3.3*
Wage group 3 (metal) → 1 (forest)	-0.1	-0.3
Wage group 3 (metal) → 2 (forest)	0.4	0.6
Wage group 3 (metal) → 3 (forest)	2.3*	1.7
Wage group 3 (metal) → 4 (forest)	5.0*	9.0*
Wage group 3 (metal) → 5 (forest)	7.0*	11.3*
Relative wage: 1.0 → 0.8	-0.2*	-2.1*
1.0 → 1.2	0.2*	2.7*

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).
* Statistically significant coefficient on the 5 % level.

4.5. Effects of the Wage Groups on the Costs of Labour Turnover

In this section the costs of labour turnover are studied on an aggregate level. The costs of labour turnover can vary remarkably among the companies and workers. In the collective wage agreements the wage groups are determined by the requirements of the jobs and the requirements of the jobs are determined by the characteristics of the jobs. Therefore a company cannot usually decrease the labour turnover by increasing the wage group of all the workers.

The starting point is that the management of the company aims to decrease the costs of labour turnover by increasing the wage group. On the other hand, the higher level of wage group increases the wage of the worker as determined by the collective wage agreement. The increase of the wage group also raises the indirect labour costs, which are in these industries about 30 per cent of the total wages (Saukkonen, 1994).

A rough estimate of the costs of increasing wage groups is obtained by using the expected value of job tenure E(T). The decrease of the costs of labour turnover is approximated by $[\Delta E(T)/E(T)]c$, where $\Delta E(T)$ is the expected change in the job tenure and c indicates the yearly costs of labour turnover. According to the previous study by STK and LTK (1978) the yearly costs of labour turnover are on average 17 per cent of the total labour costs.

Table 12 presents the estimates of the effects of wage groups on the labour costs. In the metal industry the increase of the wage groups decreases the costs of labour turnover 2 per cent among the persons who change their jobs within industry, which is clearly less than the direct cost of raising the wage. Correspondingly, among the persons who leave industry the reduced costs of labour turnover was 5-10 per cent. That is also clearly less than the cost of raising the wage.

In the forest industry the increase of the wage groups decreases the costs of labour turnover 3-5 per cent among the persons who find new industrial jobs. Among the persons who leave industry the effects are larger. On the first level the decrease of the costs of labour turnover is 10 per cent and on the third level it is 24 per cent. In other wage groups the decrease of labour costs is 3-5 per cent.

It can be concluded that increasing the wage group in the metal and forest industries is not usually an economically reasonable way to decrease the labour costs, because the cost of raising the wage has generally larger effects than the reduced costs of labour turnover. The effect is slightly larger among the workers who leave industry. Only in the third wage group in the forest industry is it reasonable to increase the wage group to reduce labour costs.

Table 12. Effects of wage groups on the labour costs

(A) The direct cost of raising the wage, %
(B) The reduced cost of labour turnover for the persons who find new industrial jobs, %
(C) The reduced cost of labour turnover for the persons who leave industry, %

	(A)	(B)	(C)
Metal industry:			
3 → 2	0.17	0.02	0.10
2 → 1	0.21	0.02	0.05
Forest industry:			
1 → 2	0.08	0.05	0.10
2 → 3	0.08	0.05	0.05
3 → 4	0.08	0.05	0.24
4 → 5	0.09	0.03	0.03

4.6. Duration-Dependent Effects of Wages

In this section the relationship of wages and the job tenure is analysed over the different lengths of employment. According to the efficiency wage models the persons with long job tenure are more valuable to the firm than newcomers (see Salop, 1979, Stiglitz, 1985 and Kurjenoja, 1991). The economic importance of the wage on the decision to leave the firm can be different for the persons who have been working for a short or a long period.

Using the microeconomic data it is shown that the wage level and relative wages are important for the persons who have been working for a long time in a firm. A low wage makes the jobs in other firms more attractive. The findings of this study support the argument that the wage level is not an important reason to leave a firm for a person who has recently entered the firm. For example, for the young people it is often more important to get experience in working life than high earnings.

There are in principle many ways to specify the wages and duration dependency in an econometric model.[1] The profiles of relative wages over the job tenure are usually constant or slightly increasing. In the case of the time trend the beginning-of-spell or the end-of-spell values would under- or overestimate the relevant wage level. Therefore the duration-dependent wages are replaced with their within spell average. The variation of wages across the workers is used to estimate the duration-dependent effects.

One suspicion about the specification is that the time-trended variation of the covariates may be absorbed by the baseline hazard. In our case there is a largevariation in the wages and the systematic part of the hazard across the workers. Therefore it is possible to distinguish between the duration dependency and sample heterogeneity (see Elbers and Ridder, 1982).

A proportional hazards assumption is commonly used in the models of transition data. The hazard function $h(t) = h_0(t)h_1(x)$ factors into the product of a function of the baseline hazard $h_0(t)$ and function of the explanatory variables $h_1(x)$. It implies constant effects of explanatory variables over the duration. The method used in this study relaxes the assumption.

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1 In the models of transition data the duration-dependency can be classified into three categories: 1) The covariates vary over the duration taking different values in the predefined intervals while the coefficients are fixed over the intervals. 2) The covariates and their coefficients take different values in the intervals. 3) The covariates are fixed, but the coefficients are duration-dependent.

The probability of leaving a firm may change over the job tenure, because the effect of wages is not constant.

For simplicity it is assumed that the effects of wages remain constant within predefined intervals. Consider A intervals of job tenure $(t_0, t_1],\ldots,(t_{A-1}, t_A]$ with $t_0 = 0$ and $t_A = 11$ years. The hazard function of the Weibull model with time-dependent effects can be written for $t_{a-1} < t \leq t_a$, $a = 1,\ldots,A$, as follows

$$(25) \quad h(t) = \alpha t^{\alpha-1} e^{x\beta+w\beta_a},$$

where the parameters β capture the constant effects of explanatory variables and β_a, $a = 1,\ldots,A$, capture the duration-dependent effects. In our case x stands for an individual's vector of explanatory variables which are constant over time and w is the average relative wage within the spell of employment.

The constant effects within the intervals are assumed in order to obtain a closed-form expression for the integrated hazard. It is obtained by integrating by parts the hazard functions of the intervals. The integrated hazard in the interval a can be written as follows

$$(26) \quad I(t) = \sum_{s=1}^{a-1} [I_s(t_s)-I_s(t_{s-1})] + [I_a(t)-I_a(t_{a-1})].$$

In the Weibull case, for instance, in the third interval, $I(t) = t_1^{\alpha} e^{x\beta+w\beta_1} + (t_2^{\alpha} - t_1^{\alpha})e^{x\beta+w\beta_2} + (t^{\alpha} - t_2^{\alpha})e^{x\beta+w\beta_3}$.

Short intervals would enable detailed analysis of the time-dependent effects. Such an analysis would lead, however, to a small number of observations in the intervals and to the larger standard errors of the time-dependent parameter estimates. In order to get robust results only three intervals were used and the time points were chosen in order to obtain a large number of observations in each of the intervals. The chosen intervals are (0, 1], (1, 3] and (3, 11] years. The number of observations in these intervals are 1329, 652 and 918, respectively.

The duration-dependent effects make the log-likelihood function more complicated than in the previous section. The likelihood contribution of an individual can be written as follows

$$(27)\quad l = \prod_{a=1}^{A} \left[\prod_{i=1}^{m} p_i h_i(t)^c e^{-I_i(t)} \right]^{D_a},$$

where D_a is an indicator for the interval. If $t_a < t \leq t_{a+1}$, then $D_a = 1$, otherwise $D_a = 0$. For an individual the first product is simply a density function, which is determined by the interval.

Table 13 presents the results of estimations of the duration-dependent wage effects. The parameter estimates of the structural parameters do not differ remarkably from the models with fixed covariates presented in Table 8, where the duration-dependent effects have not been taken into account. The log-likelihood functions of the models with duration-depended effects of wages take, however, clearly higher values. Therefore the models with duration-dependent effects are preferred.

Two points of support for the discrete mixing distribution are enough to rectify the unobserved heterogeneity in both of the models. The duration-dependent effects of wages explain a certain portion of the unobserved heterogeneity, since the need to increase the number of points of support is now less than in the model with fixed covariates.

A general remark about the results of duration-dependent wage effects is that the effects of wages on the duration of employment are more important for the persons who have been working for a long time. Therefore the determination of the wage is very important for these persons if the employer wants to keep them in the firm. The change of the wage coefficient over the job duration is large for the persons who leave industry. If a person who has been working for a long time has a relatively low wage, it is more probable that he or she leaves industry than changes his job within industry.

The effects of wages on the exit rate are negative except for the workers who find new jobs within industry and have been working for some-

Table 13. Results of estimations of the models of job tenure with the duration-dependent effects of wages

(A) The persons who find new jobs
(B) The persons who do not find new jobs

	(A)	(B)
Shape parameter	2.069	1.869
	(0.092)	(0.097)
Sex, 1=male	-0.081	0.115
	(0.100)	(0.109)
Share of men	0.168	0.393
	(0.348)	(0.366)
Age, 10 years	-0.972	-0.489
	(0.055)	(0.041)
Average age of men, 10 years	1.055	0.364
	(0.377)	(0.377)
Average age of workers, 10 years	-2.012	-0.740
	(0.431)	(0.429)
High cost area, 1=yes	0.188	-0.050
	(0.082)	(0.097)
County of Uusimaa, 1=yes	0.049	0.476
	(0.093)	(0.105)
Share of incentive hours[1]	-0.071	-0.256
	(0.162)	(0.192)
Share of incentive hours[2]	-0.299	-0.123
	(0.124)	(0.135)
Share of overtime hours	7.214	6.383
	(1.306)	(1.565)
Share of Sunday hours	0.442	-1.507
	(1.110)	(1.413)
Quarter 2, 1=yes	-0.193	0.352
	(0.110)	(0.116)
Quarter 3, 1=yes	0.060	0.879
	(0.094)	(0.110)
Quarter 4, 1=yes	-0.033	-0.758
	(0.094)	(0.128)
Wage group, metal, 1=yes: 1	-0.484	-0.466
	(0.132)	(0.154)
2	-0.287	-0.406
	(0.114)	(0.129)
(reference group, low) 3		
Wage group, forest, 1=yes: 1	0.025	-0.009
	(0.169)	(0.175)
2	-0.272	-0.224
	(0.149)	(0.163)
3	-0.698	-0.355
	(0.155)	(0.166)
4	-1.114	-1.150
	(0.193)	(0.230)
(high) 5	-1.445	-1.176
	(0.223)	(0.249)

Relative wage in industry, (0, 1] years	1.471 (0.207)	-1.202 (0.206)
Relative wage in industry, (1, 3] years	0.927 (0.087)	-2.863 (0.113)
Relative wage in industry, (3, 11] years	-0.326 (0.154)	-4.448 (0.199)
p_1	0.178 (0.031)	0.429 (0.106)
p_2	0.822 (0.031)	0.571 (0.106)
Log likelihood	-3374.3	-2298.6

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).

what less than three years. The starting wage of these persons has been usually lower than the average wage. A low starting wage is obviously one reason why the wage profiles have been increasing. It seems, however, that the wage profiles have been too flat. The job duration remains short because the workers find better jobs.

The persons who have been working at most one year received on average 3.4 per cent regular wage gains in the new job while the others lose -0.4 per cent. These findings support the argument that the workers who are relatively low paid search more actively for a better paid job within industry.

4.7. Semiparametric Models of Job Tenure

In this section an approach of piece-wise linear hazards is followed. One reason for the flexible hazard function is that job separation hazards may not be non-monotonic. Farber (1994) found using monthly data that the probability of job termination increases to a maximum at 3 months of employment and declines thereafter.

Prentice and Gloeckler (1978) have presented a semiparametric model, which has been extensively analysed by Han and Hausman (1986) and used by Meyer (1990) and Narendranathan and Stewart (1991). In the semiparametric approach the duration is expressed in intervals and separate constant baseline hazards are estimated for each of the intervals. The effect of time on the exit rate is estimated for the intervals. A nonparametric characterization of the baseline hazard ensures consistent estimation of simultaneously estimated structural parameters.

The hazard is specified assuming proportional hazards as follows

$$(28) \quad h(t) = h_0(t)\exp[x(t)\beta],$$

where $h_0(t)$ is the unknown baseline hazard, x is a vector of explanatory variables for an individual and β is a vector of unknown structural parameters. It is assumed that x(t) is constant during the specified intervals. The constant of the model is omitted. Therefore the matrix x does not include the vector of one. The shape of the baseline hazard is non-parametrically estimated and no parametric form is assumed.

Consider independent pairs of independent random variables which are the job tenure T and censoring time Z. Either a job tenure t or a censoring time c is observed for an individual, $t = \min(T, Z)$, with an indicator for the complete spells c. If $T < Z$, then $c = 1$ and $c = 0$ otherwise.

In the competing risks approach it is assumed that there are K different types of terminations of jobs ($k = 1,...,K$). It is assumed that the types of terminations are mutually exclusive and exhaust the possible destinations. In our case there are two types of job terminations. The workers can change a job within industry or leave industrial work.

Let $F^k(\cdot)$ be the distribution function of a job tenure for type k of termination. Then the survivor function is $S^k(\cdot) = 1 - F^k(\cdot)$. The probability that a job tenure terminates during a predefined interval (t, t+1) can be written as follows

$$(29) \quad h^k(t) = 1 - S^k(t+1)/S^k(t).$$

The rate that the job tenure is terminated by time t+1 due to a type k, given that the person was still working at time t, is defined by the following discrete-time proportional hazards model

$$(30)\quad h^k(t) = 1 - \exp[\,-\exp(x\beta) \int_t^{t+1} h_0{}^k(\tau)d\tau]$$

$$= 1 - \exp\{\,-\exp[x\beta + \gamma^k(t)]\},$$

where

$$(31)\quad \gamma^k(t) = \log[\int_t^{t+1} h_0{}^k(\tau)d\tau]$$

is a parameter to be estimated consistently with the structural parameters β. An advantage of the constancy of x(t) during the intervals is that h^k can be expressed in a closed form. Usually the intervals arise naturally from the data. In our case there are eight intervals predefined by the researcher. The intervals are (0, 1], (1, 2], (2, 3], (3, 4], (4, 5], (5, 6], (6, 8], (8, 11] years.

The likelihood function can then be written as follows

$$(32)\quad l(\beta,\gamma) = \prod_{n=1}^{N} \{h^k(t)^c \prod_{u=0}^{t-1} \prod_{j=1}^{K} \exp[-\exp(x\beta + \gamma^j(u))]\}.$$

where N is the size of the sample. The subscript n has been left out to simplify the notation. The log-likelihood function can be written using the hazard functions as follows

$$(33)\quad \log l(\beta,\gamma) = \sum_{n=1}^{N} \{c \log[h^k(t)] + \sum_{u=0}^{t-1} \sum_{j=1}^{K} \log[1 - h^j(u)]\}.$$

The maximum likelihood estimates of the unknown parameters β and γ are obtained by maximizing the log-likelihood using standard techniques.

It can be seen from (33) that the log-likelihood component can be partitioned into separate terms that are functions of cause specific hazards. Therefore the parameters of any cause-specific hazard can be estimated separately by treating durations terminated by other types as censored with the true censored employment spells (see Kalbfleich and Prentice, 1980, 168-171).

Table 14 presents the results of the estimations of the semiparametric models of job tenure. The estimates of the structural parameters are similar to the corresponding estimates in the models with discrete mixing distributions. Some of these estimates are, however, slightly lower in absolute value than the corresponding estimates in Table 8, where attention was paid to unobserved heterogeneity. It is well known that neglected unobserved heterogeneity biases the parameter estimates towards zero (Lancaster and Nickell, 1980).

Table 15 presents the estimates of the hazard function of job termination for an average person in the sample. The hazard function for an interval $h^k(t) = h_0{}^k(t)\exp(x\beta)$, where $h_0{}^k(t) = \exp[\gamma^k(t)]$. In *Specification I* the hazard functions have been calculated for the yearly intervals (0, 1], (1, 2], (2, 3], (3, 4], (4, 5], (5, 6], (6, 8] and (8, 11]. According to the results the hazard functions for the two types of job termination are similar during the first year of job tenure. Starting from the second year of job tenure the hazard function for the persons who find new jobs is clearly higher than the hazard function for the persons who do not find new jobs in industry. The hazard functions are decreasing with the exception that they are strongly increasing from the 6th year of job tenure in both of the destinations. The increasing hazard is at least partly due to the relatively small number of observations and large sampling error of the long durations.

In *Specification II* of Table 15 the hazard functions have been calculated for the quarterly intervals (0, 1], (1, 2], (2, 3], (3, 4] and yearly intervals (1, 3], (3, 5], (5, 7] and (7, 11]. Specification II was used to examine the results by Farber (1994) using the data from the United States that the job separation hazards are increasing during the first three months and declining thereafter. The data of our study is not as frequent as in Farber's study, because we have quarterly data of job tenures. The results based on the Finnish data supports the results by Farber that the hazard peaks at three months of job tenure. In Finland one important reason is that students and other persons are filling the holiday vacancies of ordinary staff in the summer time.

Attention was paid also to unobserved heterogeneity. Meyer presents a discrete model where he assumes a gamma distributed mixing distribution

Table 14. Results of estimations of the semiparametric models of job tenure

(A) The persons who find new jobs
(B) The persons who do not find new jobs

	(A)	(B)
Sex, 1=male	-0.115	0.126
	(0.091)	(0.098)
Share of men	2.019	1.515
	(0.292)	(0.298)
Age, 10 years	-0.730	-0.474
	(0.036)	(0.035)
Average age of men, 10 years	-1.022	-0.974
	(0.299)	(0.273)
Average age of workers, 10 years	1.528	1.593
	(0.293)	(0.269)
High cost area, 1=yes	-0.027	-0.218
	(0.070)	(0.083)
County of Uusimaa, 1=yes	0.068	0.323
	(0.084)	(0.093)
Share of incentive hours[1]	-0.130	-0.261
	(0.132)	(0.167)
Share of incentive hours[2]	-0.164	-0.041
	(0.105)	(0.121)
Share of overtime hours	7.973	6.505
	(1.029)	(1.249)
Share of Sunday hours	-0.396	-0.901
	(0.940)	(1.224)
Quarter 2, 1=yes	0.039	0.334
	(0.097)	(0.105)
Quarter 3, 1=yes	0.346	0.827
	(0.081)	(0.091)
Quarter 4, 1=yes	-0.005	-0.598
	(0.083)	(0.113)
Wage group, metal, 1=yes: 1	-0.398	-0.419
	(0.122)	(0.133)
2	-0.125	-0.218
(reference group, low) 3		
Wage group, forest, 1=yes: 1	0.152	0.138
	(0.149)	(0.157)
2	-0.022	0.019
	(0.133)	(0.139)
3	-0.515	-0.261
	(0.140)	(0.146)
4	-0.929	-0.900
	(0.166)	(0.210)
(high) 5	-1.147	-1.083
	(0.190)	(0.230)
Relative wage in industry	0.635	-1.330
	(0.163)	(0.188)

γ_1	-3.114	-1.873
	(0.280)	(0.287)
γ_2	-2.988	-2.560
	(0.285)	(0.294)
γ_3	-3.386	-3.242
	(0.291)	(0.315)
γ_4	-3.955	-3.727
	(0.306)	(0.343)
γ_5	-4.122	-3.974
	(0.317)	(0.372)
γ_6	-4.104	-4.097
	(0.320)	(0.398)
γ_7	-2.510	-2.603
	(0.286)	(0.318)
Log likelihood	-2847.6	-1977.4

1. The incentive wage based on quantity (%).
2. The incentive wage based on quality and quantity (%).

Table 15. Hazard functions of job termination for an average person in the sample

Job tenure	Persons who find new jobs	Persons who do not find new jobs
Specification I (yearly hazards):		
Year (0, 1]	0.27	0.31
Year (1, 2]	0.31	0.16
Year (2, 3]	0.21	0.08
Year (3, 4]	0.12	0.05
Year (4, 5]	0.10	0.04
Year (5, 6]	0.10	0.03
Years (6, 8]	0.25	0.07
Years (8, 11]	2.05	0.68
Specification II (quarterly and yearly hazards):		
Quarter (0, 1]	0.03	0.05
Quarter (1, 2]	0.10	0.11
Quarter (2, 3]	0.07	0.06
Quarter (3, 4]	0.05	0.06
Years (1, 3]	0.03	0.07
Years (3, 5]	0.06	0.01
Years (5, 7]	0.12	0.01
Years (7, 11]	0.46	0.16

(Meyer, 1990, 770). This approach was followed. It turned out that the computation of a semiparametric model of job tenure was difficult in practice, because the estimate of the variance of unobserved heterogeneity approached a negative value during the iterations leading to numerical overflows in computations. It seems that when the baseline hazard is non-parametrically estimated the unobserved heterogeneity is unimportant. This interpretation is given also by Meyer (1990). This argument is supported also by the results of Chapter IV of this thesis, where the model with gamma distributed mixing distribution is presented.

5. Conclusions

This study on job tenures is based on quarterly data of blue-collar workers from the administrative files of the Confederation of the Finnish Industry and Employers. Every 15th worker was picked from the outflow of employment during 1990. The final sample contains 2899 individuals who have experienced a transition from a job in the metal or forest industries during 1990. The follow-up of the job tenure and wages went back to the year 1980. The job tenure is calculated using the quarters of the year. About 14 per cent of the observations are censored, because some of the persons were working during the first quarter of 1980.

Usually wage profiles of workers are estimated from the studies of cross-section data. In our study the wage profiles are illustrated for groups of persons over their spells of employment. The wage profiles are increasing for the short spells of four years or less. The wage profiles are constant for the spells of five years or more. The wage differentials are rather small between the short- and long-term workers. The workers who have long spells of employment have on average higher wages than the workers who have short spells. Also it turned out that typical employment spells are long in the wage groups where the required level of skill is the highest. The wage groups do not determine the wage alone. They have an effect on wages according to the collective wage agreements, but they also indicate the required level of skill in a job and hence the organizational level of a worker.

The starting regular wage of the workers who have long spells of employment is higher than the average wage level of the stock of the workers. For the short spells of employment the starting wages have been lower than the average wage level. An increasing wage profile is related to the low starting wages, short employment and faster turnover of labour.

In the data there are two kinds of transitions among the persons who left the firms. The workers can immediately find another job within industry or they may leave industry. About 59 per cent of the workers found another industrial job and 41 per cent of workers left industry. The relative wage level is lower for the persons who leave industry. This gives support to the search models. For the low wage workers the opportunity costs of unemployment and non-participation are lower. Therefore the low wage workers are expected to leave industry.

The models of job tenure were estimated in a competing risk framework. According to the results of estimations the age of the workers has a negative effect on both of the destinations. Older persons have longer spells of employment. The average age of the workers in a plant take negative coefficients. They indicate that the turnover of labour is small in the plants where the average age is high. The average age of men takes a positive coefficient for the persons who find new industrial jobs.

The high cost area is positively related to the exit rate for the persons who find new jobs. In the county of Uusimaa the labour turnover is high for the persons who leave industry. The incentive work has negative coefficients. The share of overtime hours is positively related to the exit rate. The share of Sunday hours is negatively related to the exit rate for the persons who do not find new jobs in industry. The industry job-to-job transitions are frequent during the third quarter. The exit rate from industry is high during the second and third quarters. During the last quarter the turnover of labour is low.

The required level of skill, which is the wage group of the collective wage agreements, is negatively related to the exit rate. The coefficients of the indicators are similar in both of the destinations. The turnover of workers is higher in the jobs which have low requirements. This remark supports the argument that highly skilled labour cannot be replaced easily and therefore they are better paid.

The relative wage of the worker with respect to the aggregate wage level in industry is negatively related to the exit rate for the persons who do not find new jobs within industry. A low wage increases incentives for seeking better paid jobs or going back to school. On the other hand, the wage is positively related to the exit rate for the persons who leave the firm in order to get another job. These workers are better paid than the others within industry. It seems that these workers are able to compete for better jobs in the other industrial firms.

The relative wage of the worker with respect to the wage level in the plant is negatively related to the exit rate. The relative wage within the plant is remarkably lower than the average wage in industry. These differences are reasons for workers to search for better paid jobs. It turns out that the low relative wage within the plant spurs workers to search for better paid jobs. The negative relationship of the wages is larger for the persons who leave industry.

Also the duration-dependent effects of relative wages within industry were estimated. It turned out that the effects of wages on the exit rate are more important for the persons who have long spells of employment. The effect of wages was the most notable for the persons who had been working for a long time and left industry when leaving the firm. The wage effect was positive for the workers who find new jobs within industry and have been working for somewhat less than three years. These workers are characterized by low starting wages, increasing wage profiles and better paid jobs in other industrial firms.

From the view-point of a company it was studied whether it is worth increasing the wage group and wage level of the worker in order to reduce the cost of labour turnover. The increase of the wage level has a negligible effect on the labour turnover among the workers who change jobs within industry and a rather small effect among the workers who left industry. Each additional level of wage group increases the job tenure. The effect of wage group is clearly larger than the effect of the wage level. Usually it is no use to increase the wage group and wage level of workers in order to reduce the costs of labour turnover.

The results from the semiparametric models of job tenure show that the hazard functions are decreasing during the first years of employment but strongly increasing starting from the 6th year in a job. During the first year the hazard function for the persons who change their jobs in industry is higher than the hazard function for the persons who leave their industrial jobs.

References

Abraham, K.G. and Farber, H.S. (1987), Job Duration, Seniority, and Earnings, American Economic Review 77, 278-297.

Albrecht, J.W., Holmlund, B. and Lang, H. (1991), Comparative Statics in Dynamic Programming Models with Application to Job Search, Journal of Economic Dynamics and Control 15, 755-769.

Anderson, P.M. and Meyer, B.D. (1994), The Extent and Consequences of Job Turnover, Brookings Papers: Microeconometrics 1994, 177-248.

Asplund, R. (1994), Palkkaerot Suomen teollisuudessa, The Research Institute of the Finnish Economy, B 91, Helsinki.

Atkinson, A.B. and Micklewright, J. (1991), Unemployment Compensation and Labor Market Transitions: A Critical Review, Journal of Economic Literature 29, 1679-1727.

Becker, E. and Lindsay, C.M. (1994), Sex Differences in Tenure Profiles: Effects of Shared Firm-specific Investment, Journal of Labor Economics 12, 98-118.

Becker, G.S. (1964), Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education, Columbia University Press, New York.

Belzil, C. (1993), An Empirical Model of Job-to-job Transition with Self-selectivity, Canadian Journal of Economics 26, 536-551.

Bergström, R. and Edin, P.-A. (1992), Time Aggregation and the Distributional Shape of Unemployment Duration, Journal of Applied Econometrics 7, 5-30.

Berndt, E.R., Hall, B.H., Hall, R.E. and Hausman, J.A. (1974), Estimation and Inference in Nonlinear Structural Models, Annals of Economic and Social Measurement 3/4, 653-666.

Björklund, A. and Holmlund, B. (1989), Job Mobility and Subsequent Wages in Sweden, In van Dijk et al. (eds.) Migration and Labor Market Adjustment, Kluwer Academic Publishers, 201-216.

Brännäs, K. (1986a), On Heterogeneity in Econometric Duration Models, Sankhya 48, 284-293.

Brännäs, K. (1986b), Small Sample Properties in a Heterogeneous Weibull Model, Economics Letters 21, 17-20.

Brännäs, K. and Rosenqvist, G. (1988), Semi-Parametric Estimation of Heterogenous Count Data Models, Swedish School of Economics and Business Administration, Working Papers, No. 187.

Brown, J. (1992), Interpreting Panel Data on Job Tenure, Journal of Labor Economics 10, 219-257.

Brown, J.N. and Light, A. (1992), Interpreting Panel Data on Job Tenure, Journal of Labor Economics 10, 219-257.

Burdett, K., Kiefer, N.M. and Sharma, S. (1985), Layoffs and Duration Dependence in a Model of Turnover, Journal of Econometrics 28, 51-69.

Card, D. and Sullivan, D. (1988), Measuring the Effect of Subsidized Training Programs on Movements in and out of Employment, Econometrica 56, 497-530.

Chesher, A. and Lancaster, T. (1983), The Estimation of Models of Labour Market Behaviour, Review of Economic Studies 50, 609-624.

Cox, D.R. and Oakes, D. (1984), Analysis of Survival Data, Chapman and Hall, London.

Cutler, S.J. and Ederer, F. (1958), Maximum Utilization of the Life Table Method in Analyzing Survival, Journal of Chronic Diseases 8, 699-712.

Davies, R.B. (1987), Mass Point Methods for Dealing with Nuisance Parameters in Longitudinal Studies, In Crouchley, R. (ed.), Longitudinal Data Analysis, Surrey Conference on Sociological Theory and Method 4, Gower Publishing Company Limited, Avebury, 88-109.

Davies, R.B. and Crouchley, R. (1984), Calibrating Longitudinal Models of Residential Mobility and Migration, Regional Science and Urban Economics 14, 231-247.

Devine, T. and Kiefer, N. (1991), Empirical Labor Economics: The Search Approach, Oxford University Press, New York.

Dunn, R., Reader, S. and Wrigley, N. (1987), A Nonparametric Approach to the Incorporation of Heterogeneity into Repeated Polytomous Choice Models of Urban Shopping Behaviour, Transportation Research 21A, 327-343.

Elbers, C. and Ridder, G. (1982), True and Spurious Duration Dependence: The Identifiability of the Proportional Hazards Model, Review of Economic Studies 59, 403-409.

Farber, H.S. (1994), The Analysis of Interfirm Worker Mobility, Journal of Labor Economics 12, 554-593.

Flinn, C.J. and Heckman, J.J. (1982), Models for the Analysis of Labor Force Dynamics, Advances in Econometrics 1, 35-95.

Gottschalk, P. and Maloney, T. (1985), Involuntary Terminations, Unemployment and Job Matching: A Test of Job Search Theory, Journal of Labor Economics 3, 109-123.

Gritz, M.R. (1993), The Impact of Training on the Frequency and Duration of Employment, Journal of Econometrics 57, 21-51.

Ham, J.C. and Rea, S.A. Jr. (1987), Unemployment Insurance and Male Unemployment Duration in Canada, Journal of Labor Economics 5, 325-353.

Han, A. and Hausman, J.A. (1986), Semiparametric Estimation of Duration and Competing Risk Models, M.I.T, Unpublished manuscript.

Heckman, J.J. and Singer, B. (1984a), A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data, Econometrica 52, 271-320.

Heckman, J.J. and Singer, B. (1984b), Econometric Duration Analysis, Journal of Econometrics 24, 63-132.

Jovanovic, B. (1979), Job Matching and the Theory of Turnover, Journal of Political Economy 87, 972-990.

Jovanovic, B. (1984), Matching, Turnover and Unemployment, Journal of Political Economy 92, 108-122.

Juhn, C., Murphy, K.M. and Topel, R.H. (1991), Why Has the Natural Rate of Unemployment Increased over Time? Brookings Papers on Economic Activity 1991, 75-142.

Kalbfleisch, J.D. and Prentice, R.L. (1980), The Statistical Analysis of Failure Time Data, John Wiley and Sons, New York.

Katz, L.F. and Meyer, B.D. (1990), The Impact of the Potential Duration of Unemployment Benefits on the Duration of Unemployment, Journal of Public Economics 41, 45-72.

Kettunen, J. (1993a), Förändringar i lönestrukturen inom den finska industrin under 1980-talet, The Journal of the Economic Society of Finland 3, 153-158.

Kettunen, J. (1993b), Re-employment of Finnish Unemployed Workers, The Research Institute of the Finnish Economy, A 17, Helsinki.

Kettunen, J. (1993c), Suomen teollisuuden palkkarakenne, The Research Institute of the Finnish Economy, B 83, Helsinki.

Kettunen, J. (1994a), Kannustava palkkaus teollisuusyritysten paikallisen sopimisen muotona, The Research Institute of the Finnish Economy, B 90, Helsinki.

Kettunen, J. (1994b), Suomen teollisuuden palkkarakenteen muutos 1980-luvulla (The Change of the Wage Structure of the Finnish Industry during the 1980's), The Research Institute of the Finnish Economy, Discussion papers, No. 463, Helsinki.

Kettunen, J. (1996), Teollisuuden työllisyys ja työvoiman vaihtuvuus (Employment and Job Tenure in Finnish Industry), The Research Institute of the Finnish Economy, B 116, Helsinki.

Kettunen, J. and Marjanen, R. (1992), Suomen Työnantajain Keskusliiton palkkatilastot, The Research Institute of the Finnish Economy, Discussion papers, No. 425, Helsinki.

Kettunen, J. and Vartiainen, J. (1993), Suomen teollisuuden työntekijöiden palkkarakenne, The Research Institute of the Finnish Economy, Discussion papers, No. 431, Helsinki.

Kiefer, N.M. (1988a), Economic Duration Data and Hazard Functions, Journal of Economic Literature 16, 646-679.

Kiefer, N.M. (1988b), Employment Contracts, Job Search Theory, and

Labour Turnover: Preliminary Empirical Results, Journal of Applied Econometrics 3, 169-186.

Kiefer, N.M. and Neumann, G.R. (1989), Search Models and Applied Labor Economics, Gambridge University Press, Gambridge.

Kiefer, J. and Wolfowitz, J. (1956), Consistency of the Maximum Likelihood Estimator in the Presence of Infinitely Many Incidental Parameters, Annals of Mathematical Statistics 27, 887-906.

Krueger, A.B. and Summers, L.H. (1988), Efficiency Wages and the Inter-industry Wage Structure, Econometrica 56, 259-293.

Kurjenoja, J. (1991), Tehokkuuspalkat ja valvonta työnteon insentiiveinä yrityksessä, Helsingin yliopiston kansantaloustieteen laitoksen tutkimuksia, Nro 56, Helsinki.

Laird, N. (1978), Nonparametric Maximum Likelihood Estimation of a Mixing Distribution, Journal of the American Statistical Association 73, 783-792.

Lancaster, T. (1990), The Econometric Analysis of Transition Data, Cambridge University Press, Cambridge.

Lancaster, T. and Nickell, S. (1980), The Analysis of Re-Employment Probabilities for the Unemployed, Journal of the Royal Statistical Society, Series A, 143, 141-165.

Lilja, R. (1990), Older Workers at the Crossroads - Early Retirement in Finland, Labour Institute for Economic Research, Discussion Papers 100, Helsinki.

Lilja, R. (1995), Teollisuuden toimihenkilöiden ura- ja palkkakehitys, Palkansaajien tutkimuslaitos, Tutkimuksia 54, Helsinki.

Lindeboom, M. and Theeuwes, J. (1990a), Job Duration in the Netherlands: The Co-existence of High Turnover and Permanent Job Attachment, Leiden University, Department of Economics, Revised draft, September.

Lindeboom, M. and Theeuwes, J. (1990b), Job Duration in the Netherlands: The Simultaneous Occurrence of High and Low Turnover, Leiden University, Center for Research in Public Economics, Research Memorandum 90.03.

Lindsay, B.G. (1983a), The Geometry of Mixture Likelihoods: A General Theory, The Annals of Statistics 11, 86-94.

Lindsay, B.G. (1983b), The Geometry of Mixture Likelihoods, Part II: The Exponential Family, The Annals of Statistics 11, 783-792.

Meyer, B.D. (1990), Unemployment Insurance and Unemployment Spells, Econometrica 58, 757-782.

Miller, R. (1984), Job Matching and Occupational Choice, Journal of Political Economy 92, 1086-1120.

Narendranathan, W. and Stewart, M.B. (1991), How Does the Benefit Effect Vary as Unemployment Spells Lengthen?, University of Warwick, Economics Department, July 1991.

Ondrich, J.I. (1985), The Initial Conditions Problem in Work History Data, The Review of Economics and Statistics 67, 411-421.

Prentice, R. and Gloeckler, L. (1978), Regression Analysis of Grouped Survival Data with Application to Breast Cancer Data, Biometrics 34, 57-67.

Salop, S. (1979), A Model of the Natural Rate of Unemployment, American Economic Review 69, 117-125.

Saukkonen, S. (1994), Työn hinta, Yritysten työvoimakustannukset 1992-94, The Research Institute of the Finnish Economy, B 88, Helsinki.

Simar, L. (1976), Maximum Likelihood Estimation of a Compound Poisson Process, The Annals of Statistics 4, 1200-1209.

Solon, G. (1985), Weak Incentive Effects of Taxing Unemployment Benefits, Econometrica 53, 295-306.

Stiglitz, J.E. (1985), Equilibrium Wage Distributions, The Economic Journal 95, 595-618.

STK (Suomen Teollisuuden Keskusliitto) (1975), Vaihtuvuudesta pysyvyyteen, Helsinki.

STK (Suomen Teollisuuden Keskusliitto) and LTK (Liiketyönantajain Keskusliitto) (1978), Vaihtuvuuden hinta, Ohjeita vaihtuvuuden seurantaan ja kustannusten laskentaan, Helsinki.

Topel, R.H. (1986), Local Labour Markets, Journal of Political Economy 94, S111-S143.

Topel, R.H. (1991), Specific Capital, Mobility, and Wages: Wages Rise with Job Seniority, Journal of Political Economy 99, 145-176.

Topel, R.H. (1993), What Have We Learned from Empirical Studies of Unemployment and Turnover, The American Economic Review 83, 110-115.

Topel, R.H. and Ward, M.P. (1992), Job Mobility and the Careers of Young Men, The Quarterly Journal of Economics CVII, 439-479.

Trussell, J. and Richards, T. (1985), Correcting for Unmeasured Heterogeneity in Hazard Models Using the Heckman-Singer Procedure, Sociological Methodology, 242-276.

Vartia, Y. and Kurjenoja, J. (1992), Palkkadiskriminaatio, Naisten ja miesten palkkaerot samasta työstä metalli- ja metsäteollisuuden suuryrityksissä v. 1990, University of Helsinki, Department of Economics, Research Reports, No 30.

Chapter IV

UNEMPLOYMENT DURATION AND LABOUR MOBILITY

Abstract

In this chapter the mover-stayer models of transition intensities and labour mobility are examined using Finnish microeconomic data on unemployment durations. Duration models are used to analyse the probabilities of transition, because they are more efficient than the discrete choice models. The probabilities of becoming employed, moving to another region and changing occupations are estimated using censored data on unemployment durations. The models are based on a Gompertz distribution, which yields estimates of the proportion of unemployed persons who will never become employed, move or change occupations. Allowance for neglected heterogeneity is made assuming that the effect of omitted variables has a gamma distribution across persons. Attention was paid also to the features of the Finnish unemployment insurance system and the associated problem of heaping of unemployment durations at the changes in the system. Semiparametric models of unemployment duration with piece-wise linear hazards were estimated.

1. Introduction

This chapter is concerned with the estimation of transition intensities in the labour market using microeconomic data. The work is motivated by the study of Theeuwes, Kerkhofs and Lindeboom (1990), who estimated the transition intensities between the three basic labour market states: not in the labour force (non-participation), employment and unemployment. Each of these states has two transitions. Theeuwes et al. estimated six models of transitions between these states and one model allowing for transitions between different jobs using Dutch data. The problem with estimating models for all these transitions is that some transitions are observed only a few times or not observed at all.

One way to avoid estimating different models for all the transitions is to estimate discrete choice models of leaving a state. The choice between non-participation and participation in the labour market is the basis for the studies of the supply of labour. The two-state estimation procedure is one way to model the supply of labour. The first stage is a discrete choice estimation of the probability of entering the labour force. The second stage is the ordinary least square estimation of the working hours (Heckman, 1976, 1979).

There has been a lot of theoretical and empirical research concerning the transitions from employment. The main qualitative predictions of the model for tenure data are given by Jovanovic (1984). One of the implications is that a tenure distribution should be defective, i.e. it should have a property that the limit of the distribution function is positive as the duration approaches infinity, because some people will not leave the state. This requirement is satisfied, for example, by the inverse Gaussian distribution, which has been applied by Lancaster and Chesher (1985).

The models of becoming employed have been widely studied in the search theoretical and microeconometric literature. There are not, however, many studies concerning the well-known and important feature of unemployment that some persons will not return to work. Atkinson and Micklewright (1991) argue that the state of non-participation should be incorporated in models of the labour market. Recently, van den Berg (1990) has allowed for transitions from unemployment to non-participation. He estimated a model of unemployment duration using information on non-participation. Such data are not, however, available for this study.

This study shows that complete information on the state of destination is not necessarily needed and provides alternative models to estimate transition intensities from unemployment to employment and non-participation. The proportion of the persons who will never become employed is estimated from the data, where the completed spells are not observed for all the observations.

It is well known that all the unemployed persons will not become employed again. If some persons never return to work, there are some technical requirements for the distribution of unemployment durations. The distribution should allow that the probability of becoming employed be low enough for some of the individuals that they will never become employed. It means that the survivor function should allow the possibility of its asymptotically decreasing to a positive value instead of zero. Defective distributions give estimates for the proportion of persons who will never become employed. A Gompertz distribution allows for the defectiveness, which is not assumed a priori.

In the mover-stayer terminology movers become employed but stayers will never obtain acceptable offers. The hazard rate is low enough for the stayers so that they get trapped and will never find acceptable offers. The analysis is applied to the labour mobility of unemployed workers. In the cases of regional and occupational mobility movers move to new areas of residence or change their occupations to get jobs. Models of unemployment duration, regional and occupational mobility are estimated using Finnish microeconomic data.

Analogously to biological studies the Weibull model has been used for modelling total mortality (e.g. Burch, Jackson, Fairpo and Murray, 1973) and the Gompertz model for cause-specific mortality (e.g. Dix, Cohen and Flannery, 1980). The analogy is obvious, since some of the unemployed workers will not move or change occupations in order to become employed.

The specification of unemployment benefits in the models of unemployment benefits are studied. There are plenty of ways how the unemployment benefits have been introduced in the models of unemployment duration. In some studies the benefit level is used (e.g. Katz and Meyer, 1990). In the other studies the indicators for the benefit recipients have been used (e.g. Eriksson, 1985). Also the replacement ratio of benefits has been used (see Atkinson and Micklewright, 1991).

In many countries the circumstances of unemployed persons do not stay constant during the whole spell of unemployment. The duration-dependent features of the system have been often neglected in econometric work. In the Finnish system the eligibility rules of benefits become stricter and the benefits are reduced at some point of unemployment duration. Many previous studies have shown that the unemployment durations heap around the moment of benefit exhaustion (see e.g. Meyer, 1990). The duration-dependent features of the Finnish system are studied using the semiparametric models with the flexible specification of the baseline hazard.

Unobserved heterogeneity is taken into account in estimation. A Gompertz model allowing for neglected heterogeneity is derived assuming that the effect of omitted variables has a gamma distribution across individuals. The same mixing distribution was used also with the semiparametric models.

This chapter of the thesis is organized as follows. In the next section the properties of the Gompertz distribution are discussed. The log-likelihood functions are derived allowing for unobserved heterogeneity assuming that the effect of omitted variables has a gamma distribution across persons. In section 3 the data of this study are presented. In addition, the results of estimations are presented in section 3. Section 4 is concerned with the specification of unemployment benefits in the models of unemployment duration. Section 5 presents the semiparametric models of unemployment duration. The results of the study are summarized and discussed in the concluding section.

2. Parametric Models of Unemployment Duration

2.1. Gompertz Distribution

Let us consider independent pairs of independent random variables T and Z, where T is the duration variable of primary interest and Z is a censoring variable. The duration of unemployment is defined as the difference between the date of entry into unemployment and the date of becoming employed. A censoring time or a duration and a censoring indicator are observed as $t = \min(T, Z)$ with a binary indicator. The censoring indicator $c = 1$ if a person becomes employed, i.e. $T \geq Z$, and $c = 0$ if he does not.

In the cases of regional and occupational mobility the random variable T is defined as the duration of unemployment between the date of entry into unemployment and the date of exit due to moving or changing occupations to get a job. The probabilities of moving and changing occupations are implied by the search models, which may include costs of moving and changing occupations (Kettunen, 1992a). The labour mobility is interesting also from the economic policy point of view, since the Unemployment Insurance Act includes protective regulations on the labour mobility of unemployed workers.

The models of transition intensities are specified in terms of the hazard function. A generic form for the likelihood contribution of parametric duration models with censored data is written as $l\,(t) = h(t)^c e^{-I(t)}$, where h(t) is the hazard and I(t) is the integrated hazard. A commonly applied specification is the proportional hazards model, where the hazard function factors into the product of a function of duration t and a function of the regressors x. The hazard is written as $h(t) = h_0(t)h_1(x)$, where $h_0(t)$ is called the baseline hazard.

A very often neglected feature of the econometric models of unemployment duration is that some of the unemployed persons will not return to work. They may leave the labour force before re-employment. Some of the reasons may be retirement, unemployment pensions or even death. This feature of unemployment spells can be taken into account using defective distributions. Such distributions are by no means worse than others, but the defective distributions have a feature that there is always a certain amount of mass in the survivor function regardless of how long the duration is. Therefore it is reasonable to assume a Gompertz distribution, which is an extension of the exponential distribution.

The baseline hazard of a Gompertz distribution is $h_0(t) = \exp(t\theta)$. The hazard function of the two parameter Gompertz distribution may be written as follows

(1) $h(t) = \zeta e^{t\theta}$.

The hazard function varies as an exponential function of time starting from ζ. The explanatory variables x are introduced into the model by a log-linear form $\zeta = \exp(x\beta)$, where β is a vector of structural parameters.

The integrated hazard of the Gompertz distribution can be written as follows

(2) $I(t) = e^{x\beta}(e^{t\theta} - 1)/\theta$.

The survivor, density and hazard functions of the Gompertz distribution can then be written as follows

(3) $S(t) = e^{-e^{x\beta}(e^{t\theta} - 1)/\theta}$

(4) $f(t) = e^{x\beta + t\theta - e^{x\beta}(e^{t\theta} - 1)/\theta}$

(5) $h(t) = e^{x\beta + t\theta}$.

To see the shape of the survivor function of the Gompertz model consider their limits as the duration approaches to infinity:

$$\text{If } \theta < 0, \text{ then } \lim_{t \to \infty} S(t) = e^{e^{x\beta}/\theta}.$$

$$\text{If } \theta > 0, \text{ then } \lim_{t \to \infty} S(t) = 0.$$

These limits give the estimates for the proportion of individuals who will never become employed, move or change occupations to get a job.

To write the likelihood functions and estimate the unknown parameters, the hazard functions and integrated hazards of the two models presented are substituted for the log likelihood contribution. For completeness the log-likelihood functions are presented. The likelihood function of the Gompertz model can be written as follows

$$(6)\quad L(\theta, \beta) = \sum_{i=1}^{N} [c_i(x_i\beta + t_i\theta) - e^{x_i\beta}(e^{t_i\theta} - 1)/\theta],$$

where N is the number of individuals in the sample. $L(\theta, \beta)$ is maximized with respect to the unknown parameters θ and β. The data consist of the duration of unemployment measured in weeks t_i, indicators c_i and explanatory variables x_i, $i = 1,\dots,N$.

2.2. Gamma Mixing Distribution

Unobserved heterogeneity is widely discussed in the econometric literature after the pioneering study of Lancaster (1979). He found that the estimated parameters were biased towards zero if the unobserved heterogeneity was not controlled for and assumed a parametric functional form for the pattern of unobserved heterogeneity. The method of correcting for omitted variables using the gamma mixing distribution has been widely used with exponential and Weibull duration distributions (e.g. Kooreman and Ridder, 1983, Newman and McCulloch, 1984, Narendranathan, Nickell and Stern, 1985, Engström and Löfgren, 1987). In this study the assumption of gamma distributed unobserved heterogeneity has been extended to the Gompertz distribution. The mass point approach is not considered, since defective distributions imply a location of a point of support at zero leading to numerical overflows in the estimation.

Unobserved heterogeneity is characterized by an unobserved component v. The hazard function conditional on v can be written as follows

$$(7)\quad h(t|v) = vh(t).$$

The appropriate marginal functions are needed. A simple procedure is to first derive the survivor function marginal with respect to v. It can be written as follows

(8a) $$S_g(t) = \int_{-\infty}^{\infty} e^{-vI(t)} g(v)dv,$$

where it is assumed that v has a gamma density

(8b) $$g(v) = \frac{\psi^{\mu}}{\Gamma(\mu)} v^{\mu-1} e^{-\psi v} \quad \text{with } \Gamma(\mu) = \int_{0}^{\infty} w^{\mu-1} e^{-w} dw.$$

An advantage of the gamma mixing distribution is that the log-likelihood function can be expression in a closed form.

It is natural to normalize the expected value $E(v) = \mu/\psi$ to one. It is done simply by setting $\psi = \mu$. A change of variables $w = v(\mu + I(t))$ can be used in the integration. Differentiation of the marginal survivor function gives the needed density function. The marginal hazard function is obtained as a ratio of the density and survivor functions. The variance of the unobserved heterogeneity, $\sigma^2 = 1/$, is estimated.

The survivor, density and hazard functions can be written as follows

(9) $$S_g(t) = [1 + \sigma^2 I(t)]^{-1/\sigma^2}$$

(10) $$f_g(t) = h(t)[1 + \sigma^2 I(t)]^{-1/\sigma^2 - 1}$$

(11) $$h_g(t) = h(t)[1 + \sigma^2 I(t)]^{-1},$$

where I(t) is the integrated hazard of the original Gompertz distribution (2). The integrated hazard with gamma heterogeneity can be written as $I_g(t) = -\log[S_g(t)]$, which can be rewritten as follows

(12) $$I_g(t) = 1/\sigma^2 \log[1 + \sigma^2 I(t)].$$

The integrated hazards $\hat{I}(t)$ and $\hat{I}_g(t)$ evaluated at the maximum likelihood estimates of the unknown parameters are the generalized residuals of these models in the sense of Cox and Snell (1968).

The limits of survivor functions after allowing for gamma heterogeneity can be written:

$$\text{If } \theta < 0\text{, then } \lim_{t\to\infty} S_g(t) = [1 - \sigma^2 e^{x\beta} / \theta]^{-1/\sigma^2} .$$

$$\text{If } \theta > 0\text{, then } \lim_{t\to\infty} S_g(t) = 0.$$

These limits give the final estimates for the proportion of individuals who will never become employed, move or change occupations to get a job. No person remains unemployed forever. Therefore the transition intensities from unemployment to non-participation can be estimated without having prior information on the non-participation. Furthermore, the proportions of persons who change occupations or move can be estimated.

The log-likelihood function of the Gompertz model with gamma heterogeneity can be written as follows

$$(13) \quad L(\theta, \beta) = \sum_{i=1}^{N} \{c_i(x_i\beta + t_i\theta)$$

$$- (c_i + 1/\sigma^2)\log[1 + \sigma^2 e^{x_i\beta}(e^{t_i\theta} - 1)/\theta]\},$$

which is maximized with respect to the unknown parameters θ, σ^2 and β.

3. Transition Intensities from Unemployment

3.1. Description of the Data on Unemployment Durations

Finnish data on 2077 unemployed persons are used to analyse the transition intensities to employment and non-participation. The data have been compiled for this study from the administrative files of the Ministry of Labour. Every hundredth worker was picked from the inflow into unemployment during 1985. The persons were followed until the end of their spell of unemployment but at most until the end of 1986. The data include 40 per cent censored observations.

The information on the taxable assets and income have been compiled from the administrative tax register. The information on the unemployment benefits during the spells of unemployment have been obtained form the files of The Social Insurance Institution and the bank Postipankki. The data have been widely used to analyse also the effects of unemployment benefits (Kettunen, 1991a,b, 1992b, 1993a,b,c, 1994b, 1996a) and the effects of education on the duration of unemployment (Kettunen, 1993c, 1994a, 1996b, 1997).

Table 1 presents the descriptive statistics of the data on unemployed workers. Means, standard deviations, minimums and maximums of the data have been calculated in order to get a preliminary view on the data. According to the figures the unemployed workers are most often single men. Therefore the unemployed workers have few children to take care of. Usually unemployed workers are rather young, because their average age is about 31 years.

The indicator of the level of education in the data corresponds to the compulsory basic education and the secondary education. It shows if the person has vocational training. Most of the workers have a rather low education, because only 45 per cent of them have passed the criterion level chosen for the indicator. About 15 per cent of the workers have got training for further employment before their unemployment. It is not known from the data when they have got this training.

About 42 per cent of the workers are members of unemployment insurance (UI) funds. Membership in an UI fund is one requirement for the earnings related unemployment allowance (unemployment benefit). The rest of the workers are eligible for the basic unemployment allowance (unemployment assistance). About 14 per cent of the unemployed workers came from schooling and 7 per cent came from housework.

The regional and occupational demand is measured using the vacancy/ unemployment ratios (V/U-ratios). They measure the tightness of the labour market. According to the figures there are on average about 10 unemployed workers for each vacancy in the employment offices. The taxable assets are rather low. One reason is that the unemployed persons are rather young.

Table 1. Descriptive statistics of the data on unemployed workers

	Mean	Std. dev.	Minimum	Maximum
Unemployment duration, weeks	15.06	18.05	0.14	104.23
Number of children	0.23	0.62	0.00	5.00
Married, 1=yes	0.37	0.48	0.00	1.00
Sex, 1=male	0.53	0.50	0.00	1.00
Age, years	31.14	11.94	14.00	64.00
Education, 1=at least 12 years	0.45	0.50	0.00	1.00
Training for employment, 1=yes	0.15	0.36	0.00	1.00
Member of UI fund, 1=yes	0.42	0.49	0.00	1.00
Came from schooling, 1=yes	0.14	0.34	0.00	1.00
Came from housework, 1=yes	0.07	0.26	0.00	1.00
Regional demand, V/U ratio	0.11	0.13	0.02	0.42
Occupational demand, V/U ratio	0.12	0.05	0.07	0.23
Taxable assets, millions of FIM	0.011	0.03	0.00	0.54
Replacement ratio of UI benefits	0.16	0.21	0.00	0.90

The number of observations is 2077.

The replacement ratio for each worker has been calculated as an average over their spells of unemployment. The average in Table 1 has been calculated over the individuals. The replacement ratio is rather low. One reason is that about 42 per cent of the persons did not get any benefits.

Some of these persons became employed during the waiting period for benefits. Some of them did not get any benefits, because the basic unemployment allowance is means tested. Another reason is that for some of the workers the average replacement ratio is low because they became employed during the first few weeks including the waiting period.

3.2. Non-Participation

The results of estimations regarding unemployment duration and non-participation are presented in *Table 2*. The parameter estimate of the duration dependence is negative indicating that the hazard function is decreasing and that the survivor function is asymptotically decreasing to a positive value. Hence some persons will never become employed.

When gamma heterogeneity is introduced into the model, the negative duration dependence decreases, as was expected. Another implication of the negativeness of is that the expected value of the unemployment duration is not defined, because some persons do not become employed again. This fact can be seen, for example, in Broadbent (1958) and Lee (1980). The technical reason is that the integral of the survivor function from zero to infinity does not converge. The constant of the model, where the effect of omitted variables is captured, decreases and the absolute values of the statistically significant parameter estimates increase when gamma heterogeneity is introduced into the model, as was expected.

The coefficient of the number of children is statistically insignificant. Married persons seem to become employed earlier than single persons. The effect of sex is statistically insignificant. Older people are more apt to incur problems in finding jobs. The level of basic education does not have a statistically significant effect, but the training for further employment has a positive effect on the re-employment probability.

Members of the UI funds and labour unions have more elements of incentives in the UI system for becoming employed. Therefore they become employed earlier than the non-members. The school graduates and persons leaving the army find acceptable jobs clearly earlier than the others. The persons who have come from housework have low re-employment probabilities.

Table 2. Gompertz models of unemployment duration

(A) A Gompertz model (B) A Gompertz model with gamma heterogeneity	(A) Std.errors in parentheses	(B)
θ	-0.023	-0.010
	(0.002)	(0.005)
σ^2		0.332
		(0.127)
Constant	-1.639	-1.363
	(0.132)	(0.181)
Number of children	-0.001	-0.005
	(0.054	(0.063)
Married, 1=yes	0.147	0.148
	(0.069)	(0.082)
Sex, 1=male	-0.011	-0.031
	(0.060)	(0.072)
Age, years	-0.039	-0.046
	(0.003)	(0.005)
Education, 1=at least 12 years	0.044	0.051
	(0.062)	(0.075)
Training for employment, 1=yes	0.183	0.226
	(0.077)	(0.094)
Member of UI fund, 1=yes	0.208	0.258
	(0.064)	(0.078)
Came from schooling, 1=yes	0.278	0.300
	(0.082)	(0.101)
Came from housework, 1=yes	-0.649	-0.742
	(0.135)	(0.154)
Regional demand, V/U ratio	0.113	0.155
	(0.242)	(0.278)
Occupational demand, V/U ratio	0.563	-0.352
	(0.627)	(0.761)
Taxable assets, millions of FIM	0.765	0.791
	(1.115)	(1.240)
Replacement ratio of UI benefits	-1.232	-1.533
	(0.157)	(0.197)
Log likelihood	-4931.8	-4927.4

The explanatory variables for the regional and occupational demand have insignificant coefficients. That is an unexpected result. Accordingly the re-employment of unemployed workers does not depend notably on the number of unemployed workers and vacancies. It may, however, have effects on the labour mobility, which is examined in the later sections of this study.

The replacement ratio of unemployment benefits significantly decreases the re-employment probability. The result gives support to the disincentive effects of benefits based on search theory (Kettunen, 1992a). Another more detailed empirical study shows that the negative effect of unemployment benefits is during the first few months of unemployment (Kettunen, 1993c). After the first three months there is a positive shift in the coefficient of the replacement ratio and the effect vanishes for the members of labour unions, but for the non-members the negative effect decreases appreciably. After the first three months the unemployed persons can lose their benefits if they do not accept a job offer obtained from other regions or occupations. The members of labour unions are eligible for the earnings-related unemployment allowance. It has a reduction of 20 per cent at the 100th day of unemployment. According to the theoretical and empirical results the reductions of benefits are effective ways of reducing the disincentive effect of benefits. The duration-dependent effects are studied in detail in section 5 of this chapter.

Table 3 includes the estimates of proportions of the unemployed persons who do not become employed. The figures have been calculated using the average characteristics of the persons in the sample. The limits of the survivor functions as the duration of unemployment approaches infinity give the lowest estimates of the proportion of the persons who will become employed. Instead of infinity it can, however, be argued that it is more reasonable to calculate the proportions for a number of years, say, 2 and 5 years.

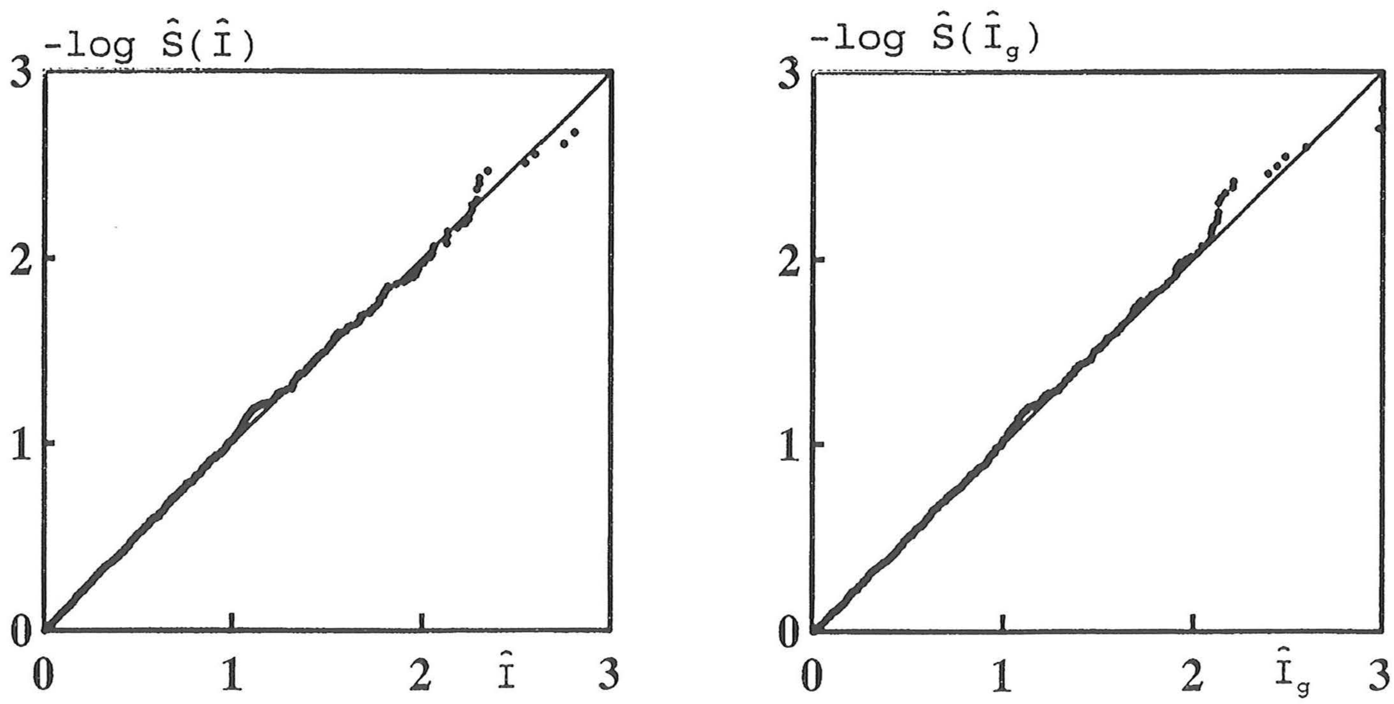
It is well known that uncontrolled unobservables bias the estimated hazards towards negative duration dependence (Heckman and Singer, 1984a,b, 1986). Consequently, it could be expected that after allowing for gamma heterogeneity the estimates of survivor functions would be lower. The estimates of the survivor function of the Gompertz model at 2 and 5 years of unemployment are 0.088 and 0.069, respectively, and the survivor function is decreasing to a value 0.062 showing that more than 6 per cent of the individuals will not become employed according to the model.

After allowing for gamma heterogeneity the corresponding estimates are 0.076, 0.038 and 0.032, respectively. The estimates of the survivor functions are lower after taking the effects of omitted variables into account, as was expected. As a final estimate it can be said that only about 3 per cent of the persons who became unemployed during 1985 will never become employed. One may argue that this is such a low figure that it does not usually matter in estimating models of unemployment duration.

Table 3. Proportion of unemployed persons who will not become employed

	Years		
	2	5	∞
Gompertz model	0.088	0.069	0.062
Gompertz model with gamma heterogeneity	0.076	0.038	0.032

Figure 1. Residual plots of the Gompertz models of unemployment duration



3.3. Regional Mobility

The model specification was examined using a graphical procedure suggested by Lancaster and Chesher (1985). The product-limit procedure allowing for censored data was applied to the integrated hazards (2) and (12) in order to estimate the residual survivor functions $\hat{S}(\hat{I})$ and $\hat{S}(\hat{I}_g)$. The plot of the negative of the logarithm of the residual survivor function should give a 45° line through the origin in large samples, when the model is correct. The residual plots are in *Figure 1*. They are fairly precisely on the 45° line except for the last few observations. The Gompertz models seem to be clearly better specified than the corresponding Weibull models (c.f. Kettunen, 1993c).

This section is concerned with the estimation of the models of regional mobility in the labour market using Finnish microeconomic data on unemployed persons. The models of becoming employed have been widely studied in the search theoretical and microeconometric literature. The important feature of becoming employed by moving to another area of residence has not, however, received notable attention. The probability of becoming employed by moving to another area of residence may be so low for some of the persons that they will not move. The proportions of these people are estimated from the data, where the completed spells of unemployment are not observed for all the observations.

There are many empirical studies on the probability of regional mobility. Usually discrete choice models are used to analyse the determinants of mobility (e.g. Holmlund, 1984, Borjas, 1987, Falaris, 1987, Hughes and McCormick, 1987, Molho, 1987, Boots and Kanaroglou, 1988 and Pissarides and Wadsworth, 1989). Our study extends the previous papers by analyzing the regional mobility of unemployed persons. Regional mobility is a rather rare phenomenon in the labour market. Therefore the number of persons who move may be low. Duration models are used because they are more efficient than the discrete choice models. Exact durations contain more information than the 0-1-valued indicators.

In this section the interest is on the persons who get a job by moving from their area of residence. These kinds of observations are complete observations. The time between the date of becoming unemployed and the date of re-employment by moving is the duration variable of interest.

Some of the persons leave unemployment by staying in their area of residence and some of them are lost in the follow-up. These kinds of observations are censored observations, i.e. the complete spells of the duration variable of interest are not observed.

The procedure differs from the traditional competing risk approach in the sense that the different ways of becoming employed are not mutually exclusive. They, however, exhaust the possible destinations (see Kalbfleisch and Prentice, 1980). The ways of becoming employed are not mutually exclusive, because one person can become employed by moving and changing his occupation. In principle mutually exclusive sets would be possible, but the few observations of the regional and occupational movers do not allow to estimate a reasonable model with explanatory variables.

Finnish data on 2077 unemployed persons are used in this study to analyse the labour mobility of unemployed workers. Re-employment by moving is a rather rare phenomenon. About 97 per cent of the observations are right censored, i.e. the complete spells of unemployment until the date of moving were not observed. In censored cases it is not known whether the persons have moved or not. Therefore a discrete choice model would clearly be inappropriate in this case. A duration model is more reasonable, because the exact durations contain more information than the 0-1-valued variables. Whereas the degree of censoring is high, it is reasonable to estimate only rather parsimonious models. The data set includes individual and market-specific information. Regions consist of one or more communities as designated by the Finnish Ministry of Labour.

Table 4 presents the results of estimations. The parameter estimate of the duration dependence θ is negative indicating that the hazard function is falling and that the survivor function is asymptotically decreasing to a positive value. Hence some of the persons will not move to get a job. When gamma heterogeneity is introduced into the model, the negative duration dependence decreases as expected. The constant of the model, where the effect of omitted variables is captured, decreases and the absolute values of the statistically significant parameter estimates increase when gamma heterogeneity is introduced into the model, as was expected.

Table 4. Gompertz models of regional mobility

(A) Gompertz model
(B) Gompertz model with gamma heterogeneity

	(A)	(B)
	Std.errors in parentheses	
Duration dependence, θ	-0.024	-0.010
	(0.013)	(0.018)
Variance of heterogeneity, σ^2		4.116
		(5.007)
Constant	-3.540	-3.353
	(0.537)	(0.698)
Age, years	-0.053	-0.059
	(0.022)	(0.026)
Member of UI fund, 1=yes	-1.378	-1.515
	(0.461)	(0.494)
Regional demand, V/U ratio	-1.941	-2.387
	(1.446)	(1.637)
Occupational demand, V/U ratio	2.761	3.692
	(3.111)	(3.449)
Replacement ratio of UI benefits	-5.185	-5.731
	(0.959)	(1.025)
Log likelihood	-333.3	-332.9

Some of the explanatory variables have significant effects on the probability of moving. Age is a statistically significant factor. Older persons are less flexible in leaving their area of residence. With substantial amounts of human capital older workers will have a narrow choice set of alternative jobs available. The incentives for moving may consequently be quite restricted. Young workers, on the other hand, have a broad choice set of jobs available. Using search theoretical results it can be argued that the moving costs of elderly workers considerably reduce their likeliness to move (Kettunen, 1993c). Therefore the incentives for job search and moving are likely to be stronger for young workers.

Members of the UI funds, who are usually members of labour unions, do not move as often as the non-members. There may be many reasons behind this result. One plausible and probably dominating explanation is that members are often skilled and more motivated workers and therefore they do not as likely as the non-members have to accept an offer outside their area of residence.

The demand for labour in the area of residence of unemployed persons seems to decrease the probability of moving. In addition, the occupational demand in the whole country seems to increase the probability of moving. The demand effects are not, however, statistically significant in these models.

The unemployment benefits are specified in the model using the benefit replacement ratio. Using the search models it can be hypothesized that the high replacement ratio reduces the probability of becoming employed by reducing the search activity and increasing the selectivity of the workers. The parameter estimate of the replacement ratio takes a negative sign, as expected, and the effect is rather strong and statistically significant. After the first three months of unemployment the persons have to accept a job offer also from other regions. Otherwise they may lose their benefits. A more detailed study using Cox's model shows that the hazard function has a prominent jump after the three months of unemployment (Kettunen, 1993c).

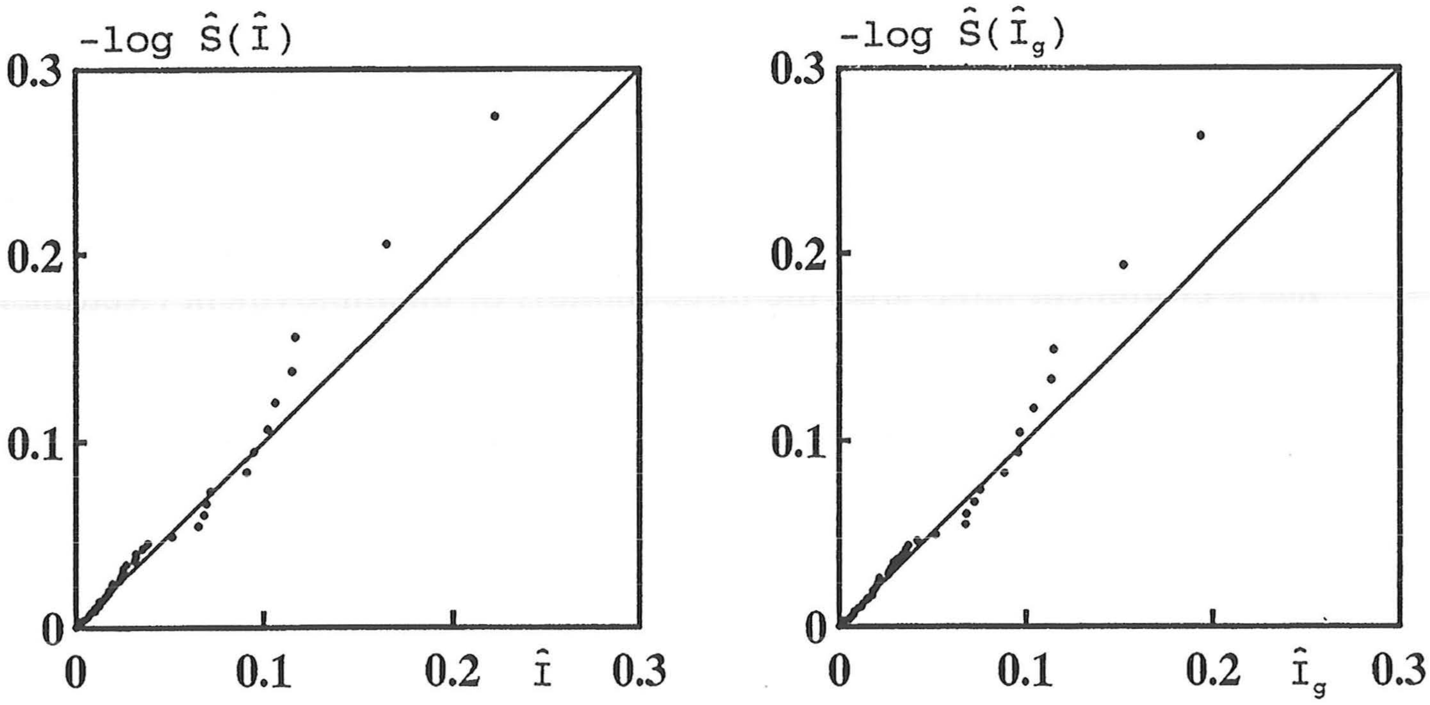
From a policy viewpoint it may be of interest to see whether an increase in unemployment benefits has any influence on the probability of moving. According to the model the increase of the replacement ratio of an average person by 1 per cent will decrease the probability by 0.88 and 0.97 per cent in these two models. One cannot, however, draw very strong conclusions about these models, since the models have rather few parameters.

Table 5 includes estimates of the proportions of the unemployed persons who do not move to get a job. The figures have been calculated using the average characteristics of the persons in the sample. The estimate of the proportion of persons who do not move is 0.94 and after allowing for gamma heterogeneity the corresponding proportion is 0.90. The residual plots are in *Figure 2*. The residuals behave reasonably well taking into account that the models are rather parsimonious.

Table 5. **Proportions of unemployed persons who will not move to get a job**

	Years		
	2	5	∞
Gompertz model	0.944	0.939	0.939
Gompertz model with gamma heterogeneity	0.928	0.905	0.896

Figure 2. **Residual plots of the Gompertz models of regional mobility**



3.4. Occupational Mobility

This section is concerned with the estimation of occupational mobility of unemployed persons in the labour market using Finnish data on unemployed workers. Occupations in the data are measured on a very detailed level. The most accurate definition of occupations includes 1320 occupations. The models of becoming employed have been widely studied in the search theoretical and econometric literature. The important feature of becoming employed by changing occupations has not, however, received notable attention. The unemployed person makes a two-stage decision, firstly to choose the occupation for which to carry out a search and secondly to accept a job within that occupational category. In this study econometric models for changing occupations are discussed and estimated using duration data.

There are some empirical studies on the educational and occupational choices, which may be regarded as investment decisions. Willis and Rosen (1979) test the human-capital maximizing hypothesis in the context of the educational choices of a panel of individuals in the United States. Similar work is done by Pissarides (1981, 1982) and Micklewright (1987) for the United Kingdom. Applications to occupational upgrading have been made by Grimes (1986) and to occupational choice decisions by Boskin (1974) and Schmidt and Strauss (1975). Stone (1982) has studied the decision of changing occupations using binary logit models with the duration of unemployment as an explanatory variable. Robertson and Symons (1990) follow these studies by estimating a logit model for the rough classification of occupations: professional, skilled and unskilled. Our study extends this vein of research by focusing the occupational mobility of unemployed persons and the effect of earnings and training for further employment with other factors in that decision.

The probability of becoming employed by changing occupations may be so low for some of the persons that they will never change occupations. The proportion of these people is estimated from the Finnish data of 2077 unemployed workers. The unemployment duration until the date of reemployment by changing occupation is the random variable of interest.

The completed spells of unemployment are not observed for all the observations. Some of the persons leave unemployment by staying in their previous occupations and some of them are lost in the follow-up. In addition, some of the workers will not return to work. They may leave the labour force. The reasons for that may be retirement, unemployment pension or even death. In some cases the previous occupation is not known. These kinds of observations are censored observations, i.e. the complete spells of the duration variable of interest is not observed.

Each occupation is measured using a 5-digit code in the Nordic Occupational Classification. The classification is such that the occupations near each other form subgroups, which are collected into groups, and the groups are collected into main groups. The first, 1-2, 1-3 and 1-5 digits classify 10, 84, 305 and 1320 groups or occupations, respectively. There are 103, 142, 161 and 202 completed spells on the different levels, i.e. the duration between the date of becoming unemployed and the date of changing occupation was observed. The rest of the observations are censored. In censored cases it is not known whether the persons have changed their occupations or not. Therefore a discrete choice model would in this case clearly be inappropriate.

People change their occupations most often on the most accurate 5-digit level, i.e. when the occupations do not differ very much from each other. It is an empirical question on which level the occupational mobility is examined. According to the Unemployment Insurance Act the unemployed workers do not have to change their occupations during the first three months. After the first three months they may lose their benefits if they refuse to accept an offer from another occupation. In practice the occupations are defined very narrowly in the employment offices. Therefore the 5-digit level is the most appropriate.

Tables 6 and 7 present the results of estimations. The parameter estimates of duration dependence are statistically significant and negative indicating that the hazard function is falling and that the survivor function is asymptotically decreasing to a positive value. Hence some of the persons will never change occupations. When gamma heterogeneity was introduced into the model the negative duration dependence decreases, as was expected. In addition, the constant of the model, where the effect of omitted variables is captured, decreases and the absolute values of the statistically significant parameter estimates increase in most cases.

The characteristics that are positively related with the probability of changing occupations are those that make the unemployed person's skills less occupation-specific. Many of the explanatory variables have significant effects on the probability of changing occupations. Age is a statistically significant factor. Old persons are not very flexible in changing occupations.

Education can be regarded as an investment decision on the part of the individual, as noted by Becker (1964). Furthermore, it can be argued that job opportunities and occupations rise with the length of schooling, because one can accept a job below the educational level, but cannot elicit a job offer above the educational level (see Groot and Oosterbeck, 1990). The results of estimations give support to these arguments.

Training for further employment provided by the government seems to have a positive effect on the probability of changing occupations. The result is as expected, since the purpose of the training is to promote the matching of workers by providing skills for new occupations. Members of the UI funds are often skilled and motivated. Therefore they are more prone than the non-members to accept other occupations. The persons leaving school or the army do not differ in this respect from other persons.

The demand for labour in the area of residence of unemployed persons is positively related to the probability of changing occupations. According to the results regarding the regional mobility rather few people move to get a job. Therefore it sounds sensible to argue that the antipathy against moving is reflected in the probability of changing occupations in the area where the unemployed workers live. On the other hand, the occupational demand in the whole country has a strong negative effect on the probability of changing occupations. The assets of the persons are negatively related to the probability of changing occupations.

It could be hypothesized that the UI benefits increase the probability that workers will seek job opportunities within the previous occupations rather than jobs associated with alternative lower-paying occupations. The effects of unemployment benefits are measured using the benefit replacement ratio. The parameter estimates of the replacement ratio take negative signs, as expected. The effect of the replacement ratio is statistically significant after allowing for gamma heterogeneity. The estimates for the elasticities of the replacement ratio on the probability of changing occupations vary between -0.15 and -0.23 depending on the level of occupations.

According to the Unemployment Insurance Act the persons have to accept offers from other occupations after the first three months of unemployment. If the workers are not willing to change their occupations, they may lose their benefits. A detailed analysis based on more flexible forms of the hazard function shows that the hazard function increases sharply just after the first three months. Also semi-parametric models can be used to verify this result (Kettunen, 1993c).

Table 6. Gompertz models of occupational mobility

	Level of classification of occupations			
	1	2	3	5
θ	-0.027	-0.026	-0.027	-0.027
	(0.009)	(0.007)	(0.007)	(0.006)
Constant	-4.030	-3.635	-3.661	-3.448
	(0.476)	(0.431)	(0.400)	(0.369)
Age, years	-0.027	-0.025	-0.030	-0.035
	(0.013)	(0.011)	(0.010)	(0.009)
Education	0.497	0.262	0.290	0.299
	(0.243)	(0.205)	(0.194)	(0.173)
Training for employment	0.245	0.241	0.241	0.340
	(0.280)	(0.233)	(0.222)	(0.188)
Member of UI fund	0.273	0.253	0.350	0.371
	(0.223)	(0.188)	(0.176)	(0.154)
Came from schooling	-0.122	0.076	0.065	-0.029
	(0.342)	(0.285)	(0.271)	(0.247)
Came from housework	0.163	0.270	0.207	0.079
	(0.341)	(0.277)	(0.265)	(0.248)
Regional demand	0.717	1.108	1.298	1.129
	(0.862)	(0.687)	(0.637)	(0.569)
Occupational demand	-5.466	-6.064	-4.861	-3.538
	(2.466)	(2.086)	(1.849)	(1.623)
Taxable assets	-1.643	-1.453	-0.610	-0.404
	(0.721)	(0.632)	(0.366)	(0.328)
Replacement ratio	-0.743	-0.743	-0.420	-0.468
	(0.493)	(0.407)	(0.366)	(0.333)
Log likelihood	-658.6	-867.3	-966.8	-1165.2

Table 7. Gompertz models of occupational mobility allowing for gamma heterogeneity

	Level of classification of occupations			
	1	2	3	5
σ^2	7.720	7.291	6.115	4.346
	(5.393)	(3.862)	(3.306)	(2.305)
θ	-0.003	-0.004	-0.002	-0.002
	(0.018)	(0.017)	(0.016)	(0.014)
Constant	-3.460	-3.011	-3.103	-2.905
	(0.674)	(0.661)	(0.602)	(0.536)
Age	-0.034	-0.033	-0.041	-0.047
	(0.018)	(0.016)	(0.015)	(0.013)
Education	0.634	0.296	0.361	0.334
	(0.350)	(0.306)	(0.282)	(0.243)
Training for employment	0.172	0.270	0.267	0.446
	(0.408)	(0.354)	(0.331)	(0.274)
Member of UI fund	0.383	0.394	0.528	0.531
	(0.318)	(0.280)	(0.258)	(0.220)
Came from schooling	-0.246	-0.039	-0.046	-0.186
	(0.459)	(0.416)	(0.388)	(0.340)
Came from housework	0.389	0.511	0.404	0.131
	(0.460)	(0.417)	(0.392)	(0.350)
Regional demand	0.985	1.844	2.141	1.705
	(1.140)	(0.966)	(0.874)	(0.747)
Occupational demand	-8.099	-8.769	-6.824	-4.600
	(3.366)	(2.957)	(2.505)	(2.167)
Taxable assets	-2.025	-1.920	-0.727	-5.266
	(0.824)	(0.784)	(0.431)	(3.992)
Replacement ratio	-1.065	-1.331	-0.888	-0.971
	(0.674)	(0.604)	(0.340)	(0.472)
Log likelihood	-657.3	-864.6	-964.1	-1162.8

An unemployed person can apply for jobs in several different occupations. The firms receiving the applications are more likely to offer the job if it is in occupations close to the applicant's training, less likely otherwise. Therefore, the probability that the unemployed person will be offered a job in his prior occupational group is higher than the probability that he or she will be offered a job in other occupational groups.

Table 8 includes estimates of the proportions of the unemployed persons who do not change occupations. The figures have been calculated using the average characteristics of the persons in the sample. The limits of the survivor function as the duration approaches infinity gives the estimates of the proportion of the persons who will never change occupations.

Some important explanatory variables cannot be observed in the data, e.g. the willingness to change occupations and the willingness of firms to offer jobs in other occupations. Therefore the unobserved heterogeneity is taken into account assuming that the effects of omitted variables have a gamma distribution across the individuals. The estimates of the proportion of persons who do not change occupations vary between 0.84 and 0.69 depending on the level of measurement. The estimates of the survivor functions are lower after taking omitted variables into account. The corresponding proportions are between 0.71 and 0.48 after allowing for gamma heterogeneity. The residual plots are in *Figure 3*. They are reasonably well on the 45° line except for the last few observations.

Table 8. Proportions of unemployed persons who will not change occupations

	Level of classification of occupations (number of digits)			
	1	2	3	5
Gompertz model	0.84	0.78	0.75	0.69
Gompertz model with gamma heterogeneity	0.71	0.68	0.58	0.48

Figure 3. **Residual plots for the Gompertz models of occupational mobility**

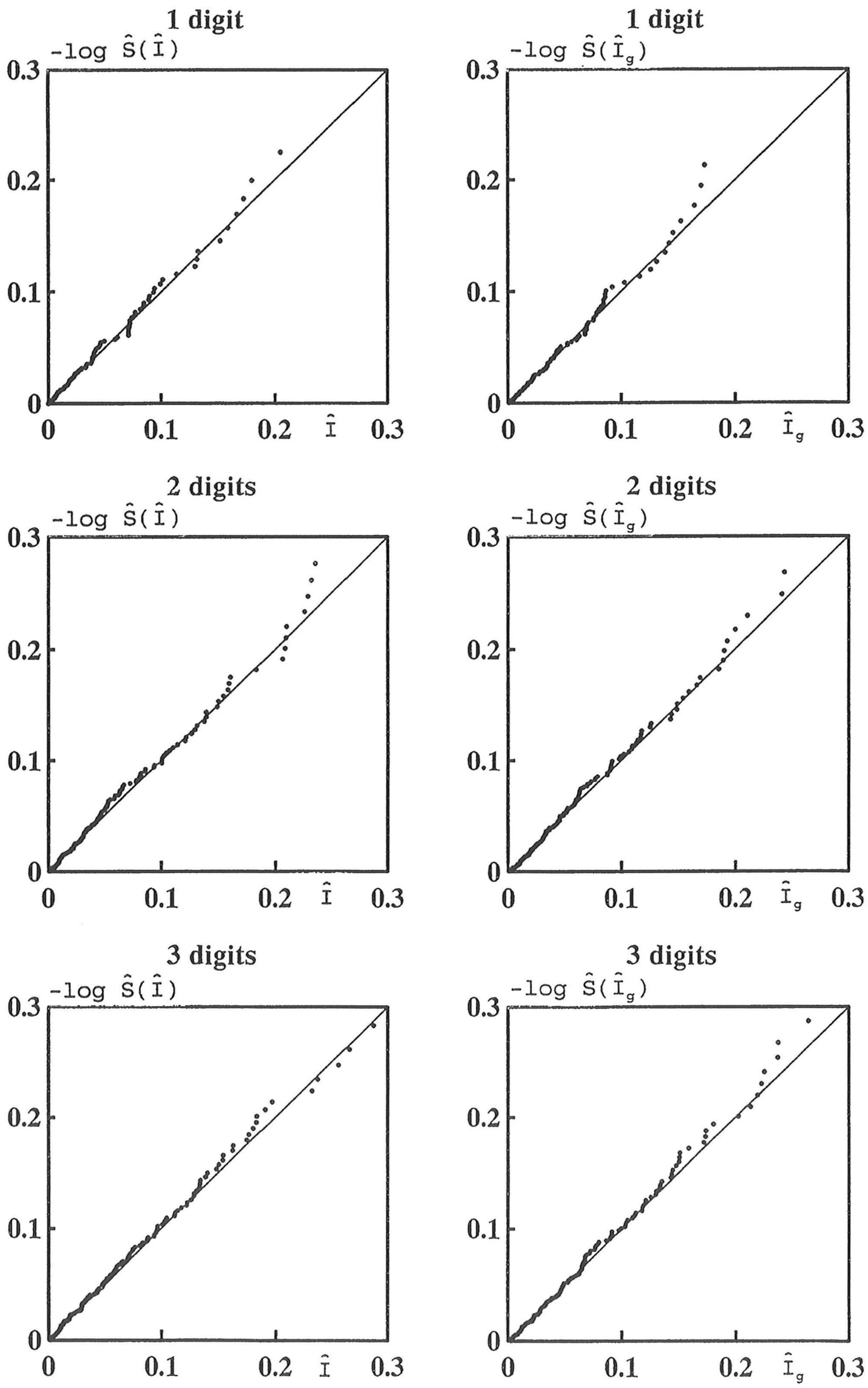
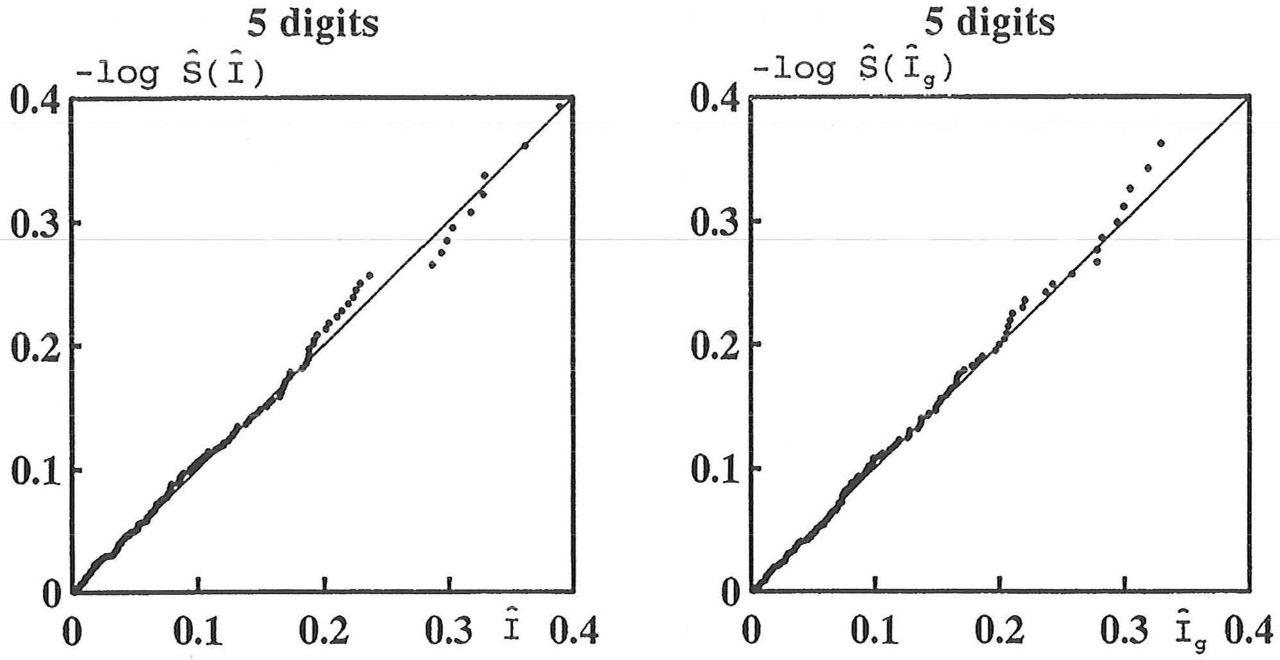


Figure 3. continued



4. Specification of Unemployment Benefits in the Models of Unemployment Duration

This section analyses the specification of the unemployment benefits, earnings and replacement ratio in the models of unemployment duration. There are many ways how these variables can appear in models of unemployment duration. This section is based on the comment on Lilja (Kettunen, 1993a).

Lilja (1992, 1993) estimated models of unemployment duration using the monthly labour income and replacement ratios of benefits as explanatory variables in the same model. The income took a positive coefficient and the coefficient of the replacement ratio was statistically insignificant. These results can be incorrectly interpreted that the coefficient of the replacement ratio, which is the ratio of benefits and earnings, may be negative without controlling for earnings in models of unemployment duration, because the earnings are positively correlated with the unemployment duration. It is shown in this section that including the earnings and replacement ration in the same model can lead to misleading interpretations.

Lilja (1992, 1993) studied the effects of unemployment benefits by using semiparametric discrete-time models and data of Labour Force Surveys from the years 1984 - 1989. Furthermore, she accounted for the potential self-selection by studying the behaviour of unemployed workers in different unemployment benefit schemes separately. The semiparametric discrete-time model has earlier been used by Meyer (1990) and Narendranathan and Stewart (1991) using the data based on flow sampling. The comments presented in this note are concerned with the effects of unemployment benefits.

Since Lilja has not presented the essential results of the estimations, it is necessary to highlight some issues of the model specification and effects of replacement ratios. In order to analyse the effects of unemployment benefits, models of unemployment duration were estimated using alternative Finnish data collected by Kettunen (1991a). The data, which have been from the flow into unemployment during 1985, include exact durations of 1250 noncensored and 827 censored spells of unemployment.

For simplicity the models were estimated using the LIFEREG procedure of the SAS package (SAS, 1985). Let the random variable T denote the duration of unemployment for the entrants into unemployment and t its realization. The Weibull distributed hazard function used in the SAS package takes the form

(14) $h(t) = (1/\sigma)t^{(1/\sigma)-1}\, e^{x\beta/\sigma}$,

where σ is the shape parameter, x includes the explanatory variables and β is a vector of structural parameters.

Table 9 includes the results concerning the effects of monthly unemployment benefits, earnings and replacement ratios. The models include twelve other explanatory variables, but their parameter estimates have been left out from the table to save space. In the models (1), (2) and (3) continuous explanatory variables are used. The benefits and replacement ratio decrease the probability of becoming employed, but the effect of monthly earnings is statistically insignificant.

Models (4), (5) and (6) include the corresponding models using dummy variables. The effects of unemployment benefits are increasing over the benefits except in the highest benefit group. The reason seems to be that the replacement ratio is decreasing over earnings due to the Finnish Unemployment Insurance Act. The monthly earnings do not have statistically significant effects in model (5). Model (6) shows that the replacement ratio has a negative and statistically significant effect on the probability of finding an acceptable job offer.

The model presented by Lilja (1992) corresponds to model (7). In her model previous earnings are used with replacement ratios. She presents no economic theory why previous earnings should have effects on the duration of unemployment. If dummies for the replacement ratio are included, the monthly earnings seem to increase the hazard function. The reason for the spurious effect of monthly earnings is that the earnings and replacement ratio are negatively correlated. It would be interesting to see the effects of the replacement ratios without monthly earnings on the hazard function using the data of Labour Force Surveys.

The expected value of an unemployment spell is obtained by integrating the survivor function as follows

Table 9. **Effects of monthly benefits, earnings and replacement ratios on the probability of becoming employed**

Models	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Std. errors in parentheses						
Benefits	-0.46 (0.06)						
Earnings		-0.023 (0.015)					
Replacement ratio			-1.47 (0.18)				
Benefits:							
(0, 500]				-0.53 (0.11)			
(500, 1500]				-0.75 (0.08)			
(1500, 2500]				-0.78 (0.13)			
2500 <				-0.23 (0.31)			
Earnings:							
(1000, 3000]					0.00 (0.16)		0.35 (0.16)
(3000, 5000]					0.29 (0.16)		0.58 (0.16)
(5000, 7000]					0.11 (0.18)		0.23 (0.18)
7000 <					-0.27 (0.20)		-0.17 (0.20)
Replacement ratio:							
(0.0, 0.2]						-0.53 (0.10)	-0.50 (0.10)
(0.2, 0.4]						-0.74 (0.09)	-0.87 (0.09)
(0.4, 0.6]						-0.77 (0.11)	-0.89 (0.12)
0.6 <						-0.99 (0.17)	-1.02 (0.17)

Benefits, earnings and replacement ratios are after tax. Other explanatory variables are number of children, marital status, sex, age, level of education, training for employment, member of UI fund, came from schooling, came from housework, regional demand, occupational demand and taxable assets.

$$\text{(15)} \quad E(T) = \int_0^\infty e^{-u^{1/\sigma} e^{x\beta/\sigma}} du$$

$$= \sigma e^{x'\beta} \Gamma(\sigma) \ ,$$

where Γ is the complete gamma function. Using a continuous variable for the replacement ratio in model (3) the expected value of an unemployment spell for an average person in the sample is 24.5 weeks. With no benefits the expected value would be 19.3 weeks. A straightforward conclusion is that the UI benefits increase the unemployment duration by 27 percent. Clearly the replacement ratio of benefits is an essential variable to increase the unemployment duration.

5. Semiparametric Models of Unemployment Duration

This section presents a discussion of the features of the Finnish unemployment benefit system and the associated problem of heaping of unemployment durations at particular changes in the system. Usually the circumstances of unemployed persons change during the spells of unemployment duration. There is plenty of evidence that plotting the hazard function by duration indicates spikes around the moment of benefit exhaustion (see Moffitt, 1985, Ham and Rea, 1987, Katz and Meyer, 1990 and Meyer, 1990).

Unfortunately the data does not allow us to study the moment of benefit exhaustion, because the follow-up period is at most two years and the earnings-related unemployment benefits are paid in Finland during the first 500 working days of unemployment excluding Saturdays and Sundays. Using the search theoretical models one can expect similar kinds of spikes and heaping when the protective period regarding labour mobility terminates and when the benefits are reduced (Kettunen, 1992a). These changes in the system can be examined using the data.

An unemployed person does not have to accept an offer outside his area of residence during the first three months of unemployment (13 weeks). Also, the person does not have to accept an offer if the work is not suitable for him with respect to his previous work experience or education. After the first three months the person has a risky period, because he can lose benefits if he does not accept a job outside his area of residence.

Another interesting feature of the Finnish system of unemployment insurance during the period of study was that the earnings-related unemployment benefits were reduced 20 per cent after the first 100th days of unemployment (20 weeks). According to the search models the reduction increases the incentives for re-employment and we may expect heaping of observations around the moment of reduction. The non-members of labour unions are eligible for the basic unemployment allowance, which is flat during the unemployment duration. The eligibility for the basic unemployment allowance was unlimited during the period of study. It has been recently shown that the risky period and reductions of unemployment benefits decrease the negative effect of unemployment benefits on the probability of becoming employed (Kettunen, 1996a).

The first week of unemployment is a waiting period for the unemployment benefits. Therefore we may expect a high hazard during the first week. There may be also other reasons for the high hazard at the beginning of unemployment. In many cohort data the hazard of the sample is inherently decreasing, because the active persons are first leaving the cohort.

During the period of study there was a regulation in Finland that an employment office has to offer a job to the long-termed unemployed after the first year of unemployment. This kind of rule may lead to a practice that the persons who have been unemployed less than a year are rather seldom offered jobs. As a result an increasing hazard is expected to appear after the first 52 weeks.

A model of piece-wise linear hazards presented by Prentice and Gloeckler (1978) is estimated. In this approach the effect of unemployment duration on the probability of becoming employed is expressed non-parametrically. The hazard function $h(t) = h_0(t)\exp[x(t)\beta]$, where $h_0(t)$ is the unknown baseline hazard, t is unemployment duration, x includes the explanatory variables which are constant in our case and β is a vector of unknown structural parameters. The simultaneously estimated structural parameters are estimated consistently with the baseline hazard.

The probability that the unemployment duration is terminated by time, given that the person was still unemployed at time t, is defined by the following discrete-time proportional hazards model

$$(16)\quad h(t) = 1 - \exp[-\int_t^{t+1} h(\tau)d\tau]$$

$$= 1 - \exp\{-\exp[\gamma(t) + \exp(x\beta)]\},$$

where

$$(17)\quad \gamma(t) = \log[\int_t^{t+1} h_0(\tau)d\tau]$$

is a parameter to be estimated consistently with the structural parameters β.

In our case the unemployment duration is measured continuously, because the dates of entry and exit are known in the data. Therefore the intervals for the semiparametric estimation have to be predefined. The selected intervals are (0, 3], (3, 6], (6, 9], (9, 13], (13, 20], (20, 36], (36, 52] and (52, 104] weeks. The intervals have been selected in order to study the interesting features of the system of unemployment insurance.

The likelihood function can be written as follows

$$(18) \quad l(\beta,\gamma) = \prod_{n=1}^{N} \{h(t)^{c} \prod_{u=0}^{t-1} \exp[\gamma(u) + \exp(x\beta)]\},$$

where N is the size of the sample and $\exp[\gamma(u) + \exp(x\beta)]$ is the probability that the spell lasts until u+1 given that it has lasted until u. The subscript n has been left out from h, c and x to simplify the notation.

The log-likelihood function can be written as a function of hazards as follows

$$(19) \quad \log l(\beta,\gamma) = \sum_{n=1}^{N} \{c \log[h(t)] + \sum_{u=0}^{t-1} \log[1 - h(u)]\}.$$

The maximum likelihood estimates of the unknown parameters β and γ are obtained by maximizing the log likelihood using standard techniques. The models were estimated with a programme which has been written using the SAS/IML matrix language.

Attention was paid also to unobserved heterogeneity across workers, which may bias the parameter estimates. That may be due to unobserved explanatory variables or measurement error. It is assumed that the unobserved heterogeneity takes a multiplicative form so that the hazard function is multiplied by a random variable v_n. The hazard function can then be written as follows

$$(20) \quad h_n(t) = v_n h_0(t)\exp[x_n(t)].$$

It is assumed that v_n is independent of the explanatory variables $x_n(t)$.

The log-likelihood function is obtained by conditioning on the unobserved v and then integrating over its distribution. The log-likelihood function is then as follows

$$(21)\quad l(\beta,\gamma,\mu) = \sum_{n=1}^{N} \log\{\int \exp[-v\sum_{t=0}^{d-1} \exp[\gamma(t)+x\beta]]d\mu(v)$$

$$- c\int \exp[-v\sum_{t=0}^{d} \exp[\gamma(t)+x\beta]]d\mu(v)\}.$$

The previous expression did not assume any parametric form for the distribution of v. A convenient and commonly used mixing distribution is the gamma, because it gives a closed form expression for the likelihood function. This property is also provided by some other distributions. In principle, for example, the inverse Gaussian distribution could be used (see Hougaard, 1984). The gamma distribution has been previously used by Meyer (1990) in semiparametric models. The mean of the gamma distribution is normalized to one and the variance σ^2 remains to be estimated. The log-likelihood function can be written as follows

$$(22)\quad l(\beta,\gamma,\sigma^2) = \sum_{N=1}^{N} \log\{[1-\sigma^2\sum_{t=0}^{d-1}\log[1-h(t)]]^{-1/\sigma^2}$$

$$- c[1-\sigma^2\sum_{t=0}^{d}\log[1-h(t)]]^{-1/\sigma^2}\}.$$

Table 10 presents the results of estimations of the semiparametric models of unemployment duration. Separate models were estimated for the members and non-members of labour unions, because the rules of the system of the unemployment insurance are different for these groups. Also a model for the whole sample was estimated. The estimates of the structural parameters are similar to the corresponding estimates in Table 2.

Table 11 presents the results of estimations of the semiparametric models of unemployment duration with the gamma distributed mixing distribution for the non-members of UI funds. The estimate of the variance of the unobserved heterogeneity approached a negative value during the iterations for the whole sample and members of unemployment insurance funds. For the non-members the variance of the unobserved heterogeneity σ^2 took a small value of 0.178, which is not statistically significant on the level of 5 per cent. The previous study using discrete mixing distribution shows that unobserved heterogeneity is larger in the models for the non-members than for the members of unemployment insurance funds (Kettunen, 1993c). It seems that unobserved heterogeneity is unimportant in these models when the baseline hazard is nonparametrically estimated.

Table 12 presents the estimates of the weekly hazard functions of becoming employed for an average person in the sample. *Specification I* in Table 12 is based on the models in Table 10. The hazard function for an interval $h(t) = h_0(t)\exp(x\beta)$, where $h_0(t) = \exp[\gamma(t)]$ is the baseline hazard calculated for a unit of interval. To get a weekly hazard one has to divide the hazard by the number of weeks. According to the results the hazard functions of the two groups are rather similar. Both of them are monotonously decreasing. The most active persons leave the ranks of the unemployed first. Therefore the hazard function is highest at the beginning of the spell of unemployment. These results do not give support the proposition that changes in the circumstances of unemployed persons have a notable effect on the hazard function.

It should be pointed out that the estimates of the baseline hazard have been calculated for the predefined intervals. Different kinds of choices can be made leading to different kinds of estimates of the hazard functions. In *specification II* of Table 12 the selected intervals are (0, 5], (5, 10], (10, 15], (15, 20], (20, 25], (25, 30], (30, 50] and (50, 104] weeks. The hazard function for the members increases slightly at the 15th week and remains constant until the 30th week. The hazard function for the non-members is constant from the 10th week until the 30th week. These figures can be seen as weak evidence for the incentive effects of the risk period and reductions of unemployment benefits. Also many other sets of intervals were tried without any significantly better evidence.

In the previous study the baseline hazard was estimated using Cox's model (Kettunen, 1993c). It shows that there are increasing hazards just after the 13th and 20th week in the models for the members of unemploy-

Table 10. Results of estimations of the semiparametric models of unemployment duration

(A) Members of UI funds (B) Non-members of UI funds (C) Whole sample	(A)	(B) Std.errors in parentheses	(C)
Number of children	-0.000 (0.080)	-0.037 (0.079)	0.001 (0.055)
Married, 1=yes	0.242 (0.101)	0.038 (0.107)	0.114 (0.071)
Sex, 1=male	0.091 (0.097)	0.041 (0.082)	0.026 (0.062)
Age, years	-0.037 (0.005)	-0.029 (0.005)	-0.035 (0.003)
Education, 1=at least 12 years	-0.022 (0.111)	0.155 (0.083)	0.065 (0.066)
Training for employment, 1=yes	0.264 (0.117)	0.167 (0.119)	0.194 (0.080)
Member of UI fund, 1=yes			0.163 (0.066)
Came from schooling, 1=yes	0.248 (0.196)	0.325 (0.094)	0.318 (0.085)
Came from housework, 1=yes	-0.433 (0.212)	-0.655 (0.191)	-0.580 (0.140)
Regional demand, V/U ratio	0.648 (0.388)	0.057 (0.322)	0.284 (0.245)
Occupational demand, V/U ratio	2.457 (0.867)	0.075 (0.978)	1.326 (0.622)
Taxable assets, millions of FIM	0.705 (1.394)	-0.763 (2.174)	0.167 (1.103)
Replacement ratio of UI benefits	-0.734 (0.253)	-1.840 (0.225)	-1.278 (0.16
γ_1	-0.842 (0.200)	-0.748 (0.176)	-0.785 (0.128)
γ_2	-0.898 (0.211)	-0.704 (0.184)	-0.790 (0.135)
γ_3	-0.928 (0.217)	-0.712 (0.196)	-0.811 (0.142)
γ_4	-0.982 (0.228)	-0.502 (0.205)	-0.726 (0.149)
γ_5	-0.464 (0.223)	-0.075 (0.206)	0.266 (0.149)
γ_6	0.393 (0.211)	0.737 (0.203)	0.570 (0.145)
γ_7	-0.525 (0.316)	0.217 (0.256)	-0.105 (0.201)
Log likelihood	-1353.2	-1586.2	-2942.6

Table 11. Results of estimations of the semiparametric models of unemployment duration with gamma distributed mixing distribution for the non-members of UI funds

σ^2	0.178
	(0.115)
Number of children	-0.037
	(0.086)
Married, 1=yes	0.026
	(0.117)
Sex, 1=male	-0.040
	(0.005)
Age, years	-0.032
	(0.005)
Education, 1=at least 12 years	0.179
	(0.095)
Training for employment, 1=yes	0.216
	(0.132)
Came from schooling, 1=yes	0.366
	(0.111)
Came from housework, 1=yes	-0.710
	(0.198)
Regional demand, V/U ratio	0.119
	(0.346)
Occupational demand, V/U ratio	0.071
	(1.106)
Taxable assets, millions of FIM	-0.003
	(2.287)
Replacement ratio of UI benefits	-2.122
	(0.278)
γ_1	-0.660
	(0.191)
γ_2	-0.566
	(0.206)
γ_3	-0.526
	(0.226)
γ_4	-0.272
	(0.245)
γ_5	0.657
	(0.260)
γ_6	0.916
	(0.260)
γ_7	0.511
	(0.364)
Log likelihood	-1574.5

Table 12. Estimates of the weekly hazard functions of becoming employed for an average person in the sample

Unemployment duration, weeks	Members	Non-members	Whole sample
Specification I:			
(0, 3]	0.06	0.06	0.06
(3, 6]	0.06	0.06	0.06
(6, 9]	0.06	0.06	0.06
(9, 13]	0.04	0.06	0.05
(13, 20]	0.04	0.05	0.04
(20, 36]	0.04	0.05	0.04
(36, 52]	0.02	0.03	0.02
(52, 104]	0.01	0.01	0.01
Specification II:			
(0, 5]	0.06	0.06	0.06
(5, 10]	0.05	0.07	0.06
(10, 15]	0.03	0.05	0.04
(15, 20]	0.04	0.05	0.04
(20, 25]	0.04	0.05	0.04
(25, 30]	0.04	0.05	0.05
(30, 50]	0.02	0.03	0.03
(50, 104]	0.01	0.01	0.01

ment insurance funds. The baseline hazard of Cox's model is very flexible, because it has been estimated separately for each length of unemployment duration. It can be concluded that a model of piece-wise linear hazards presented by Prentice and Gloeckler (1978) is not flexible enough to detect the heaping of observations around the changes in the system of unemployment insurance.

6. Conclusions

Gompertz models of unemployment duration and labour mobility were estimated using Finnish microeconomic data collected from various administrative files. Completed spells are not observed for all the observations in the data. The model takes into account the censored observations and the feature of unemployment spells that for some of the persons the probabilities are very low so that they will never become employed, move or change their occupations to get a job.

The model can be used to obtain estimates of the proportions of persons who will never find a job, move or change occupations. The estimates of these proportions given by a Gompertz model are about 6, 94 and 69 - 84 per cent (depending on the level at which the occupation is measured).

Even though the data are rich in explanatory variables and more reliable than the data based on interviews, it can be argued that relevant variables have been omitted from the model. Neglected heterogeneity across individuals was taken into account in estimation. A Gompertz model allowing for gamma distributed unobserved heterogeneity was derived and estimated assuming that the effect of omitted variables has a gamma distribution across individuals.

Comparing the results of the two models shows that the model without correcting for unobserved heterogeneity gives lower estimates of parameters. The absolute values of parameters increase when heterogeneity is introduced into the model. In addition, the Gompertz model gives estimates for the hazard function that are too low. Consequently, the survivor functions of the models with gamma distributed unobserved heterogeneity are lower.

As a final estimate based on the correction for omitted variables it can be concluded that the estimate of the proportion of persons who will never become employed is slightly more than 3 per cent. The corresponding estimates for the persons who will never move or change their occupations to get a job are 90 and 48 - 71 per cent (depending on the accuracy of measuring occupations).

An investigation of the parameter estimates of the explanatory variables shows that married persons and school graduates become employed earlier than others. Training for further employment has a positive effect on the re-employment probability. Persons who have come from housework have low re-employment probabilities. Younger people and the persons with low unemployment benefits are more apt to leave unemployment, change occupations and move to get a job.

The unemployment insurance system seems to induce unemployed persons to stay unemployed in their area of residence and avoid taking a different sort of job. Members of the UI funds (i.e. members of labour unions) are more prone to leave unemployment and change occupations. On the other hand, they are less prone to move. One reason is that they may be more skilled workers. Therefore they are able to change their occupations and need not move to get a job.

The demand for labour in the area of residence of unemployed persons seems to increase and the occupational demand in the whole country to decrease strongly the probability of changing occupations. In addition, it can be noted that the taxable assets of the workers have a negative effect on the probability of changing occupations.

Semiparametric models of unemployment duration were estimated using a flexible specification of the baseline hazard with piece-wise linear hazards. These models did not provide strong support to the hypothesis of heaping of unemployment durations at the changes of the unemployment benefit system. The baseline hazards were decreasing with some exceptions. The risk period of benefits related to the labour mobility starts after the first three months of unemployment and the earnings-related unemployment benefits are reduced at the 100th day of unemployment (4.6 months). Around these changes in the system the hazard functions were constant. Unobserved heterogeneity was studied allowing a gamma distributed mixing distribution. It can be concluded that unobserved heterogeneity is unimportant in these models when the baseline hazard is nonparametrically estimated.

References

Atkinson, A.B. and Micklewright, J. (1991), Unemployment Compensation and Labour Market Transitions: A Critical Review, Journal of Economic Literature 29, 1679-1727.

Becker, G.S. (1964), Human Capital, NBER Columbia University Press, New York.

Berg, G.J. van den (1990), Search Behaviour, Transitions to Non-Participation and the Duration of Unemployment, The Economic Journal 100, 842-865.

Boots, B.N. and Kanaroglou, P.J. (1988), Incorporating the Effects of Spatial Structure in Discrete Choice Models of Migration, Journal of Regional Science 28, 495-509.

Borjas, G.J. (1987), Self-Selection and the Earnings of Immigrants, The American Economic Review 77, 531-553.

Boskin, M.J. (1974), A Conditional Logit Model of Occupational Choice, Journal of Political Economy 82, 389-398.

Broadbent, S. (1958), Simple Mortality Rates, Applied Statistics, Journal of the Royal Statistical Society 7, 86-95.

Burch, P.R.J., Jackson, D., Fairpo, C.G. and Murray, J.J. (1973), Gingival Recession ('Getting Long in the Tooth'), Coloretical Cancer, Degenerative and Malignant Changes as Errors of Growth Control, Mechanisms of Ageing and Development 2, 251-273.

Cox, D.R. and Snell, E.J. (1968), A General Definition of Residuals, Journal of the Royal Statistical Society, Series B, 30, 248-275.

Dix, D., Cohen, P. and Flannery, J. (1980), On the Role of Aging in Cancer Incidence, Journal of Theoretical Biology 83, 163-173.

Engström, L. and Löfgren, K.-G. (1987), Disguised and Open Unemployment Intensified Employment Service and Unemployment Durations, Trade Union Institute for Economic Research, Working Paper Series, No. 39, Stockholm.

Eriksson, T. (1985), Some Investigations into Finnish Unemployment Dynamics, Meddelanden från stiftelsen för Åbo Akademi Forskningsinstitut, Nr 107.

Falaris, E.M. (1987), A Nested Logit Migration Model with Selectivity, International Economic Review 28, 429-443.

Grimes, P.W. (1986), Occupational Mobility and Racial Equity in the Labor Market, Journal of Behavioral Economics 15, 55-69.

Groot, W. and Oosterbeek, H. (1990), Optimal Investment in Human Capital under Uncertainty, Research Memorandum 9014, University of Amsterdam, Department of Economics, The Netherlands.

Ham, J.C. and Rea, S.A.Jr. (1987), Unemployment Insurance and Male Unemployment Duration in Canada, Journal of Labor Economics 5, 325-353.

Heckman, J.J. (1976), The Common Structure of Statistical Models with Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models, Annals of Economic and Social Measurement 5, 475-492.

Heckman, J.J. (1979), Sample Selection Bias as Specification Error, Econometrica 47, 153-161.

Heckman, J.J. and B. Singer (1984a), A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data, Econometrica 52, 271-320.

Heckman, J.J. and Singer, B. (1984b), Econometric Duration Analysis, Journal of Econometrics 24, 63-132.

Heckman, J.J. and Singer, B. (1986), Econometric Analysis of Longitudinal Data, In Griliches, Z. and Intriligator, M.D. (eds.), Handbook of Econometrics, Vol. III, North-Holland, Amsterdam, 1689-1763.

Holmlund, B. (1984), Labor Mobility, Studies of Labor Turnover in the Swedish Labor Market, The Industrial Institute for Economic and Social Research, Almqvist & Wiksell International, Stockholm.

Hougaard, P. (1984), Life Table Methods for Heterogenous Populations: Distributions Describing the Heterogeneity, Biometrika 71, 75-83.

Hughes, G. and McCormick, B. (1987), Housing Markets, Unemployment and Labour Market Flexibility in the UK, European Economic Review 31, 615-645.

Jovanovic, B. (1984), Wages and Turnover: A Parametrisation of the Job Matching Model, In Neumann, G.R. and Westergaard-Nielsen, M.C. (eds.), Studies in Labor Market Dynamics, Springer-Verlag, Berlin.

Kalbfleish, J.D. and Prentice, R.L. (1980), The Statistical Analysis of Failure Time Data, John Wiley and Sons, New York.

Katz, L.F. and Meyer, B.D. (1990), The Impact of the Potential Duration of Unemployment Benefits on the Duration of Unemployment, Journal of Public Economics 41, 45-72.

Kettunen, J. (1991a), The Effects of Unemployment Insurance: Description of the Finnish System and Data, Suomen Tilastoseuran vuosikirja 1990 (The Yearbook of the Finnish Statistical Society 1990), Helsinki, 85-108.

Kettunen, J. (1991b), Työttömyysturvajärjestelmän muutospaineet, Kansantaloudellinen aikakauskirja (The Finnish Economic Journal) 2/1991, 201-207.

Kettunen, J. (1992a), A Search Theoretical Analysis of the Finnish Unemployment Insurance System, Finnish Economic Papers 5, 129-138.

Kettunen, J. (1992b), Työttömien työllistyminen sekä alueellinen ja ammatillinen liikkuvuus, Kansantaloudellinen aikakauskirja (The Finnish Economic Journal) 2/1992, 212-217.

Kettunen, J. (1993a), Comment on Lilja (Unemployment Benefit System and Unemployment Duration in Finland), Finnish Economic Papers 6, 38-40.

Kettunen, J. (1993b), Increasing Incentives for Reemployment, Finnish Economic Papers 6, 51-60.

Kettunen, J. (1993c), Re-employment of Finnish Unemployed Workers, The Research Institute of the Finnish Economy, A 17, Helsinki.

Kettunen, J. (1994a), The Effects of Education on the Duration of Unemployment, Labour: Review of Economics and Industrial Relations 8, 331-352.

Kettunen, J. (1994b), Time-dependent Effects of Unemployment Benefits, Finnish Economic Papers 7, 120-129.

Kettunen, J. (1996a), Duration-dependent Features of Unemployment Insurance, Economics Letters 51, 115-121.

Kettunen, J. (1996b), Education and Labour Market Training in a Nordic Perspective, Nordic Labour Journal, No. 2, 14-15.

Kettunen, J. (1997), Education and Unemployment Duration, Economics of Education Review (in press).

Kooreman, P. and Ridder, G. (1983), The Effects of Age and Unemployment Percentage on the Duration of Unemployment, European Economic Review 20, 41-57.

Lancaster, T. (1979), Econometric Methods for the Duration of Unemployment, Econometrica 47, 939-956.

Lancaster, T. and Chesher, A. (1985), Residuals, Tests and Plots with a Job Matching Illustration, Annals de L'Insee, No 59/60, 47-70.

Lancaster, T. and S. Nickell (1980), The Analysis of Re-Employment Probabilities for the Unemployed, Journal of the Royal Statistical Society, Series A, 143, 141-165.

Lee, E.T. (1980), Statistical Methods For Survival Data Analysis, Lifetime Learning Publications, Belmont, California.

Lilja, R. (1992), Modelling Unemployment Duration in Finland, Labour Institute for Economic Research, Discussion papers 112, Helsinki.

Lilja, R. (1993), Unemployment Benefit System and Unemployment Duration in Finland, Finnish Economic Papers 6, 27-37.

Lindsay, B.G. (1983), The Geometry of Mixture Likelihoods: A General Theory, The Annals of Statistics 11, 86-94.

Meyer, B.D. (1990), Unemployment Insurance and Unemployment Spells, Econometrica 58, 757-782.

Micklewright, J. (1987), Choice at Sixteen, Queen Mary College, Department of Economics, Discussion Paper No. 160.

Moffitt, R. (1985), Unemployment Insurance and the Distribution of Unemployment Spells, Journal of Econometrics 28, 85-101.

Molho, I. (1987), The Migration Decisions of Young Men in Great Britain, Applied Economics 19, 221-243.

Narendranathan, W., Nickell, S. and Stern, J. (1985), Unemployment Benefits Revisited, The Economic Journal 95, 307-329.

Narendranathan, W. and Stewart, M.B. (1991), How Does the Benefit Effect Vary as Unemployment Spells Lengthen?, University of Warwick, Economics Department, July 1991.

Newman, J.L. and McCulloch, C.E. (1984), A Hazard Rate Approach to the Timing of Births, Econometrica 52, 939-961.

Pissarides, C. (1981), Staying on at School in England and Wales, Economica 48, 345-363.

Pissarides, C. (1982), From School to University, The Demand for Post Compulsory Education in Britain, Economic Journal 92, 654-667.

Pissarides, C.A. and Wadsworth, J. (1989), Unemployment and the Inter-Regional Mobility of Labour, The Economic Journal 99, 739-755.

Prentice, R. and Gloeckler, L. (1978), Regression Analysis of Grouped Survival Data with Application to Breast Cancer Data, Biometrics 34, 57-67.

Robertson, D. and Symons, J. (1990), The Occupational Choice of British Children, The Economic Journal 100, 828-841.

SAS User's Guide: Statistics (1985), Version 6 Edition, SAS Institute Inc.

Schmidt, P. and Strauss, R.P. (1975), The Prediction of Occupation Using Multiple Logit Models, International Economic Review 16, 471-486.

Stone, J.A. (1982), The Impact of Unemployment Compensation on the Occupation Decisions of Unemployed Workers, The Journal of Human Resources 17, 299-306.

Theeuwes, J., Kerkhofs, M. and Lindeboom, M. (1990), Transition Intensities in the Dutch Labour Market 1980-85, Applied Economics 22, 1043-1061.

Willis, R.J. and Rosen, S. (1979), Education and Self-Selection, Journal of Political Economy 87, S7-S36.

Chapter V

SUMMARY AND CONCLUSIONS

This chapter summarizes and discusses the conclusions of this thesis. Chapter II extended the static model of the method of pay to a dynamic case. The limited search horizon gives a prediction that the persons who have no possibility of planning a stable and long lasting attachment to the firms have a higher probability of working on an incentive wage basis. For example, women and students who cannot in many cases stay in a firm as long as men are expected to work on an incentive wage basis.

The econometric part of the study uses an extensive set of cross-section data collected from the files of the Confederation of Finnish Industry and Employers. Logit models were used to examine the effects of various explanatory variables on the probability of working on an incentive work basis. Special attention is paid on the unobserved explanatory variables. A small variance approximation of unobserved heterogeneity was used to derive an extended logit model. The results of estimations show that allowing for unobserved heterogeneity in logit models is of great importance even though the data are rich and reliable.

The incrementals of the time-based wage were negatively related to the probability of working on the incentive wage basis. It was expected by the theoretical model. Women work more often than men on the incentive wage basis. The age has a positive effect for the young workers, but the effect turns negative for the elderly persons. The wage groups in the collective wage agreements are determined by the required level of skill in a job. The wage groups are positively related to the probability of working on an incentive wage basis in the wood industry, but negatively related in the paper and metal industries. Shift work is positively related to the incentive work.

In the estimation of the wage equations a two-stage logit-ols procedure was used to estimate the effects of various factors conditional on the fact that the person is working in accordance with the chosen method of pay. According to the wage equations men usually have higher wages than women. The difference is even larger in the case of incentive wages. That supports the argument that men are more efficient. The wage contacts on the union level have been used to decrease the wage differentials between men and women in time-based wages. The age of the workers has a concave effect on the wage level.

The required level of skill has a positive effect on the wage level, as expected. An important result is that the required level of skill has larger effects on the time-based wage than on the incentive wage. Consequently, it can be concluded that the wage dispersion based on the wage groups is too wide to reflect the differences in the productivity of workers.

Chapter III analysed the data on job tenure, which were obtained from the administrative files of the Confederation of Finnish Industry and Employers. The sample was taken from the outflow of employment spells. The wage profiles are increasing for the short spells of four years or less. They are constant for the spells of five years or more. The workers with longer spells of employment have on average higher wages than the workers who have short spells.

The starting regular wage of the workers has been higher than the average wage level for the workers who have long spells of employment. For the short spells of employment the starting wages have been lower than the average wage level. An increasing wage profile is related to the low starting wages, short employment and faster turnover of labour.

The relative wage level is lower for the persons who leave industry. This gives support to the search models. For low wage workers the opportunity cost of unemployment is lower. Therefore the low wage workers are expected to leave industry.

The fact that there are alternative channels out from a firm is explicitly accounted for. The worker can leave the firm in order to get another industrial job or the person can leave industrial work. This study sheds some light on the recent phenomenon of a remarkable decrease in the number of industrial workers in Finland. The models of job tenure were estimated in a competing risk framework.

According to the results of estimations the age of the worker is negatively related on the exit rate in both of the destinations. Older persons have lower rates of turnover. Also the average age of the workers in a plant decrease the labour turnover. On the other hand, the average age of men takes a positive coefficient for the persons who find new industrial jobs.

The indicator for the high cost area has a positive coefficient on the exit rate for the persons who find new industrial jobs. The county of Uusimaa has a positive coefficient for the persons who leave industry. Also the incentive work has negative coefficients. The share of overtime hours is positively related to the exit rate. On the other hand, the share of Sunday hours is negatively related to the exit rate for the persons who do not find new jobs in industry. The exit rate from industry is high during the second and third quarters. The turnover of labour is low during the last quarter.

The required level of skill in a job is negatively related to the exit rate. The relationship is similar in both of the destinations. Consequently, the turnover of workers is high in the jobs which have low requirements. This result supports the argument that highly skilled labour cannot be replaced easily and therefore they are better paid.

The relative wage of the worker with respect to the aggregate wage level in industry has a negative relationship with respect to the exit rate for the persons who do not find new jobs within industry. The negative effect was expected by the economic model. As a result of a low wage the workers are apt to seek better paid jobs or go back to school. On the contrary, the wage is positively related to the exit rate for the persons who leave the firm in order to get another job. These workers are relatively well paid within industry.

The relative wage of the worker within a plant is clearly lower than the average wage in industry. It is negatively related to the exit rate on both of the destinations, but the negative effect of the wages is large for the persons who leave industry.

The duration-dependent effects of relative wages within industry were estimated. According to the results the effects of wages are large for the persons who have long spells of employment. Consequently, the wage level is not an important reason to leave the firm if the workers have been working for a short time. The relative wage is positively related for the workers who find new jobs within industry and have been working for somewhat less than three years. These workers are characterized by low starting wages, increasing wage profiles and better paid jobs in other industrial firms.

Chapter IV studied the unemployment duration and labour mobility using microeconomic data. Some factors were found which will decrease the probability of becoming employed. Aged persons are apt to incur problems in finding acceptable offers. They are less prone to move and change occupations than the younger persons. The persons who came from housework have lower probabilities of becoming employed than the others. Training for further employment was found to help the re-employment. A reason for concern is that the replacement ratio of benefits has a negative effect on the probability of becoming employed.

In addition, models of labour mobility were estimated. The models are based on a Gompertz distribution, which can be used in order to get estimates of the proportion of unemployed persons who will never become employed, move or change occupations. The estimates of these proportions given by a Gompertz model allowing for gamma distributed unobserved heterogeneity are 3, 90 and 48 - 71 per cent (depending on the level at which the occupation is measured).