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68
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Tomi Kyyrä

# WELFARE DIFFERENTIALS AND INEQUALITY IN THE FINNISH LABOUR MARKET OVER THE 1990s RECESSION

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Government Institute for Economic Research

Hämeentie 3, 00530 Helsinki, Finland

Email: tomi.kyyra@vatt.fi

J-Paino Oy

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**ABSTRACT:** Using a large panel of Finnish males, we study how the recession of the early 1990s hit different worker groups and affected inequality in the labour market. Despite large employment losses the cross-section dispersion of earnings is found be almost constant, while differences in layoff and hiring rates between groups have been changing over the early 1990s. To bring these divergent patterns together, we analyse the evolution of inequality in the cross-section distributions of life-time employment values derived from a search model. We show that the recession caused welfare losses in all worker groups and increased inequality. Compared to the figures reported for the U.S., the average levels of inequality based on life-time welfare measures are found to be very close to each others in both countries, even though wage inequality is much lower in Finland.

**Keywords: Inequality, search theory, labour market**

**TIIVISTELMÄ:** Tutkimuksessa hyödynnetään laajaa paneeliaineistoa analysoitaessa 1990-luvun alun laman vaikutuksia eri työntekijäryhmiin sekä eriarvoisuuteen työmarkkinoilla. Laman työllisyysvaikutukset olivat dramaattiset ja tämä on heijastunut myös eri ryhmien välisiin työllistymiseroihin sekä työpaikan menettämisriskiin. Siitä huolimatta palkkajakauman hajonta on pysynyt miltein vakiona yli lamaperiodin. Tutkimuksessa pyritään arvioimaan näiden erilaisten trendien yhteisvaikutusta eriarvoisuuteen työmarkkinoilla laskemalla ns. työpaikkojen nykyarvoja ja analysoimalla muutoksia niiden jakaumassa yli ajan. Työpaikkojen nykyarvot johdetaan etsintäteoreettisesta mallista ja niiden empiiriset vastineet estimoidaan aineistosta. Tulosten perusteella lama aiheutti hyvinvointitappioita kaikissa työntekijäryhmissä sekä lisäsi jonkin verran eriarvoisuutta. Verrattaessa vastaaviin USA:sta saatuihin tuloksiin havaitaan, että vaikka palkkahajonta on huomattavasti pienempi Suomessa, ei maiden työmarkkinoiden välillä ole oleellisia eroja eriarvoisuudessa, kun sitä mitataan työpaikkojen nykyarvoilla.

**Asiasanat: Eriarvoisuus, etsintäteoria, työmarkkinat**

# Foreword

Wage inequality in the Finnish labour market has been traditionally low. Dispersion in wages has also exhibited remarkable stability during the years of deep recession in the early 1990s. These features are often viewed as signs of the egalitarian nature of the Finnish labour market. On the other hand, the early 1990s was marked by a dramatic rise in unemployment, and unemployment experiences were not distributed evenly across workers. Some groups of workers faced much higher rates of unemployment than other groups. If the rigid wage structure prevented the labour market from adjusting to changes in economic conditions, it has been partly responsible for high levels of unemployment. This calls to doubt the Finnish labour market being in a broader context so egalitarian after all.

This research report studies the consequences of the 1990s recession for inequality in the Finnish labour market taking into account both wages and unemployment risks. It develops a life-time welfare measure based on a dynamic search model. The aim is to integrate the observed patterns of wages and labour market mobility over the early 1990s in order to measure the development of labour market inequality more comprehensively than earlier. The study belongs to a series of empirical research reports on the functioning of the labour market carried out in VATT during recent years.

When measured by this new life-time welfare indicator, the recession period is found to be marked by increasing inequality levels. This is in contrast to the stability of observed wage dispersion. Moreover, when compared to the U.S. figures, the average level of inequality seems to be very close to the U.S. level, even though wage inequality is much lower in Finland. Thus incorporating unemployment risk into a measure of inequality makes the picture of equality in the Finnish labour market somewhat less flattering. These findings suggest that inequality inferences using life-time welfare measures can be very different from the inferences based on static income distributions.

Helsinki, October 2000

Reino Hjerppe

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Helsinki, October 2000

Tomi Kyyrä

# Summary

This study examines how the recession of the early 1990s hit different worker groups and affected inequality in the Finnish labour market. Regulated labour markets with centralised wage setting – such as the Finnish one – are often viewed to be inefficient but egalitarian. Union wage setting makes wages rigid downwards and negotiated wage increases are dispersed evenly across worker groups, making relative wages sticky. Standard economic models, however, imply that negative shocks on labour demand will lead to larger employment losses if labour market institutions prevent wage adjustments. The flexibility that allows relative wages to decline in respond to a shift in the relative demand potentially increases wage differentials between worker groups, leading to higher wage inequality in the labour market. On the other hand, the change in relative wages dampens down the negative shift in the relative employment of workers hit most severally by the shock. This reduces the likelihood of unemployment and hence the risk of even higher income losses due to unemployment. In a rigid labour market unemployed workers have also lower chances of finding a job, which leads to longer periods out of work and to higher individual costs of unemployment. This in turn may lead to wider welfare differentials between individuals in work and those out of work.

This kind of reasoning suggests that the impact of labour market flexibility on inequality is generally ambiguous. It follows that computing welfare measures which not only incorporate the current income stream but also the likelihood and values of future positions in the labour market (including unemployment) may provide some new insights about labour market inequality. In this study we therefore follow the so far narrow empirical literature which uses dynamic structural models to study inequality in the labour market. The model adopted is an augmented version of the equilibrium search model of Burdett and Mortensen (1998) as developed by Bowlus and Robin (1999). It is concerned with the behaviour of a risk-neutral worker who is maximising the expected present value of future income stream. The supply side of the labour market is populated by a large number of workers who are otherwise identical but differ in experience. Workers upgrade their skills by moving into higher experience groups through a stochastic process. Each worker is assumed to be facing a known distribution of wage offers with associated jobs, from which he randomly samples wage offers both on and off the job. Firms are assumed to set wages monopsonistically, but the demand side which generates the wage offer

distribution is not explicitly modelled. As jobs are identical apart from the wage associated with them, employed workers are willing to move into higher paying jobs whenever the opportunity arises. Wages can also decrease due to negative wage shocks, and exogenous demand shocks occasionally destroy existing jobs throwing workers from employment into unemployment.

Using this modelling framework we derive value functions for different positions in the labour market (i.e. life-time labour values). These life-time labour values incorporate besides the value of the current income stream (wage or unemployment benefit) also the likelihood and value of future positions in the labour market. Cross-section distributions of life-time labour values can then be seen to reflect current labour market conditions with respect to wage distributions, transition probabilities and skill composition of the labour force. By studying the evolution of inequality in the cross-section distributions of labour values, changes in the labour market environment can be associated with the expected welfare outcomes.

Our empirical analysis is based on a large administrative panel of Finnish males for the period 1988-1996. The data is large in size as it contains practically all males who have been employed in the private sector during that period. We begin with the description of earnings patterns and worker flows between employment and unemployment for various education and experience categories. As expected, hiring and layoff rates are found to be changing dramatically over the recession period. It appears that the recession has smoothed down differences in layoff rates (the likelihood of becoming unemployed) between worker groups, while variation in hiring rates (the likelihood of finding a job when unemployed) exhibits an increasing trend over time. In terms of unemployment rates, the early 1990s is found to be marked by increasing educational differentials.

Except for the recession years, average earnings are found to be increasing slowly with decreasing educational differentials. It appears that less educated and more experienced workers have faced relatively smaller declines, if any, in their real wages during the recession years. Earnings inequality as a whole has not changed notably over the observation period, however. This is explained by increases in earnings inequality within the groups of highly educated workers. In the light of dramatic employment changes, the evolution of wages has been remarkably stable, especially as the wage adjustments during the recession have occurred only in the worker groups of the smallest size. Thus, it seems that the adjustment to the demand shock has occurred mainly through the transition rates between employment and

unemployment, i.e. the incidence and average duration of unemployment.

This raises the question how the divergent patterns of employment and earnings have together affected inequality in the labour market. To address this issue, we first estimate the structural parameters of our search theoretical model by using simple flow statistics and empirical earnings functions, and then compute the empirical counterparts of the life-time labour values given the parameter estimates. The analysis is performed assuming that the structural setting does not change over time, even though the parameters are re-estimated for each month from January 1988 to November 1996. Along the lines of Bowlus and Robin (1999), we then analyse the evolution of inequality in the cross-section distributions of life-time labour values.

We find that the average levels of life-time labour values have dropped for the recession period in all worker groups, indicating losses in the expected levels of life-time welfare. These losses caused by the recession turn out to be mainly temporary, however. The average welfare discrepancy between employed and unemployed workers exhibits a slightly increasing trend over the early 1990s, especially within education groups and among workers with over 25 years of experience. Contrary to the earnings patterns, we find educational differentials in life-time labour values to be increasing during the recession years. This suggests that the impact of decreasing educational differentials in earnings on the welfare differentials has been offset by changes in the transition rates across groups.

Moreover, we find some evidence that the recession period was marked by increasing inequality levels, though it remains a little unclear to which extent these increases were offset during the period of recovery. Inequality in our life-time welfare measure is found to be only slightly lower than the corresponding wage inequality on average, which is in contrast to the recent findings from the U.S. data. While wage inequality in Finland is approximately half of that in the U.S., inequality in life-time welfare measures seems to be very close to the U.S. level, having been perhaps some 15 per cent lower at the end of the 1980s and vanishing thereafter. This suggests that higher labour turnover and wage mobility in the U.S. labour market can compensate for higher wage inequality to a great extent.

# Yhteenveto

Säännösteltyjä työmarkkinoita pidetään usein tasa-arvoisina, joskin tehottomina. Keskitetyssä palkkajärjestelmässä suhteelliset palkat ovat varsin jäykkiä, koska nimellispalkat eivät juurikaan jousta alaspäin ja sovitut palkankorotukset jakaantuvat usein tasaisesti kaikille työntekijöille. Talousteorian mukaan negatiivinen työvoiman kysyntäshokki johtaa kuitenkin suurempiin menetyksiin työllisyydessä silloin, kun työmarkkinainstituutiot estävät palkkojen sopeutumisen. Suhteellisten palkkojen joustaessa työvoiman kysynnän muutosten mukaan saattaa seurauksena olla palkkaerojen kasvu. Toisaalta suhteellisten palkkojen muutos vähentää paineita työllisyyden muutosten suhteen. Tällöin työntekijäryhmän, jonka suhteellinen asema työmarkkinoilla on heikentynyt, työllisyys voi säilyä korkeammalla tasolla kuin tilanteessa, jossa palkat eivät jousta. Työttömän näkökulmasta katsottuna työmarkkinajäykkyyksien voidaan olettaa hidastavan uuden työpaikan löytymistä, mikä johtaa pidempiin työttömyysjaksoihin ja siten korkeampiin yksilötason kustannuksiin. Tämä taas voi kostautua suurempina hyvinvointieroina työttömien ja työllisten välillä.

Yleisesti ottaen työmarkkinoiden joustavuuden vaikutus eriarvoisuuteen on epäselvä. Työmarkkinoiden dynamiikka vaikuttaa sekä työttömien työllistymismahdollisuuksiin että työllisten työttömyysriskiin ja mahdollisuuksiin siirtyä työpaikasta toiseen. Siksi hyvinvoinnin mittarit, jotka huomioivat työntekijän nykytilanteen lisäksi myös liikkuvuuden eri työmarkkinatilojen välillä, saattavat tarjoata varsin hyödyllistä informaatiota työmarkkinoiden eriarvoisuudesta. Tässä tutkimuksessa hyödynnetään tällaista lähestymistapaa tarkasteltaessa miten 1990-luvun lama vaikutti eri työntekijäryhmien väliseen eriarvoisuuteen Suomen työmarkkinoilla. Metodologisesti tutkimus sijoittuu varsin suppeaan empiiriseen kirjallisuuteen, jossa hyödynnetään dynaamisia työmarkkinoiden rakennemalleja tutkittaessa työntekijöiden välistä eriarvoisuutta.

Teoreettisena viitekehikkona toimii Bowlusin ja Robinin (1999) muunnelma Burdettin ja Mortensenin (1998) etsintäteoreettisesta tasapainomallista. Mallissa tarjontapuoli koostuu riskineutraaleista työntekijöistä, joka pyrkivät maksimoimaan odotettuja elinaikaisia tulojaan. Kukin työntekijä työmarkkinoilla on joko työtön tai työllinen. Työntekijät poikkeavat toisistaan työmarkkinakokemuksensa suhteen ja siirtyvät satunnaisesti kokemusryhmästä toiseen. Sekä työlliset että työttömät etsivät työpaikkoja jatkuvasti. Yritykset asettavat palkkatarjoukset, jotka muo-

dostavat palkkatarjousten jakauman, jonka työntekijät kohtaavat. Koska työpaikat eroavat toisistaan ainoastaan palkan suhteen, työlliset ovat halukkaita siirtymään paremmin palkkattuihin töihin aina, kun siihen tarjoutuu mahdollisuus. Työntekijän palkka saattaa toisinaan myös laskea negatiivisen palkkashokin vaikutuksesta. Lisäksi eksogeeniset kysyntäshokit tuhoavat työpaikkoja, jolloin työllisiä siirtyy työttömiksi.

Tämän mallikehikon puitteissa voidaan johtaa ns. arvofunktiot työttömyydelle ja työpaikoille (eli työttömyyden ja työpaikkojen nykyarvot). Työttömyyden ja työpaikkojen nykyarvot ottavat huomioon nykyisen työttömyyskorvauksen tai palkan lisäksi myös tulevien työmarkkinatilojen arvot sekä todennäköisyydet siirtyä työmarkkinatilasta toiseen. Esimerkiksi työttömyyden nykyarvo riippuu työttömyyskorvauksen, etsintäkustannusten ja vapaa-ajan arvon lisäksi todennäköisyydestä löytää työpaikka sekä uuden työpaikan odotetusta nykyarvosta. Vastaavasti työpaikan nykyarvo ei riipu pelkästään siihen liittyvästä palkasta vaan myös työttömyysriskistä ja työttömyyden nykyarvosta sekä todennäköisyydestä saada vaihtoehtoinen työpaikkatarjous ja tämän odotetusta nykyarvosta. Koska mallissa yksilöt vaihtavat myös kokemusryhmää, työttömyyden ja työpaikkojen nykyarvot riippuvat myös todennäköisyydestä siirtyä seuraavaan kokemusryhmään sekä uudelle kokemusryhmälle ominaisista nykyarvoista. Kaiken kaikkiaan työttömyyden ja työllisyyden nykyarvot heijastelevat siis vallitsevia työmarkkinaolosuhteita palkkajakaumien ja siirtymätodennäköisyyksien suhteen. Nykyarvojen poikkileikkausjakaumien kehitystä yli ajan tutkimalla voidaan arvioida millaisia vaikutuksia työmarkkinaympäristön muutoksilla on ollut odotettuun hyvinvointiin (eli odotettuun elinaikaiseen tuloon).

Tutkimuksen empiirinen analyysi perustuu laajaan rekisteripohjaiseen paneeliaineistoon, joka sisältää tietoja suomalaismiehistä periodilta 1988-1996. Aineisto on varsin massiivinen, sillä se kattaa periaatteessa kaikki suomalaismiehet, jotka ovat työskennelleet yksityisellä sektorilla havaintoperiodin aikana. Aluksi tarkastellaan, miten palkat ja työntekijävirrat työllisyyden ja työttömyyden välillä ovat kehittyneet eri koulutus- ja kokemusryhmissä yli ajan. Laman vaikutuksesta työntekijävirtojen volyymit ovat muuttuneet voimakkaasti tarkasteluperiodilla. Lisäksi näyttäisi siltä, että lama supisti eroja työttömyysriskissä (ja siten virrassa työllisyydestä työttömyyteen) eri työntekijäryhmien välillä. Toisaalta eri ryhmien väliset erot työllistymistodennäköisyydessä (ja siten virrassa työttömyydestä työllisyyteen) näyttäisivät olleen kasvussa koko havaintoperiodin ajan. Erot työttömyysasteissa

eri koulutusryhmien välillä ovat myös kasvaneet lama-aikana.

Lukuun ottamatta pahimpia lamavuosia keskimääräiset reaalipalkat ovat kasvaneet kaikissa työntekijäryhmissä hiljakseen. Lisäksi palkkaerot koulutusasteiden välillä ovat supistuneet tasaisesti yli koko tarkastelujakson. Lamavuosina reaalipalkat laskivat vähiten (jos ollenkaan) heikommin koulutettujen ja iäkkäimpien ryhmissä. Palkkojen hajonta korkeasti koulutettujen työntekijöiden keskuudessa on jonkin verran kasvanut, mutta palkkahajonta kokonaisuudessaan ei ole oleellisesti muuttunut tarkasteluperiodin aikana. Yleisesti voitaneen sanoa, että muutokset palkkajakaumassa ovat olleet varsin vaatimattomia suhteessa työllisyydessä tapahtuneisiin muutoksiin. Näin ollen näyttäisi siltä, että sopeutuminen laman aiheuttamaan kysyntäshokkiin on tapahtunut pitkälti työllisyyskehityksen kautta eli viime kädessä työttömyyden kohtaannon ja keskimääräisen keston kautta.

Mikä on palkoissa, työttömyysriskissä ja työllistymistodennäköisyydessä tapahtuneiden muutosten yhteisvaikutus eriarvoisuuteen työmarkkinoilla? Tähän kysymykseen pyritään etsimään vastausta laskemalla työttömyyden ja työpaikkojen nykyarvojen empiiriset vastineet aineistosta. Ensiksi estimoidaan teoreettisen mallin rakenneparametrit käyttäen aineistosta laskettuja siirtymätodennäköisyyksiä ja empiirisiä palkkajakaumia. Parametrit estimoidaan erikseen jokaiselle kuukaudelle aina vuoden 1988 tammikuusta vuoden 1996 marraskuulle. Toisessa vaiheessa lasketaan parametriestimaattien avulla työttömyyden ja työpaikkojen nykyarvot kuukausittain. Tämän jälkeen tutkitaan muutoksia nykyarvojen poikkileikkausjakaumissa yli ajan.

Tulosten mukaan työttömyyden ja työllisyyden nykyarvot ovat keskimäärin laskeneet kaikissa työntekijäryhmissä 1990-luvun alkuvuosina heijastellen laman aiheuttamia hyvinvointitappioita. Nämä hyvinvointitappiot osoittautuvat kuitenkin väliaikaisiksi, sillä tilanne korjaantuu entiselleen havaintoperiodin loppuun mennessä. Keskimääräisen hyvinvointieron työllisen ja työttömän välillä (eli työpaikkojen keskimääräisen nykyarvon ja työttömyyden nykyarvon erotuksen) havaitaan hieman kasvaneen 1990-luvun alkupuoliskolla erityisesti koulutusryhmien sekä ylimmän kokemusryhmän sisällä. Päinvastoin kuin mitä palkoissa on tapahtunut ovat koulutusryhmien väliset erot nykyarvoissa kasvaneet lamaperiodilla. Näin ollen koulutusluokkien välisten erojen kasvu siirtymätodennäköisyyksissä on kumonnut palkkaerojen pienentymisen hyvinvointieroja pienentävän vaikutuksen.

Lamavuosien aikana on työttömyyden ja työpaikkojen nykyarvojen jakaumien hajonta kasvanut, joten lama näyttäisi lisänneen eriarvoisuutta työmarkkinoilla. Tosin

nykyarvojakaumien hajonnan havaitaan supistuneen talouden käännyttyä jälleen kasvu-uralle. Eriarvoisuus työmarkkinoilla, kun sitä mitataan työpaikkojen nykyarvojen hajonnalla, on keskimäärin hieman alhaisempi kuin eriarvoisuus palkoissa. Tämä poikkeaa selvästi tuoreista tutkimustuloksista koskien USA:n työmarkkinoita, joilla palkkahajonta on huomattavasti suurempi kuin vastaava hajonta työpaikkojen nykyarvoissa. Vaikka palkkahajonta on Suomessa noin puolta pienempi, ei USA:n ja Suomen työmarkkinoiden välillä ole oleellisia eroja eriarvoisuudessa, kun sitä mitataan työpaikkojen nykyarvoilla. Näyttäisikin siltä, että suurempi dynamiikka USA:n työmarkkinoilla (siirtymät työttömyyden ja työllisyyden välillä sekä työpaikasta toiseen) kompensoi korkean palkkahajonnan vaikutusta pitkän aikavälin hyvinvointieroihin.

# Contents

# 1 Introduction

Regulated labour markets with centralised wage setting – such as the Finnish one – are often viewed to be inefficient but egalitarian. Union wage setting makes wages rigid downwards and negotiated wage increases are dispersed evenly across worker groups, making relative wages sticky. Standard economic models, however, imply that negative shocks on labour demand will lead to larger employment losses if labour market institutions prevent wage adjustments. Some economists for example believe that differences in institutional factors can explain the clear contrast in labour market trends between the U.S. and most Western European countries during the past two decades. In the U.S. falling real wages and increasing wage inequality (especially during the 1980s) have been accompanied with strong overall employment growth.[1] At the same time in most European countries average real wages have increased slowly with more stable inequality levels and overall employment has been stagnant, leading to high levels of unemployment. It has been argued that steady employment growth in the U.S. is attributed to the higher labour market flexibility which has led to a decline in the real wages of low-skilled workers in respond to decreasing relative demand.[2]

The flexibility that allows relative wages to decline in respond to a shift in the relative demand potentially increases wage differentials between worker groups, resulting in higher wage inequality in the labour market. On the other hand, the change in relative wages dampens down the negative shift in the relative employment of workers hit most severally by the shock. This decreases the likelihood of unemployment and hence the risk of even higher income losses due to unemployment. In a rigid labour market unemployed workers have also lower chances of finding a job, which leads to longer periods out of work and to higher individual costs of unemployment. This in turn may lead to wider welfare differentials between individuals in work and those out of work. Overall, the impact of labour market flexibility on inequality is ambiguous.

In this paper we examine how the recession of the early 1990s hit different worker groups and affected inequality in the Finnish labour market. The period around the turn of the 1990s was an exceptional chapter in Finnish economic history. The

[1] See Acemoglu (1998, 1999) for the theoretical literature on the causes of increasing wage inequality.

[2] See Card, Kramarz and Lemiux (1998) for detailed discussion and attempts to empirically test this hypothesis.

beginning of the 1980s was time of steady economic growth, but there was an overheating of the economy in the last years of the decade, and finally a slump in the early 1990s. The recession that hit the Finnish economy was exceptionally severe. The annual change in GNP was negative during the period 1991–1993, and in the worst year, 1991, GNP decreased by over 7 per cent. Large-scale job destruction took place in virtually every sector of the economy. The number of unemployed in 1994 was roughly fivefold to that at the end of the 1980s and the open unemployment rate reached almost 20 per cent. This occurred even though masses of people were removed from the unemployment register and directed to labour market programmes.[3] Although the economy turned onto a strong growth path in 1994, aggregate unemployment has been declining relatively slowly.

Evolution of employment has been accompanied with a strong change in the composition of the employed labour force. Although the relative decline of employment for low-skilled workers was in progress already in the 1980s, the recession of the 1990s accelerated this progress to a great extent. Since the beginning of the recovery job creation for high-skilled workers has been strong, whereas the progress for the low-skilled has been much more unsatisfactory. In spite of these dramatic patterns of employment, average real wages have been roughly constant and wage dispersion stable over the recession years.[4]

These divergent patterns of employment and wages raise the question whether these patterns can be considered in a coherent way and how they have together affected inequality in the labour market. The point we will emphasise is that inequality inferences using cross-section income distributions may be very different from the inferences based on life-time welfare measures. This point can be illustrated with a simple example. Suppose that there are two labour markets which have identical static income distributions (covering both earned and unemployment incomes). While one labour market is characterised by high wage mobility and high labour turnover, the second one exhibits great rigidity. The ranking of individuals in the income distribution varies from year to year in the first labour market but individuals stay in the same positions year after year in the latter one. When life-time

[3] In 1994, for example, on average almost 30,000 people were on labour market training courses and over 65,000 people were employed by labour administrative measures at the end of each month. Adding these people to the figure of the unemployed indicates that some 590,000 people — almost the one-fourth of the entire labour force — were displaced from the open labour market in 1994.

[4] There is in fact some evidence that the relative wages have moved slightly to the opposite direction than what is predicted by economic theory. See Uusitalo (1999) for empirical evidence and discussion on the patterns of relative wages and unemployment levels.

welfare differentials are concerned the rigid labour market is clearly more unequal, even though there never exist cross-section differences in income dispersion between the two labour markets. This kind of reasoning suggests that computing life-time welfare measures may provide some new insights about labour market inequality.

In this study we follow the so far narrow empirical literature which uses dynamic structural models to study inequality in the labour market. Using search theory we aim to integrate the observed patterns of earnings and labour market mobility over the period 1988-1996 into a single measure of labour market inequality. In dynamic search models the life-time values of employment and unemployment (the expected present values of future income stream given the current labour market state) play important roles in determining the behaviour of individuals in the labour market. These life-time labour values incorporate besides the value of the current income stream (wage or unemployment benefit) also the likelihood and values of future positions in the labour market. Examining the cross-section distributions of the life-time labour values over time provides a way to integrate the evolution of earnings and that of the likelihood and value of moving across different labour market states. In this sense the structural dynamic search models may capture better the degree and nature of inequality in a labour market with large worker flows,[5] as pointed out by Bowlus and Robin (1999).

Contributions of the structural dynamic approach to labour market inequality literature contain Flinn (1997), Cohen (1999), and Bowlus and Robin (1999). Using a search theoretical model, Flinn (1997) estimates life-time labour values for samples of young U.S. and Italian males. Despite higher wage inequality among young U.S. males, he finds a more compressed distribution of life-time labour values for the U.S., which results from a higher frequency of movements in the U.S. labour market. Cohen (1999) employs a matching model to construct estimates of life-time labour values for U.S. and French labour markets. According to his results, life-time welfare differentials among workers are quite close to each others in the U.S. and French labour markets, even though income inequality is much higher in the U.S.

Unlike Flinn (1997) and Cohen (1999), who consider differences in inequality

[5]Since a pioneering work of Davis, Haltiwanger and Schuh (1996), a substantial amount of empirical evidence on job and worker flows has became available for various countries. This literature has documented a large degree of allocation of jobs and workers across different industries and over time. Recent findings from Finnish data, much of which is documented and summarised in Ilmakunnas and Maliranta (2000), suggest that the Finnish labour market does not make an exception in this respect but is characterised by large job and worker flows.

between two countries at a single point of time, Bowlus and Robin (1999) study changes in labour market inequality within the U.S. over time. They derive life-time labour values from a search model of the labour market and estimate the patterns of inequality from the U.S. Current Population Survey (CPS) for the period 1977-1995. Like Flinn (1997) and Cohen (1999), they find lower inequality in their life-time measures than in wages. While both wage and labour value inequality increases over the period, the increase in their measure of life-time welfare is only half of the increase in wage inequality. The lower increase in labour value inequality is explained by slightly falling (or stable) dispersion in wage mobility and employability across worker groups over the period.

In this paper we follow Bowlus and Robin (1999) who use a modified version of the equilibrium search model of Burdett and Mortensen (1998). In the Burdett-Mortensen model workers search for a new job both on and off the job, and the wage offer distribution they face while searching emerges as the equilibrium of a non-cooperative job search and wage posting game between firms and workers. The model is capable to generate labour market transitions between employment and unemployment as well as wage increases associated with job-to-job transitions. To make the model more flexible for empirical work, Bowlus and Robin introduce several extensions. First of all, they extend the basic model by allowing workers to upgrade their skills by moving into higher experience categories through a stochastic process, so that the structural parameters of the model are changing with experience. Secondly, they add wage shocks (wage offers which cannot be rejected) to the model which makes the model consistent also with negative wage changes.[6] Perhaps most importantly, contrary to the Burdett-Mortensen model which generates the equilibrium wage offer distribution of a particular parametric form,[7] Bowlus and Robin follow a more flexible approach in leaving the mechanism that generates the wage offer distribution unspecified. The life-time value of employment derived from the model is then a function of the current wage, the likelihood and value of wage changes as well as the likelihood and value of unemployment. To estimate

[6] In the standard Burdett-Mortensen model wage losses can occur only through unemployment.

[7] The solution for the wage distributions in the homogeneous version of the Burdett-Mortensen model leads to the distributions that have increasing densities over the whole wage range which is at odds with the observed wage data. However, one can avoid this unsatisfactory prediction of the model by introducing heterogeneity in marginal labour productivity of firms (see Bowlus, Kiefer and Neuman, 1995; Van den Berg and Ridder, 1998; Bontemps, Robin and Van den Berg, 2000) or in the opportunity cost of workers (see Eckstein and Wolpin, 1990) or in both (see Bontemps, Robin and Van den Berg, 1999).

the structural parameters of the model, Bowlus and Robin exploit simple worker flow statistics and recover the wage offer distribution nonparametrically from the observed distribution of earnings.

We use a large administrative panel of Finnish males covering the period 1988-1996 to describe the observed patterns of earnings and labour market transitions. The data is large in size as it contains practically all males who have been employed in the private sector during the sample period. We compute monthly measures of wage distributions and worker flows between employment and unemployment for various worker groups. Since the flow into unemployment is quite low for some worker groups, large sample size is essential to produce reliable figures. Using worker flow measures and empirical earnings functions, we then estimate the structural parameters of the Bowlus-Robin model and compute life-time labour values given the parameter estimates. The analysis is performed assuming that the structural setting does not change over time, although the parameters are re-estimated for each month from January 1988 to November 1996. Resulting cross-section distributions of life-time labour values reflect current labour market conditions with respect to wage distributions, transition probabilities and skill composition of the labour force. By examining the evolution of inequality in these cross-section distributions over time, we can study how changes in the labour market environment has affected the expected welfare outcomes.

This study differs from that of Bowlus and Robin (1999) in some essential ways. Most importantly, our analysis is performed mainly on a monthly basis, whereas Bowlus and Robin have to use annual data due to limitations of the CPS.[8] Obviously, a year is a very long time interval for examining labour market transitions between employment and unemployment, leading potentially to some kind of aggregation bias. Secondly, we exploit slightly less restrictive assumptions about worker flows. In particular we do not require the flows of workers into and out of employment to be equal, even though the assumption that the shapes of wage distributions do not change over time is retained. This relaxation is important because the time period under investigation is marked by great variation in employment.

The rest of the paper is organised as follows. The next section introduces the model to be used in computing life-time labour values. Section 3 describes the data

[8]Bowlus and Robin face other problems with the CPS data as well. Namely, only a fraction of individuals in a given cross-section in the CPS can be potentially found from the next cross-section, and matching of individuals across the cross-sections must be done without individual identification codes. These shortcomings lead occasionally to mismatches and failed matches.

and explains how the needed variables are constructed, while Section 4 discusses the estimation of the structural parameters of the model. Section 5 gives an overview of the Finnish labour market trends over the sample period and reports the estimation results. The final section concludes.

# 2 A Search Model with Experience Rating

In this section we describe the augmented version of the equilibrium search model of Burdett and Mortensen (1998) as developed by Bowlus and Robin (1999). The model is concerned with the behaviour of a risk-neutral worker who is maximising the expected present value of future income stream. The supply side of the labour market is populated by a large number of workers who are otherwise identical but differ in experience. Workers upgrade their skills by moving into higher experience groups through a stochastic process. Each worker is assumed to be facing a known distribution of wage offers with associated jobs, from which he randomly samples wage offers both on and off the job. Firms are assumed to set wages monopsonistically, but the demand side which generates the wage offer distribution is not explicitly modelled.[9] As jobs are identical apart from the wage associated with them, employed workers are willing to move into higher paying jobs whenever the opportunity arises. Wages can also decrease due to negative wage shocks, and exogenous demand shocks occasionally destroy existing jobs throwing workers from employment into unemployment.

Events the worker faces in the labour market arrive at random time intervals, modelled as the Poisson processes. At any point in time, the worker is assumed to take current labour market conditions as given and constant over time when choosing his search strategy. With these simplifying assumptions, modelling sequential search behaviour of the worker reduces to a simple dynamic programming formulation with stationary value functions.

In Section 2.1 below we explicitly characterise the model and derive the value functions to be used in inequality considerations. To recover the wage offer distribution, we consider how the aggregate worker flows implied by the model evolve over time in Section 2.2. Because the time period under investigation is a very turbulent one, we relax some steady-state restrictions of Bowlus and Robin (1999) when dealing with the aggregate worker flows.

[9] Burdett and Mortensen (1998) characterise the demand side by assuming a simple linear production technology for firms. This assumption in turn leads to wage distributions of a particular functional form. Bowlus and Robin (1999) prefer not to impose more structure on the model than is strictly necessary and therefore leave the demand side unspecified, avoiding all restrictions on the shape of wage distributions. We follow Bowlus and Robin in this respect.

## 2.1 Value Functions

Let the number of experience groups in the labour market be $I$. Workers with experience level $i \in \{1, 2, ..., I-1\}$ have an instantaneous transition rate $\mu_i$ to the next experience group. The entry rate into the labour market is $\mu_0$, and the transition rate into retirement is $\mu_I$.[10] Each worker in the labour market is either employed or unemployed. Workers randomly search for a job that pays a higher wage while employed and an acceptable wage when unemployed. The arrival rate depends both on worker's experience level and the state he is currently occupying.[11] We assume that unemployed workers with experience level $i$ receive wage offers at rate $\lambda_i^0$. To make both upward and downward wage changes possible, it is assumed that there are two sorts of alternative offers for employed workers: some that they are free to reject and some that they are compelled to accept.[12] Let the arrival rate for the former type of offers be $\lambda_i^1$ and that for the latter type be $\lambda_i^2$, so that the overall arrival rate to employed workers with experience level $i$ is $\lambda_i = \lambda_i^1 + \lambda_i^2$. We do not require the wage offers of the former type to be from outside the current employer, so the wage can increase (but not decrease) also on the current job. Moreover, job-worker matches in experience group $i$ are destroyed at exogenous rate $\delta_i$, leading to a transition from employment to unemployment.

Firms are assumed to set wages monopsonistically. As workers search randomly among employers and they are identical within experience groups, a wage offer to a worker with experience level $i$ can be viewed to be a realisation of a random draw from the known wage offer distribution of his experience group, characterised by cumulative distribution function (c.d.f.) $F_i$. Under these assumptions the behaviour of workers is, outside of experience upgrading and wage shocks, characterised with the standard job search model with search on the job (see e.g. Mortensen, 1986). Thus,

[10] It should be stressed that the allocation of individuals into the experience groups is based on age in our empirical analysis, and ageing is certainly not a Poisson process. However, we still retain the simplifing assumption that workers are moving across experience groups according to a Poisson process in order to maintain the stationarity of value functions.

[11] There are several reasons to expect that wage offer arrival rates may be different for unemployed and employed workers. For example, unemployed workers are likely to be able to spend more time in searching for jobs, while employed workers may be more informed about alternative job possibilities.

[12] The basic Burdett-Mortensen model allows wage losses only via unemployment spells, but in the data wage losses are not uncommon for continuously employed workers either. In addition to Bowlus and Robin (1999), the two sorts of wage offers to employed workers are considered also by Ridder and Van den Berg (1997). An alternative way of incorporating wage losses in the search models is to introduce measurement error in wage variables; see e.g. Christensen and Kiefer (1994), Flinn (1997), and Ridder and Van den Berg (1998).

the optimal search strategy which maximises the expected present value of future income stream has the reservation wage property: all wage offers above or equal to the reservation wage are accepted, and all offers below are rejected (if possible). While employed the current wage serves as the reservation wage. Since firms which offer wages below the reservation wage of unemployed workers in experience group $i$ are unable to attract any workers from the group, the lowest wage offered to workers with experience level $i$ is the group's reservation wage $\underline{w}_i$.

Given the framework outlined above, the present value of being unemployed for a worker in experience group $i$, $V_i$, can be expressed as the solution to the continuous time asset pricing equation

$$rV_i = b_i + \lambda_i^0 \left( E_{F_i} \left[ W_i(\widetilde{w}) \right] - V_i \right) + \mu_i \left( V_{i+1} - V_i \right), \tag{1}$$

where $r$ is the discount rate, $W_i(w)$ is the present value of a job paying wage $w$,[13] and $b_i$ is the value of non-market time, including unemployment benefits net of search costs. In other words, the present value of unemployment is made up of the value of non-market time, the likelihood and value of receiving a job offer, and the likelihood and value of being upgraded to the next experience level. Note that the unemployed worker who moves into the higher experience group is assumed to remain unemployed.

Similarly, the present value of employment for a worker with experience level $i$ who is currently employed at wage $w$ solves

$$\begin{aligned} rW_i(w) \;=\; & w + \delta_i \left[ V_i - W_i(w) \right] + \mu_i \left[ E_{F_{i+1}} \left[ W_{i+1}(\widetilde{w}) \right] - W_i(w) \right] \\ & + \lambda_i^1 \left[ E_{F_i} \left[ \max \left\{ W_i(\widetilde{w}), W_i(w) \right\} \right] - W_i(w) \right] \\ & + \lambda_i^2 \left[ E_{F_i} \left[ W_i(\widetilde{w}) \right] - W_i(w) \right], \end{aligned} \tag{2}$$

where we assume that when the worker enters the next experience category he will instantaneously receive an offer, which cannot be rejected, from the wage offer distribution of his new experience category. The present value of employment consists of the current wage, the likelihood and value of becoming unemployed, the likelihood and value of being upgraded to the next experience level, the likelihood and value of receiving an alternative job offer and the likelihood and value of experiencing a wage shock (i.e. receiving a wage offer which cannot be rejected).[14]

[13] $E_{F_i}[.]$ indicates the expectation over the support of $F_i$, and the tilde above $w$ refers to a random draw from $F_i$.

[14] In the model $\lambda_i^2$ picks up downward and $\lambda_i = \lambda_i^1 + \lambda_i^2$ upward wage mobility within experience

For the value of retirement, we make the simplifying assumption that

$$E_{F_{I+1}}\left[W_{I+1}(\widetilde{w})\right] = V_{I+1} = 0. \tag{3}$$

Bowlus and Robin justify this assumption in the U.S. case by claiming that retirement income results from the savings and is therefore already included in the gross wage summation. In Finland both the employer and worker are obligated to contribute to the pension system in proportion to the wage rate. In this sense retirement income is simply postponed earnings, and the same claim applies also to the Finnish case.

Since the reservation wage $\underline{w}_i$ solves $W_i(\underline{w}_i) = V_i$, we have also

$$\left(r + \mu_i + \lambda_i\right) V_i = \underline{w}_i + \lambda_i E_{F_i}\left[W_i(\widetilde{w})\right] + \mu_i E_{F_{i+1}}\left[W_{i+1}(\widetilde{w})\right]. \tag{4}$$

Let us define

$$\Psi_i\left(w\right) \equiv E_{F_i}\left[\max\left\{W_i(\widetilde{w}) - W_i(w), 0\right\}\right], \tag{5}$$

which in turn implies

$$\Psi_i\left(\underline{w}_i\right) = E_{F_i}\left[W_i(\widetilde{w})\right] - V_i, \tag{6}$$

with $\Psi_{I+1}\left(\underline{w}_{I+1}\right) = 0$. Now we can rewrite (4) as

$$\left(r + \mu_i\right) V_i = \underline{w}_i + \lambda_i \Psi_i\left(\underline{w}_i\right) + \mu_i \Psi_{i+1}\left(\underline{w}_{i+1}\right) + \mu_i V_{i+1}, \tag{7}$$

and combining (2) and (4) yields

$$\left(r + \delta_i + \mu_i + \lambda_i^2\right)\left(W_i(w) - V_i\right) = w - \underline{w}_i + \lambda_i^1\left[\Psi_i\left(w\right) - \Psi_i\left(\underline{w}_i\right)\right]. \tag{8}$$

So, what we wish to do is to obtain the estimates of the life-time values of employment and unemployment, $W_i$ and $V_i$. Given the terminal condition (3) and the estimates of structural parameters, reservation wages and $\Psi_i$, these life-time values can be computed by solving the system of forward difference equations (7) and (8) by backward induction.[15]

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group $i$. To see this, note that

$$E_{F_i}\left[W_i(\widetilde{w})\right] - W_i(w) = E_{F_i}\left[\max\left\{W_i(\widetilde{w}) - W_i(w), 0\right\}\right] + E_{F_i}\left[\min\left\{W_i(\widetilde{w}) - W_i(w), 0\right\}\right].$$

Substituting this into (2) yields

$$\begin{aligned} rW_i(w) &= w + \delta_i\left[V_i - W_i(w)\right] + \mu_i\left[E_{F_{i+1}}\left[W_{i+1}(\widetilde{w})\right] - W_i(w)\right] \\ &\quad + \lambda_i E_{F_i}\left[\max\left\{W_i(\widetilde{w}) - W_i(w), 0\right\}\right] + \lambda_i^2 E_{F_i}\left[\min\left\{W_i(\widetilde{w}) - W_i(w), 0\right\}\right], \end{aligned}$$

which explains the claim.

[15]Note that we can also rewrite (1) as

$$\left(r + \mu_i\right) V_i = b_i + \lambda_i^0 \Psi_i\left(\underline{w}_i\right) + \mu_i V_{i+1},$$

## 2.2 Aggregate Worker Flows

Estimators of wage mobility parameters and $\Psi_i$ will depend on the wage offer distribution $F_i$. Since in equilibrium all wage offers are acceptable for unemployed workers (i.e. post-unemployment wages are random draws from $F_i$), we could in principle estimate $F_i$ from the cross-section wage distribution of workers who were hired from unemployment using some nonparametric estimation method (a kernel estimator, for example). However, the flow into employment is too low for some groups in some periods to produce reasonable sized samples of post-unemployment wages for purposes of estimating $F_i$ in this way. To overcome this difficulty, we follow an alternative approach and exploit flow conditions implied by the theory to generate a relationship between the wage offer distribution and the observed distribution of wages received by currently employed workers. We refer to this latter distribution as the earnings distribution in order to make a distinction between the wages offered to job searchers and wages earned by employed workers.

Given an initial allocation of workers to firms and denoting the stock of employed workers in group $i$ as $L_i$, the number of employed workers with experience level $i$ receiving a wage no greater than $w$ is $G_i(w)L_i$, where $G_i$ is the cumulative distribution function of earnings for experience group $i$. At time $t$ a fraction $\delta_i$ of them lose their jobs, a fraction $\mu_i$ moves into the next experience group, and a fraction $\lambda_i [1 - F_i(w)]$ receives and accepts an offer higher than $w$. Thus the instantaneous flow out of jobs paying $w$ or less at time $t$ is

$$O_i(w,t) = (\delta_i + \mu_i + \lambda_i [1 - F_i(w)]) G_i(w) L_i. \tag{9}$$

Similarly, the instantaneous flow into such jobs at time $t$ is

$$I_i(w,t) = \left(\lambda_i^0 U_i + \mu_{i-1} L_{i-1} + \lambda_i^2 [1 - G_i(w)] L_i\right) F_i(w), \tag{10}$$

with the convention that $L_0 = 0$, i.e. workers who enter the labour market are assumed to become unemployed first.[16] The inflow consists of a fraction $\lambda_i^0 F_i(w)$ of the stock of unemployed workers, $U_i$, who receive a wage offer no greater than $w$, a fraction $\mu_{i-1} F_i(w)$ of the stock of employees in the lower experience group, $L_{i-1}$, who receive an experience upgrade and draws a wage offer no greater than $w$,

which might be used in the place of (7) if we had information on $b_i$. We cannot exploit this possibility since our data do not contain information on unemployment benefits (and since $b_i$ generally captures also the value of non-market time and search costs).

[16] This assumption will be of no consequence in our empirical analysis.

and a fraction $\lambda_i^2 F_i(w)$ of the stock of employees paid over $w$, $[1 - G_i(w)] L_i$, who experience a negative wage shock that drops their wage at or below $w$.

It is common in both theoretical and empirical work in this field to restrict attention on the steady-state case by assuming that the flows into and out of different parts of the earnings distribution are equal, so that $I_i(w,t) = O_i(w,t)$ is assumed to hold for all $w$. Due to the severity of the 1990s recession in Finland, it is quite clear that these kind of assumptions are not valid in our case. We therefore follow a somewhat more flexible approach and do not require the worker flows to be equal.

The stock of employed workers with experience level $i$ receiving a wage no greater than $w$ evolves as

$$\frac{dG_i(w,t)L_i(t)}{dt} = \dot{G}_i(w)L_i + G_i(w)\dot{L}_i = I_i(w,t) - O_i(w,t), \tag{11}$$

where $\dot{G}_i(w) \equiv dG_i(w,t)/dt$ and $\dot{L}_i \equiv dL_i(t)/dt$. Substituting (9) and (10) into (11) and solving for $F_i$ yields the following messy relationship between the wage offer distribution and earnings distribution:

$$F_i(w) = \frac{(\delta_i + \mu_i + \lambda_i) G_i(w) L_i + G_i(w)\dot{L}_i + \dot{G}_i(w)L_i}{\lambda_i^0 U_i + \mu_{i-1} L_{i-1} + \lambda_i^2 L_i + \lambda_i^1 G_i(w) L_i}. \tag{12}$$

Note that the stock of employed workers with experience level $i$ as a whole evolves as[17]

$$\dot{L}_i = \lambda_i^0 U_i + \mu_{i-1} L_{i-1} - (\delta_i + \mu_i) L_i, \tag{13}$$

with the convention that $L_0 = 0$. This can be used to simplify (12) into the following form:[18]

$$F_i(w) = \frac{(1 + \kappa_i) G_i(w) + (\kappa_i / \lambda_i^1) \dot{G}_i(w)}{1 + \kappa_i G_i(w)}, \tag{14}$$

where

$$\kappa_i \equiv \frac{\lambda_i^1}{\delta_i + \mu_i + \lambda_i^2 + \theta_i} \tag{15}$$

and $\theta_i \equiv \dot{L}_i / L_i$ is the rate of growth of the employed stock of experience group $i$.

In a steady state, where the time derivatives of $G_i$ and $L_i$ are zero, the relationship expressed in (14) and (15) reduces to that exploited by Bowlus and Robin

[17] This follows directly from (11) by setting $w$ equal to its maximum value.

[18] In particular, we replace $\lambda_i^0 U_i + \mu_{i-1} L_{i-1}$ by $\dot{L}_i + (\delta_i + \mu_i) L_i$.

(1999). In general, if we can compute measures for $\dot{L}_i$ and $\dot{G}_i$, the wage offer distribution can be recovered from the earnings distribution without steady-state assumptions. It is also worth emphasising that we did not make assumptions on the mechanism that generates the wage offer distribution, nor did we impose shapes on the wage distributions. Thus the use of flow conditions to recover the wage offer distribution does not require us to add more structure on the model.

Recall from the preceding subsection that at any point in time individual workers are assumed to take the structural parameters of the model as given and constant over time. These parameters, however, can be expected to be related to the number of agents participating in the labour market as well as to current business conditions. For example, if there are more unemployed workers searching compared to a given number of firms, it might be reasonable to expect that the arrival rate of job offers to unemployed workers is lower. We assume that workers take the parameters as to be fixed at their current values, even though the employed and unemployed stocks as well as wage distributions can change over time. In other words, although the labour market is not necessarily in a steady-state, workers are assumed to take the current conditions as given and fixed when determining the value of employment and unemployment. In this sense we are implicitly assuming that the search environment of workers may be subject to *unanticipated* changes which do not affect the optimality conditions of job search behaviour. This is a reasonable assumption if the changes in the structural parameters of the model are due to random macroeconomic shocks, for example.

# 3 Data

Our empirical analysis is based on the worker data of the Integrated Panel of Finnish Companies and Workers (the IP data), which is described in detail in Korkeamäki and Kyyrä (2000). Information on workers in the IP data comes from the Employment Statistics (ES), a major administrative database of Statistics Finland. Since 1987 the ES database has been updated annually by combining information from over 20 administrative registers. The statistical unit being an individual identified by the unique social security number, the ES database covers effectively all people with a permanent residence in Finland.

Each individual in the ES database who holds a job at the last week of the year is associated to his or her employer with a company and establishment identifier. All people in the ES database with a link to the private-sector employer at least in one of the years between 1988 and 1996 have been added to the worker panel of the IP data. As a result, the worker panel to be analysed covers practically *all* persons who have been employed in the private sector during the period 1988-1996 (at least at the end of one year). For these people a set of variables, collected by combining the annual records of the ES database, is available over the period from 1987 to 1997. The total number of persons in the worker panel of the IP data is slightly below two million.[19]

Our empirical analysis is performed on a monthly basis. We restrict each one-month cross section to cover males between the ages of 16 and 65 who have not been employed by a non-profit corporation nor been in work in the public sector (excluding job placement periods) during the period 1988-1996.[20] We exclude also workers who have been self-employed during the period because their behaviour in the labour market probably differs from that of other workers to a great extent.[21]

[19] In addition to the worker panel, the IP data contain a dynamically representative panel of Finnish companies from different sectors of the economy for the period 1989-1995. Worker and company records of the IP data can be easily matched to form linked data sets of companies and workers by using the company identifiers attached to workers; see Korkeamäki and Kyyrä (2000) for details.

[20] The main reason for focusing on males is an attempt to produce figures which are easily comparable to those reported in Bowlus and Robin (1999). Secondly, since females are more sensitive to move into and out of the labour force and our theoretical model does not account for such transitions, the model can be expected to describe labour market behaviour of males better. Thirdly, we need to compute monthly wages from annual earnings without detailed information on working time. This can be done more reliably for males as they work less on a part-time basis.

[21] Whether or not a worker is self-employed is observed only for the employment relationships that are in force at the last week of the year.

The resulting sample is then stratified by education and experience. Education is categorised as follows: comprehensive school (9 years or less), lower vocational (10-11 years), upper vocational (including high school graduates, 12-13 years), and the lowest level of university or higher. Experience is computed as age minus 7 minus years of education, and the categories to be used are: 5 years or less, 6-15 years, 16-25 years, and more than 25 years. These categories are chosen to be comparable to those used by Bowlus and Robin (1999). Workers whose education code has changed during the observation period are added to the sample only after the reception of the final degree.

To examine the evolution of wages and labour market transitions, we need information on individual wages and labour market states on a monthly basis over the sample period. For each cross-section year, the data contain information at most on two terminated job spells, on four terminated spells of unemployment, and on one terminated period of job placement. If the individual has more than the maximum number of spells of a given type terminated within the year, the information available refers to the latest spells. In addition there is a variable on the labour market state at the end of each year,[22] and if the state is employment, unemployment or participation in a labour market programme there is also information on the starting date of that ongoing spell. Using these pieces of information we construct monthly codes which tell us the labour market state of the individual at the end of each month over the whole sample period.

We begin by exploiting information on the starting and ending dates of the terminated spells over the whole observation period. This identifies most of employment, unemployment and job placement months. The next step is to check whether or not this procedure revealed the individual's labour market state at the end of a particular year. If it didn't we can determine the labour market state in December by using the existing variable on the end-of-year state. If this is the case and the starting date of the ongoing spell is available, we can use it to determine when the spell started. But if the starting date is missing, we search for missing monthly labour market codes backwards month by month in order to determine the starting month of the ongoing spell. We continue this iterative procedure backwards until we find a non-missing code or reach the beginning of the current year, after which all missing

[22]The variable contains the following classification for labour market states: employment, unemployment, temporary layoff, participation in a labour market training course, participation in a job placement programme, retirement or some other state out of the labour force.

codes between December and the termination month of the iterative procedure are set equal to the end-of-year code. We proceed in a similar way to determine the ending date of the spell ongoing at the turn of the year by looking monthly codes forward month by month until we find a non-missing code or reach the end of the next year. The months whose labour market codes remain missing the individual is assumed to be outside the labour force.

At the end we have monthly codes over the whole period which classify sampled individuals to be employed, unemployed (including temporary laid off), retired, outside the labour force or employed by labour administrative measures (i.e. on a job placement programme) at the end of each month. It should be stressed that we do not interpret workers employed by labour administrative measures as 'really' employed but treat them as their own group.[23] Some drawbacks are also worth noting. Although we observe job placement periods, we are not able to separate periods on labour market training courses from periods outside the labour force. Workers participating in labour market training courses are therefore classified as being outside the labour force.[24] Secondly, if a worker has very unstable labour market history in the sense that he has several labour market transitions of a *particular* type within the same year, it might be that in some months his labour market state will be recorded incorrectly. This seems to be a minor problem, however.

Information on earnings in the IP data comes from the tax records which contain income information on an annual basis. The first step is to convert all annual earnings into 1996 money by using the Consumer Price Index of Statistics Finland. The average monthly wage for a given year is then computed by dividing annual earnings by the months worked. Since information on hours worked is not available, wages and earnings are used interchangeably in the text. When computing monthly wages from annual earnings, one faces difficulties in differentiating between distinct wage rates in the cases where a worker has more than one job spell in the same year. When this separation problem appears, we attempt to separate different wage rates by using longitudinal information on earnings over the consecutive years. If the job spell started in the previous year and there is no separation problems associated with

[23] Job placement programmes are targeted to those unemployed groups with the worst employment prospects and the duration of the programmes is usually limited to six months. Thus employment resulting from participation in a job placement programme is only temporary, and the likelihood of entering the programme and that of finding a job from the open labour market are two very different things.

[24] This is consistent with the administrative practice, however.

that year, we use only previous earnings to compute the wage rate on the job spell. Similarly, we use the earnings of the next year to solve the separation problem if possible. Unfortunately, in some cases there is no way to circumvent this separation problem. In these cases the best we can do is to use the average monthly earnings of the relevant year when the job spell occurred within a single year or to use the weighted average of the earnings in two consecutive years otherwise. For job spells lasting over several years, we use the average monthly wage of a given year only to compute the wage rate on the job during that year, allowing for the wage rate to change from December of one year to January of the next year. The resulting variation around the turn of the year will be used in detecting wage changes on the job.

Due to some inaccuracies in the wage data and a lack of information on working time, there are some observations with an extremely low or high monthly wage in the data. To deal with outliers in the earnings data, we therefore trim the cross-section distributions of monthly wages. The trimming values are determined separately for each education-experience group and for each one-month cross section. We first require that all monthly wages have to be at least 3000 FIM, and then we trim the data by excluding the lowest and highest 3 per cent of cross-section wages for a given group. However, we do not drop out of the sample those employees with a wage outside the acceptable range, but we will not use their wages when computing earnings figures.

# 4 Estimation Method

To estimate the structural parameters of the model, we follow a simple estimation approach of Bowlus and Robin (1999) which circumvents complex estimation procedures by using empirical flow rates and empirical earnings functions.[25] We estimate mobility parameters by computing the observed flow rates in the data and solving a system of equations. The wage offer distribution is then recovered nonparametrically from the observed earnings distribution. The structural parameters and wage distributions are estimated separately for each one-month period. When computing value functions for a given cross section, workers are assumed to take the structural setting as given and fixed over time. Overall, this is a very simple way of generating the required estimates as it does not require much more than sorting the data and computing frequencies and cumulated sums.

## 4.1 Mobility Parameters

The hiring rate $\lambda_i^0$ is estimated by computing the fraction of unemployed workers with experience level $i$ at the end of one month who are employed at the end of the next month. Similarly, the fraction of employed workers with experience level $i$ at the end of one month who are unemployed at the end of the next month serves as the estimator of the layoff rate $\delta_i$. Since we do not consider transitions into and out of the labour force, individuals outside the labour force at the end of either month are excluded when computing flow rates.[26] To be consistent with our theoretical model, we exclude also workers who will be in the higher experience group at the end of the next month. Moreover, we make a difference between workers employed by labour administrative measures and those working in the open labour market by omitting transitions between unemployment and job placement programmes when computing flow rates.

Since $\theta_i$ is a function of $\dot{L}_i$, we use the approximation

$$\dot{L}_i = \lim_{dt \to 0} \left\{ \frac{L_i(t+dt) - L_i(t)}{dt} \right\} \approx \frac{L_i(t+dt) - L_i(t)}{dt} \tag{16}$$

[25] In what follows, our equations differ occasionally from the corresponding ones in Bowlus and Robin (1999) since we do not impose the steady-state conditions on aggregate worker flows as they do.

[26] Recall that we are unable to separate periods on labour market training courses from periods out of the labour force, so that workers moving between the training courses and unemployment become classified as moving into and out of the labour force.

and estimate $\dot{L}_i$ as a change in the stock of employed workers with experience level $i$ from one month to the next month.[27] Once again, we exclude workers who are outside the labour force at the end of either month when computing the estimate of $\theta_i$. To estimate $\mu_i$, we simply use the inverse of the average length of time individuals in experience group $i$ have left in their experience category. Workers with the highest level of experience are assumed to retire at the age of 65. The monthly discount factor $r$ is just set at .01.

To recover the wage offer distribution from the (directly observable) earnings distribution, we use a simplified version of (14)

$$F_i(w) = \frac{(1+\kappa_i)\, G_i(w)}{1+\kappa_i G_i(w)}, \tag{17}$$

where $\kappa_i$ is given by (15) but $\dot{G}_i$ is set to zero. Intuitively, we are assuming that the worker flows evolve in such a way that $G_i$ remains (approximately) stable over time. The principal reason for this simplification is that we do not observe all variation in monthly wages. Since the monthly wages had to be computed using annual earnings, the observed variation in the wage distribution within the calendar years picks up the effect of flows into and out of employment but only a part of monthly wage changes. This is because the variation in wages resulting from wage changes on the job are observed in the form of differences in monthly wages associated with different calendar years. Thus the evolution of $G_i$ observed in the data is somewhat too smooth within the calendar years while there is a jump from December of one year to January of the next year,[28] making the adequate estimation of changes in $G_i$ impossible. On the other hand, the assumption that $G_i$ is time-invariant is perhaps not too strong as the distribution of (annual) earnings is relatively stable over the whole observation period as we will see later on. Given the stability assumption of $G_i$ we can characterise the wage offer distribution in terms of $\kappa_i$ and $G_i$ using the relationship in (17).

Following Bowlus and Robin, we can estimate wage mobility rates $\lambda_i$ and $\lambda_i^2$ by computing how many workers are experiencing wage changes through time. The number of employed workers with experience level $i$ 'promoted' at a given point of

[27] Note that when computing changes in the number of employed workers directly from the data we do not need to specify where the new entrants come from. Thus the restrictive assumption that workers entering the youngest experience group become unemployed first does not matter.

[28] This jump picks up also wage changes due to converting annual earnings into 1996 money.

time, i.e. experiencing a wage increase, can be expressed as

$$\begin{aligned} P_i &= \int_{\underline{w}_i}^{\overline{w}_i} \lambda_i \left[1 - F_i(z)\right] L_i dG_i(z) \\ &= \frac{\lambda_i (1+\kappa_i)}{\kappa_i^2} \left[\ln(1+\kappa_i) - \frac{\kappa_i}{1+\kappa_i}\right] L_i, \end{aligned} \tag{18}$$

where $\overline{w}_i$ is the upper bound of the support of $G_i$ and $F_i$.[29] Analogously, the number of employed workers in experience group $i$ 'demoted' at a given point of time, i.e. experiencing a negative wage shock, is

$$\begin{aligned} D_i &= \int_{\underline{w}_i}^{\overline{w}_i} \lambda_i^2 F_i(z) L_i dG_i(z) \\ &= \frac{\lambda_i^2 (1+\kappa_i)}{\kappa_i^2} \left[\kappa_i - \ln(1+\kappa_i)\right] L_i. \end{aligned} \tag{19}$$

Combining (18) and (19) yields

$$L_i = \frac{P_i}{\lambda_i} + \frac{D_i}{\lambda_i^2}, \tag{20}$$

which defines $\lambda_i^2$ as a function of $\lambda_i$, and imposes the restriction

$$\lambda_i \geq \frac{P_i + D_i}{L_i}, \tag{21}$$

so that $\lambda_i^2 = \lambda_i = (P_i + D_i)/L_i$, with $\lambda_i^1 = 0$, whenever the inequality holds with equality. In order to exploit these relationships for estimating $\lambda_i$ and $\lambda_i^2$, we first need to compute the empirical promotion and demotion rates, $P_i/L_i$ and $D_i/L_i$ respectively.

As pointed out above, we do not observe wage changes on the job on a monthly basis. Moreover, the establishment (and company) identifiers referring to the employer, which we use in detecting job-to-job transitions, are attached to workers only at the end of each year. We therefore compute the annual promotion and demotion rates by comparing wage rates and establishment identifiers associated with two consecutive Decembers. As a first step, we select workers employed in December of one year who were employed also in December of the previous year. Since we are interested in job-to-job transitions and wage changes on the job, we exclude workers whose employment spell was interrupted by a period out of work during the year, as well as workers with a missing establishment identifier in either year. Workers who

[29] To obtain the last expression in (18), we first substitute $F_i$ for $G_i$ using (17) and then integrate over the wage range.

changed their employer during the year are then identified by comparing the two establishment identifiers.[30] These individuals are further classified to be promoted or demoted, depending on whether their wage increased or decreased from December to December. Since promotions are allowed to occur also within the current employer, we further add workers with no change in the establishment identifier but who display over 20 per cent wage increase to the number of promoted workers. The relatively high threshold value for on-the-job promotions is chosen to sort out regular wage increases and temporary wage increases associated with annual bonuses or changes in working hours. We then compute the annual promotion (demotion) rate as the fraction of workers who became classified as promoted (demoted).[31] To obtain monthly rates, we then simply divide the annual rates by 12, assuming the wage mobility rates to be constant within the calendar years. This procedure is obviously subject to several drawbacks but it is perhaps the best we can do with the available data.

Denoting monthly promotion and demotion rates as $p_i$ and $d_i$ respectively, we can finally estimate structural parameters $\lambda_i^2$ and $\lambda_i$ by solving the just identified system

$$\lambda_i = \frac{\kappa_i^2 p_i}{(1+\kappa_i)\ln(1+\kappa_i) - \kappa_i}, \tag{22}$$

$$\lambda_i^2 = \frac{\kappa_i^2 d_i}{(1+\kappa_i)\left[\kappa_i - \ln(1+\kappa_i)\right]}, \tag{23}$$

where

$$\kappa_i \equiv \frac{\lambda_i^1}{\delta_i + \mu_i + \lambda_i^2 + \theta_i} = \frac{\lambda_i - (p_i + d_i)}{(\delta_i + \mu_i + \theta_i)\left[1 - p_i/\lambda_i\right] + d_i} \tag{24}$$

for $\lambda_i > p_i + d_i$. In other words, given $p_i$, $d_i$ and the estimates of $\delta_i$, $\mu_i$ and $\theta_i$, one can choose some initial value for $\lambda_i$ to compute $\kappa_i$ using (24). Substituting the obtained value of $\kappa_i$ into (22) yields the next value for $\lambda_i$, which is then used to generate a new value for $\kappa_i$ and so on. This simple algorithm converges quickly to a fixed point of $\lambda_i$, after which the final estimates of $\kappa_i$ and $\lambda_i^2$ can be computed.[32]

[30] We use establishment identifiers instead of company identifiers as they are not so sensitive to change due to changes in the ownership, legal status or sector of the employing company.

[31] Annual promotion and demotion rates are given in the Appendix.

[32] We considered also a generalised model without the assumption of time-invariant earnings distribution. Evolution of $G_i$ was modelled by computing changes in $G_i$ from one month to the next one at different percentiles of the earnings distribution. Assuming the time derivative of $G_i$ to be approximately constant between the percentiles, we were then able to describe changes

## 4.2 Estimation of $\Psi_i$

We use the lowest wage in the cross-section earnings distribution of experience group $i$ after trimming as an estimate of the reservation wage $\underline{w}_i$.[33] Next we need to estimate $\Psi_i$ for each individual in experience group $i$. To put $\Psi_i$ into a tractable form, we integrate by parts to obtain

$$\begin{aligned}\Psi_i(w) &\equiv E_{F_i}\left[\max\left\{W_i(\widetilde{w}) - W_i(w), 0\right\}\right] \\ &= \int_w^{\overline{w}_i} \left[W_i(z) - W_i(w)\right] dF_i(z) \\ &= \int_w^{\overline{w}_i} \left[1 - F_i(z)\right] dW_i(z).\end{aligned} \tag{25}$$

We then get the expression for $dW_i(z)$ by differentiating (2) with respect to $w$, which substituted into (25) yields

$$\Psi_i(w) = \int_w^{\overline{w}_i} \frac{1 - F_i(z)}{r + \delta_i + \mu_i + \lambda_i^2 + \lambda_i^1\left[1 - F_i(z)\right]} dz. \tag{26}$$

By using (17) to substitute $F_i$ out of (26) and integrating by parts, we find

$$\begin{aligned}\Psi_i(w) &= \int_w^{\overline{w}_i} \frac{1 - G_i(z)}{r + \delta_i + \mu_i + \lambda_i + \kappa_i(r - \theta_i)G_i(z)} dz \\ &= \int_w^{\overline{w}_i} (z - w) \frac{r + \delta_i + \mu_i + \lambda_i + \kappa_i(r - \theta_i)}{\left[r + \delta_i + \mu_i + \lambda_i + \kappa_i(r - \theta_i)G_i(z)\right]^2} dG_i(z).\end{aligned} \tag{27}$$

This can be expressed equivalently as

$$\Psi_i(w) = E_{G_i}\left(\frac{r + \delta_i + \mu_i + \lambda_i + \kappa_i(r - \theta_i)}{\left[r + \delta_i + \mu_i + \lambda_i + \kappa_i(r - \theta_i)G_i(z)\right]^2} \max\left\{\widetilde{w} - w, 0\right\}\right). \tag{28}$$

By replacing $G_i$ and the structural parameters by their estimates in (28), we can estimate $\Psi_i$ at any $w$ from the cross-section data by taking the sample means over employed individuals in experience group $i$. To estimate $G_i$, we use the empirical

in $G_i$ with a piecewise linear function, which also made integration over the wage range easy. With this appoximation, we used (14) in the place of (17) to recover the wage offer distribution and solved a generalised version of equation system (22)-(24) in order to estimate wage mobility parameters. This procedure occassionally collapsed for periods corresponding to Decembers due to large (spurious) changes in $G_i$, while the results for other periods did not differ notably from those based on the simplified model.

[33] Of course, our measure of the reservation wage is sensitive to the threshold values used in the trimming procedure. We emphasise that changing the threshold values (within a reasonable range) affects the absolute values of the reservation wages but the effect on their time patterns is quite moderate.

c.d.f. of earnings for experience group $i$

$$\hat{G}_i(w) = \frac{1}{L_i} \sum_{j \in L_i} 1\{w_j \leq w\}, \tag{29}$$

where $1\{\cdot\}$ is the indicator function, taking a value of unity if the argument is true and zero otherwise. By using the empirical counterpart of $G_i$, we get rid of imposing any particular shape on the earnings distribution (and hence on the wage offer distribution). Note also that via sorting the data with respect to wage within the groups the estimates of $\Psi_i$ can be generated recursively by using cumulative sums. This is a pleasant feature as the number of individuals in our data is huge and the estimations must be performed over 120 periods.

# 5 Empirical Results

In this section we report the observed patterns of earnings and labour market transitions, and describe the evolution of labour market inequality based on our computations of life-time labour values.

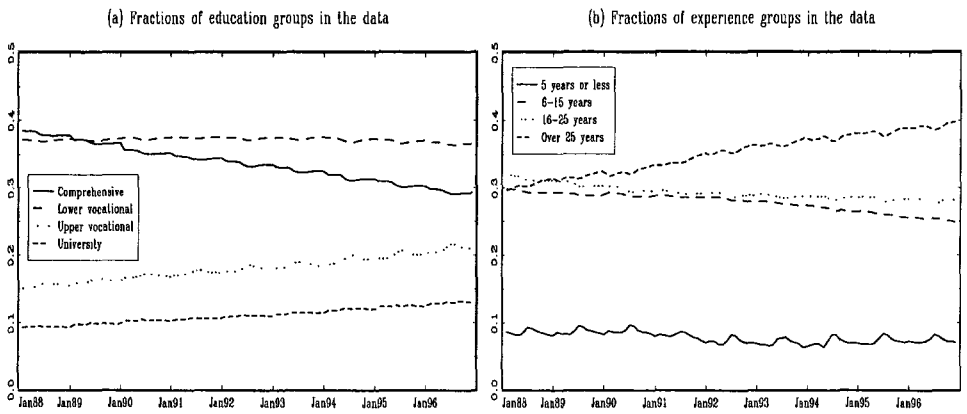
## 5.1 Labour Market Trends

We begin by looking at changes in the sample composition over the observation period. Figure 1 shows the fractions of education and experience groups in the cross-section populations of employed and unemployed workers. We can see a clear shift towards higher levels of education: the fractions of workers with upper vocational and university education are steadily growing, whereas the fraction of those without any degree is strongly declining. In contrast, the fraction of those with lower vocational education is found to be roughly stable over the observation period. Ageing of the large postwar generation is also clearly seen as the fraction of workers with over 25 years of experience is rapidly increasing. Sample shares of other experience groups in the data are found to be smoothly declining over the whole observation period.[34]

Figures 2a and 2b represent the unemployment rates for different education and experience categories. The unemployment rate is computed as the ratio of unemployed workers to the sum of unemployed and employed workers at the end of a given month. For the reasons discussed previously, we exclude workers who are employed by labour administrative measures from the stock of the employed, although they are classified as employed in the official statistics. The cyclical pattern from full employment of the late 1980s to the deep recession of the early 1990s is dramatically reflected in the graphs. As expected, highly educated workers have in general lower unemployment rates than their less educated counterparts, and seasonality in unemployment rates declines with education. Unemployment rates for the two least educated groups are practically identical up until 1992, after which the difference between the unemployment rates increases strongly over the rest of the observa-

[34]The fraction of the least experienced workers in the later part of the observation period is attributed also to the sampling design underlying the worker panel of the IP data. Recall that to be included in the data, it was required that the individual is associated with a company or establishment identifier of the private-sector employer at least in one of the years between 1988 and 1996. Consequently, young workers who have entered the labour market in the latter part of the sample period but did not find a job from the private sector by the end of 1996 are excluded from the data by construction.

Figure 1: Composition of Data




tion period. Moreover, the relative level of unemployment between workers with lower and upper vocational education also increases during the recession years. In terms of unemployment levels, the early 1990s has been thus marked by increasing educational differentials.

Except for the last years of the sample period, unemployment among workers with the lowest level of experience is clearly at a higher level than unemployment in other groups. There are no observable differences in the unemployment rates between more experienced groups prior to 1991. Note that a sharp drop in the unemployment rate for the group with the lowest level of experience is largely due to the underlying sampling design. The unemployment rate for workers with 6 to 15 years of experience exhibits a similar drop, though less dramatic. Contrary to the other groups, whose unemployment rates begin to decline when the economy turns on a growth path (in 1994), the unemployment rate for workers with over 25 years of experience remains at the recession level.

Layoff rates ($\delta$) in Figures 2e and 2f exhibit countercyclical patterns, while hiring rates ($\lambda^0$) in Figures 2c and 2d are procyclical. Levels of the transition rates have changed dramatically during the 1990s, reflecting the severity of the recession that hit the economy. As one might expect, both the level and seasonality of layoff rates declines with education and experience. While the patterns of layoff rates for the two most experienced groups are somewhat identical, the layoff rate for workers

Figure 2: Unemployment, Hiring and Layoff Rates

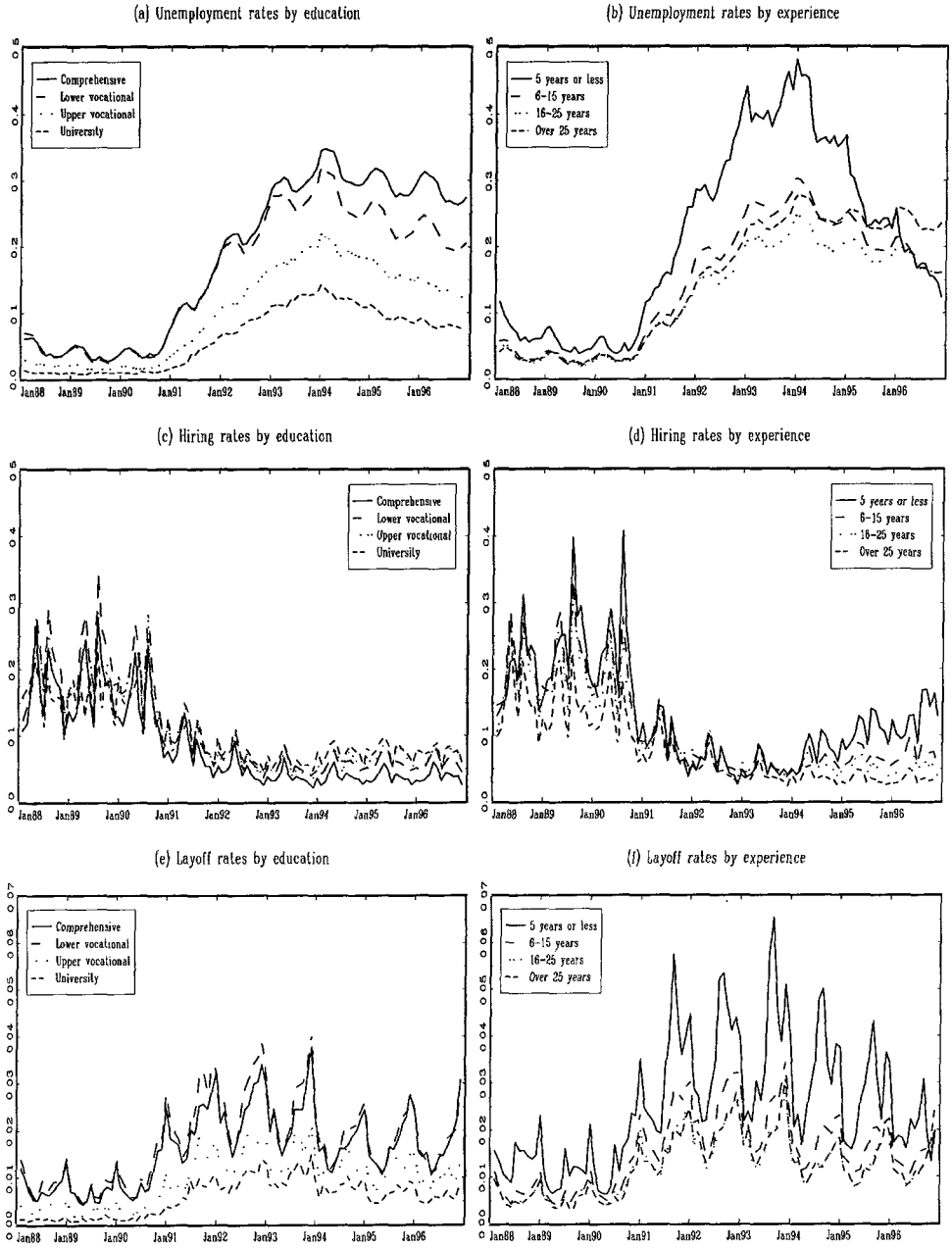
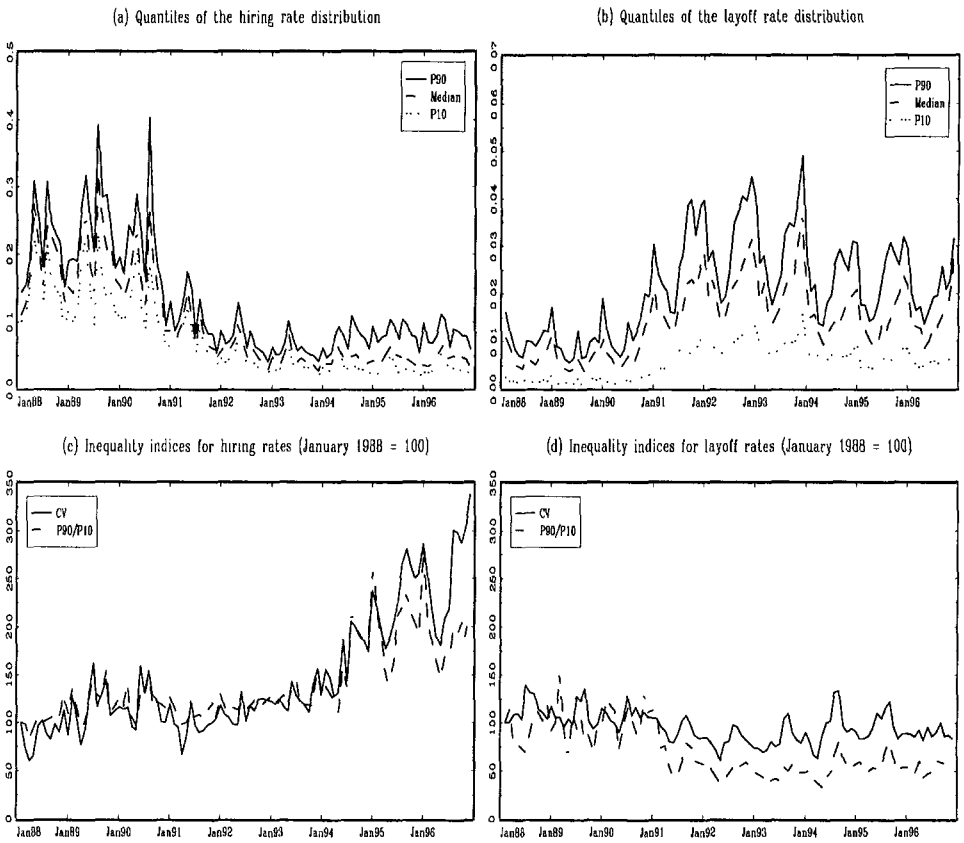


Figure 3: Distributions of Hiring and Layoff Rates




with 5 years or less of experience is clearly highest on average and exhibits strong seasonal variation. Differences in hiring rates between education and experience groups become significant in the latter part of the recession period and remain so over the rest of the sample period. In general, more educated and less experienced workers have had better chances of finding a job when unemployed during the early 1990s.

Characteristics of the layoff and hiring rate distributions are shown in Figure 3. The distributions are defined over 16 education-experience groups, assuming that workers are identical within the groups and weighting each cell by the number of

observations in the relevant cell.[35] The lower panels show the patterns of between-groups inequality in the distributions, measured by the coefficient of variation (CV) and the 90/10 percentile ratio.[36] It appears that the recession has smoothed down differences in the likelihood of becoming unemployed between worker groups, leading to a more compressed distribution of layoff rates. In contrast, dispersion in the hiring rate distribution increases over the observation period. But note that the sharp increase in hiring rate dispersion during the last years of the period is of a spurious form. It is driven by the least experienced group whose hiring rate increases at a false level due to the underlying sampling design.

Since large-scale job destruction during the recession moved masses of people from employment into unemployment, one might suspect that changes in the composition of the underlying populations are responsible for the observed patterns. However, if we eliminate this composition effect by fixing the cell weights at their averages over the observation period, the pattern of inequality will not change essentially in either distribution. Thus the variation in the relative shares of different groups in the data is not the driving force behind the observed trends. Overall, since there exist notable differences in the hiring rates in the latter part of the observation period, we may say that some groups of workers have remained unemployed for a much longer time than other groups during the recession.

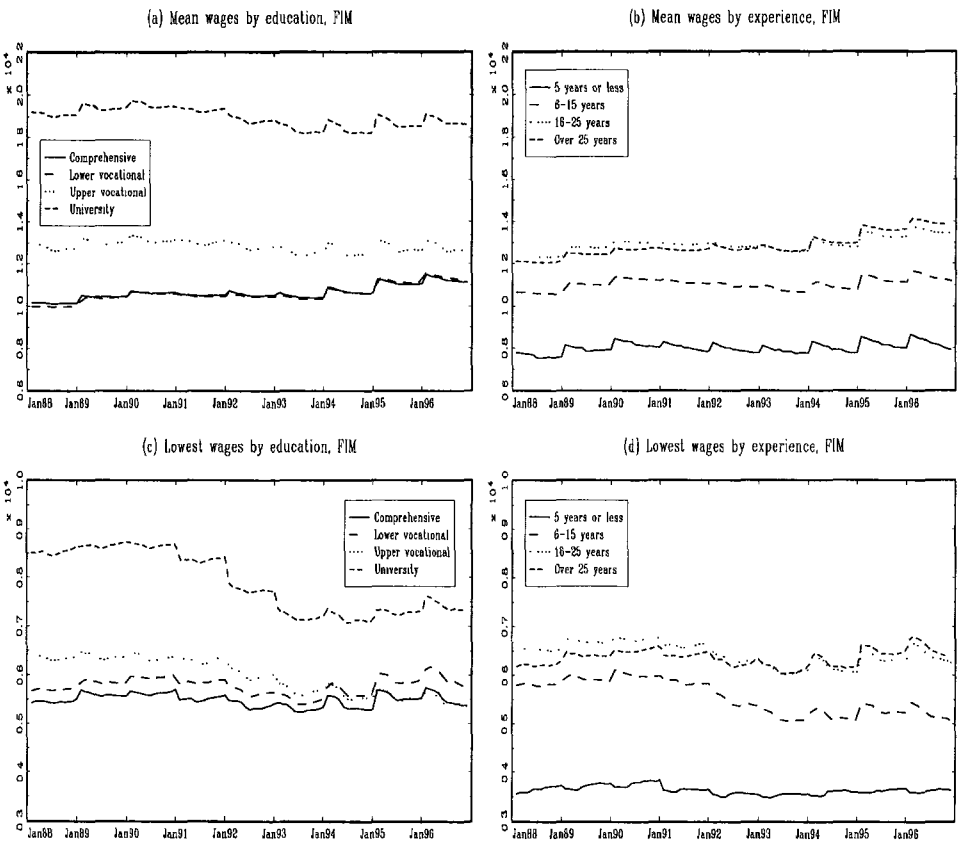
Next we turn our attention to wages. Figures 4a and 4b show mean wages by education and experience respectively.[37] Mean wages are first growing until they turn on a stable or decreasing path in respond to the recession, after which they exhibit an increasing path again. Less educated and more experienced workers seem to be faced with relatively smaller declines, if any, in their real wages during the recession. It is important to note that these observed reductions in monthly wages are potentially attributed to temporary declines in working hours during the recession period. This is because we were not able to control the variation in working time when computing monthly wages. Against this background, one might say that the response of average wages to the demand shock has been very

[35] In case of layoff (hiring) rates the number of workers in the cell who are employed (unemployed) at the end of the month serves as the weighting variable. It follows that the distributions in Figure 3 are defined over the different populations which should be kept in mind.

[36] Coefficient of variation is a relative measure of variation, and it is defined as the sample standard deviation divided by the sample mean.

[37] Spikes around the turn of the years are attributed to high labour turnover at that time and to the fact that we allow for the wage rate on a given job to jump discontinuously from December of one year to January of the next year.

Figure 4: Mean and Lowest Wages




limited, especially as the reductions have occurred only in the worker groups of the smallest size. Furthermore, there are no significant differences in mean wages between workers at the two lowest levels of education, while higher education yields clearly higher wages. Educational differentials exhibit a smooth declining trend over the whole period. Returns to experience are generally positive, though there is no clear difference between the two most experienced groups.

Figures 4c and 4d represent the lowest wages for different education and experience groups.[38] Recall that the lowest wages serve as our estimates of the reservation

[38] One should keep in mind that the measure of the lowest wage is sensitive to the *ad hoc* trimming procedure, so the patterns of the lowest wages must be interpreted with caution. However, changes in the threshold values for the trimming procedure affect mainly the absolute levels of lowest wages,

wages ($\underline{w}_i$) in the value function calculations. For most groups the lowest wage exhibits a declining or stable trend up until 1994 when it begins to increase in almost all groups. The decreasing pattern of the lowest wage of the most educated workers is strikingly sharp, though the starting level is also quite high. Interestingly, the lowest wages of other education groups converge to a given joint level, from which they start to diverge again (with a different ranking) once the recovery takes place. The lowest wage for the least experienced group is approximately constant over the whole observation period.[39] Note that the respond of the lowest wage of workers over 25 years of experience to the recession is much weaker than that of other groups, even though the development of unemployment in this group has been relatively depressing.

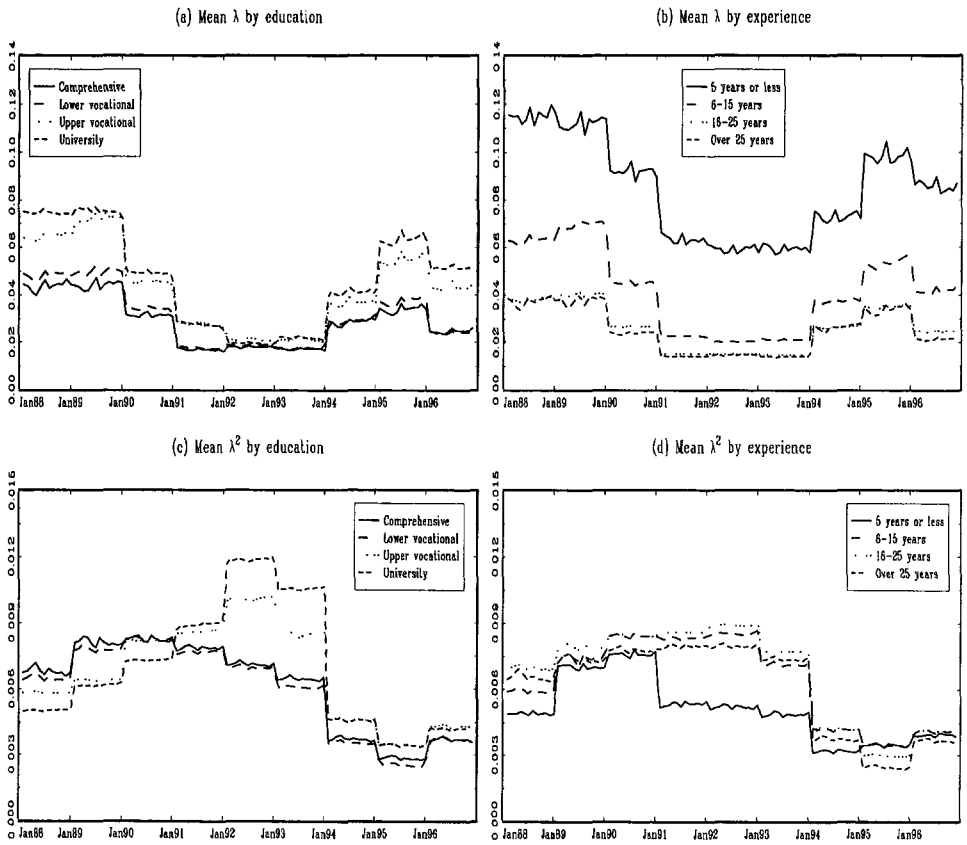
Trends in earnings differentials should be contrasted with the patterns of corresponding differentials in unemployment rates and the transition rates behind unemployment. It is remarkable that educational differentials in earnings are shrinking at the same time when the relative unemployment of less educated workers is strongly increasing. Moreover, the earnings of workers with over 25 years of experience seem to evolve almost independently of what is happening in the unemployment figures of this group. The sole exception is workers with a university degree. Their earnings turned out to be strongly procyclical, while the relative employment of the group has been improving over the observation period. It is quite possible that higher wage flexibility in this group has attributed to the less depressing development of unemployment.

Bowlus and Robin (1999) emphasise the importance of the fact that workers do not stay at the same wage level over employment spells but are occasionally experiencing wage changes. When we are concerned with life-time welfare this is an essential point because a high degree of wage mobility makes the current wage less important. Wage mobility results for several reasons; it is attributed, among others, to job changes, to differences in the career profiles on the job, and to the wage agreements negotiated by labour market organisations. To give an idea of the extent of wage mobility, the means of our estimates of $\lambda$ and $\lambda^2$ by education and experience are reported next. Since $\lambda$ governs upward wage mobility and $\lambda^2$ downward wage mobility in the model, the patterns of these parameters in Figure 5

whereas the effect on their time patterns and ranking across the groups is quite moderate.

[39]It should be stressed that the lowest wage of the least experienced group is quite low compared to minimum requirements, reflecting perhaps a large degree of measurement error or part-time working for this group.

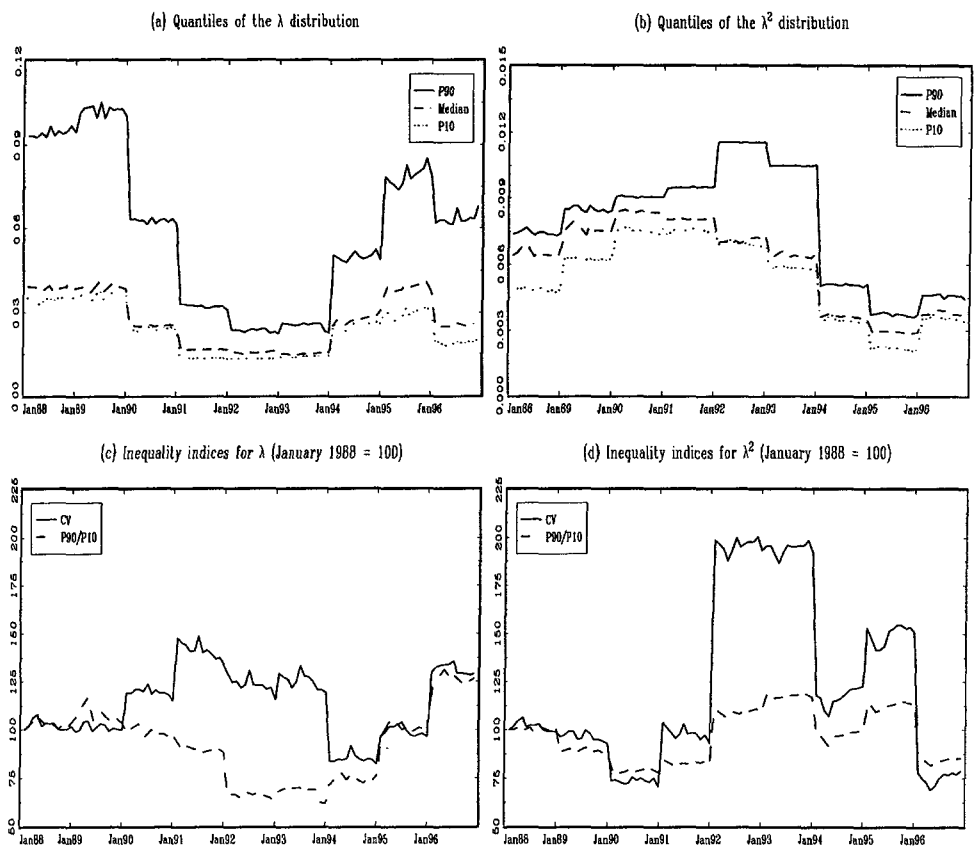
Figure 5: Estimates of $\lambda$ and $\lambda^2$




are similar to those of annual promotion and demotion rates which are reported in the Appendix.

As a result of downward wage rigidity, $\lambda^2$ tends to account only for a small share of $\lambda$, except for the worst recession years. Less experienced workers are more likely to be promoted than more experienced workers as predicted by the standard models of human capital accumulation. Outside of the recession years, $\lambda$ increases with education. There are no large differences in the downward wage mobility parameter $\lambda^2$ between the groups. However, in the highly educated groups $\lambda^2$ displays quite substantial increases for the recession period. This might be a reflection of higher wage flexibility among highly educated workers. Overall, except for the least

Figure 6: Distributions of $\lambda$ and $\lambda^2$




experienced group, differences in the wage mobility parameters across the groups are relatively moderate. Finally, the distributions of wage mobility parameters over homogeneous education-experience groups and the corresponding measures of dispersion are shown in Figure 6. Variation in the distributions do not exhibit clear trends over the observation period.

## 5.2 Welfare Differentials

Time series of estimated value functions for different worker categories are described in Figure 7. One should bear in mind that there are only 16 unemployment values ($V$), one for each education-experience group, whereas the employment values ($W$)

are computed for all individuals in work (excluding those dropped due to the trimming of the wage distribution). Recall that variation in employment values stems from two sources: from variation in the structural parameters across the groups and from variation in wages within the groups.[40]

As expected, higher education yields substantially higher life-time employment values. In addition to higher wages more educated workers face a lower risk of unemployment and when unemployed they find a new job more easily than their less educated counterparts.[41] Because of a shorter horizon, life-time labour values are clearly lowest among the most experienced workers. The recession is clearly reflected in the graphs as both the employment and unemployment values drop for the period 1991-1994. It appears that the welfare losses caused by the recession are lowest among workers with 5 years or less of experience as their mean labour values have decreased less than in other groups during the recession. The improvement of the relative position of the least experienced group with respect to other experience groups is further reflected in the changing ranking of the mean labour values.

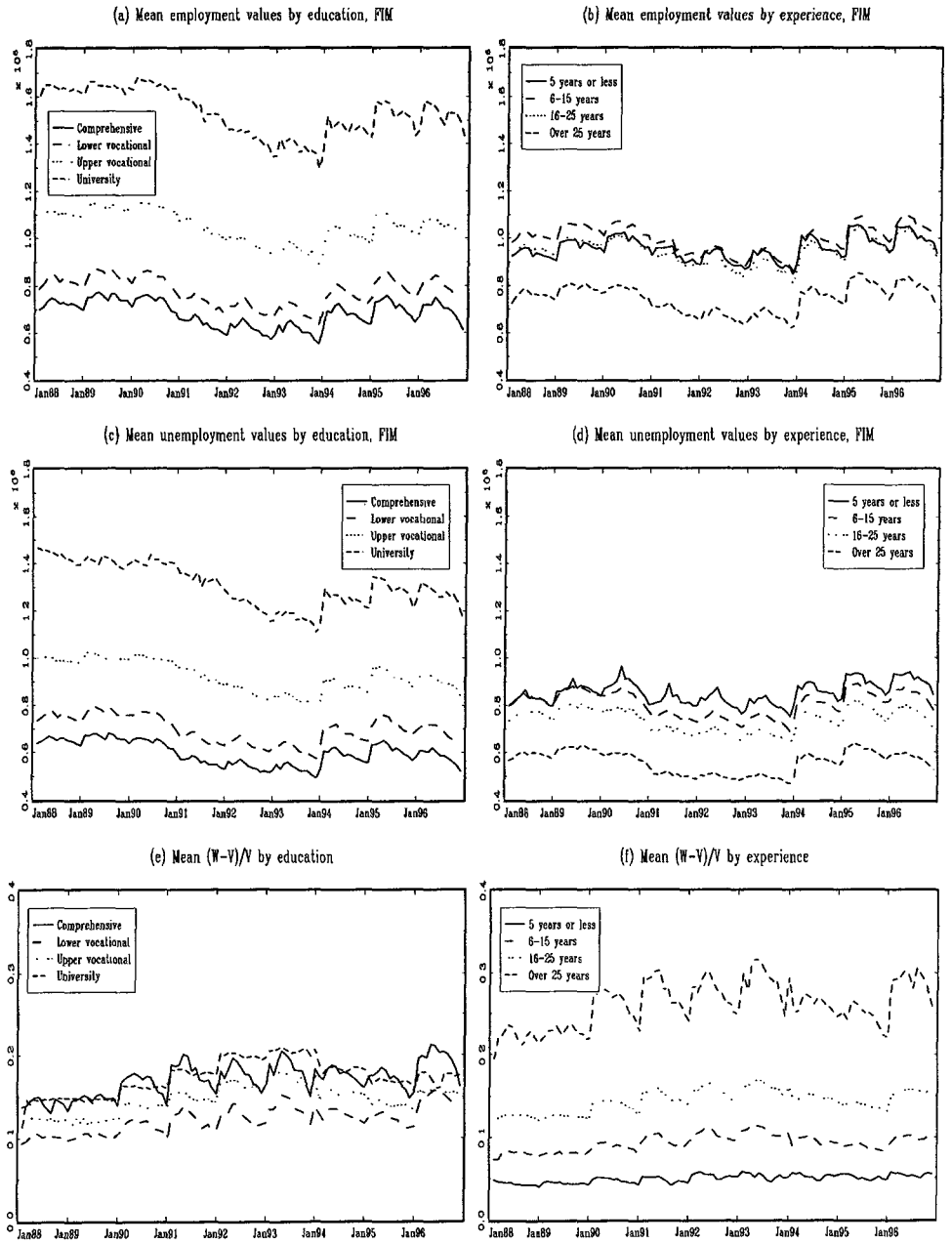
Figures 7e and 7f describe how much the current job accounts for the life-time value of employment by depicting the mean shares of employment values exceeding the corresponding unemployment values. These figures may be viewed as measures of the discrepancy between the expected life-time welfare of currently employed workers and that of currently unemployed workers. Resulting from wage mobility and labour turnover, differences between the employment and unemployment values are relatively small. Not surprisingly, the importance of the current job increases strongly with experience – the shorter the horizon, the higher is the weight of current income stream in the present value calculations. In terms of group-specific average wages, the difference corresponds roughly to 10 monthly wages for workers with over 25 years of experience and 5 to 7 monthly wages for less experienced workers. With respect to education, there are no large differences across groups, albeit workers with a university degree display a somewhat smaller welfare difference. Overall, it seems that the welfare discrepancy between employed and unemployed workers has increased a little bit during the 1990s, especially within education groups and among workers with over 25 years of experience.

It is important to emphasise that our assumption of the layoff rate being independent of job duration may be problematic if recently hired workers are in reality more

[40] The set of structural parameters for experience group $i$ is $\left(r, \lambda_i^0, \lambda_i^1, \lambda_i^2, \delta_i, \mu_i, \theta_i, b_i, \underline{w}_i\right)$.

[41] Highly educated workers are also younger on average.

## Figure 7: Mean Labour Values



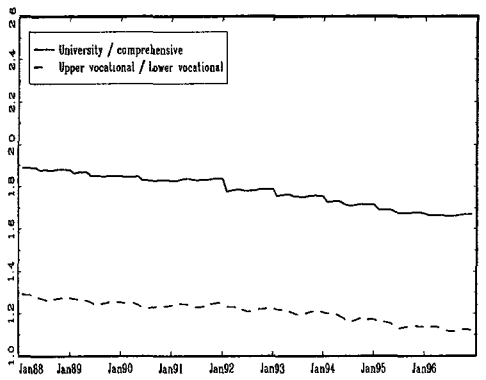
likely to be laid off than more tenured workers. If this is the case, an unemployed worker who finds a job is faced with a high risk of falling back to unemployment which in turn reduces the value of his new job. In this sense the welfare differentials between employed and unemployed workers may be underestimated and should be interpreted with caution. Anyway, it is interesting to note that these relative welfare differentials (especially by experience) are roughly identical to those found by Bowlus and Robin (1999) from the U.S. data. Moreover, Cohen (1999) estimates the discrepancy between the expected life-time welfare of an employed worker and that of an unemployed worker to correspond to 9 monthly wages in the U.S. and 13 monthly wages in France. These figures can be viewed to be roughly consistent with our findings, even though Cohen exploits a modelling strategy which is quite different from ours, making direct comparisons somewhat questionable. Cohen takes a higher job destruction rate of new hires explicitly into account, for example.

As pointed out earlier, educational differentials in wages have been decreasing over the period under investigation. This is further illustrated in Figures 8a and 8b which show the ratios of average wages between education groups. The difference in the average wages between the most and least educated groups, as well as the difference between workers at the lower and upper levels of vocational education, decreases smoothly over the observation period, with an overall decrease of over 10 percentage points. This might be seen to be in accordance with the standard view that an increase in the relative supply of skills depresses the skill premium. It is still remarkable that the patterns of educational differentials do not exhibit any signs of response to the recession despite the fact that the demand shock has affected various education groups quite differently.

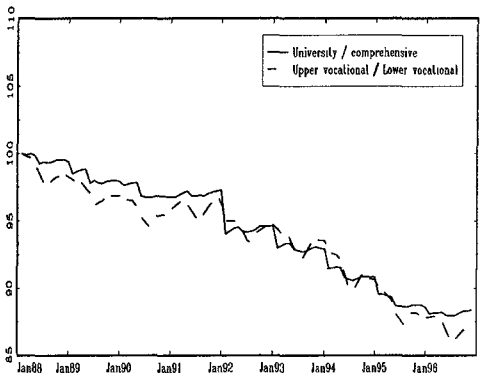
Figures 8c-8f depict the similar ratios for average employment and unemployment values between education groups. Interestingly, educational differentials in labour values display increases for the recession period, but these are approximately offset by the following decreases which bring the educational differences back to their initial levels. Closer investigation reveals that similar patterns of educational differentials in both wages and employment values exist also within the experience groups. Thus the divergent patterns of educational differentials in labour values are driven by the changing differentials in the structural parameters across education groups, which in turn may be attributed to inflexibility of the wage structure. Overall, it seems that the adjustment to the (asymmetric) demand shock has occurred mainly through the transition probabilities, that is, through the incidence and average duration of

# Figure 8: Educational Differentials

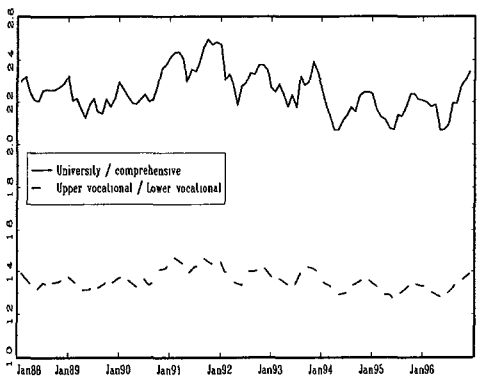
(a) Educational differentials in wages



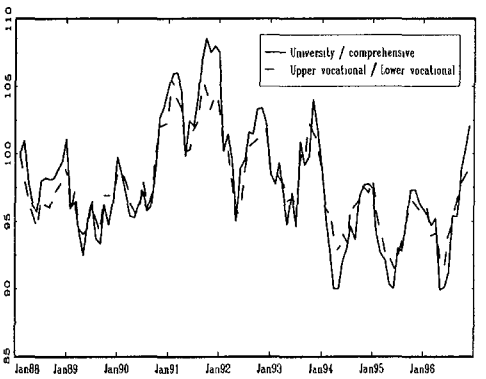

(b) Educational differentials in wages (January 1988 = 100)



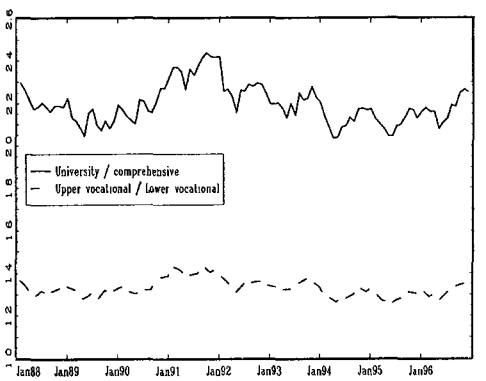

(c) Educational differentials in employment values



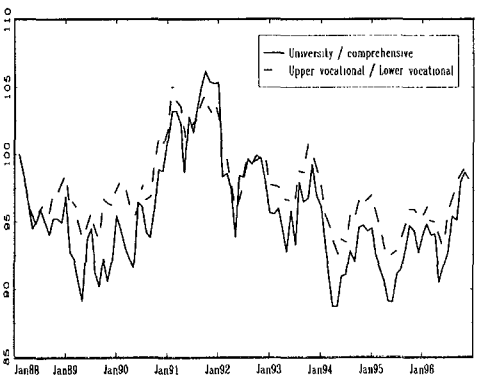

(d) Educational differentials in employment values (January 1988 = 100)




(e) Educational differentials in unemployment values




(f) Educational differentials in unemployment values (January 1988 = 100)



unemployment. In particular, the impact of decreasing educational differentials in earnings on the educational differentials in welfare measures is offset by changes in the transition probabilities across groups. Note also that educational differentials in labour values are generally slightly higher than the corresponding differentials in wages.

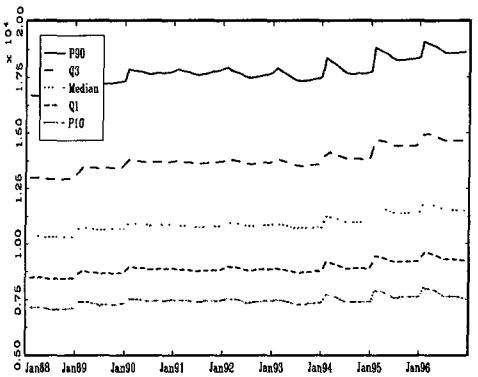
## 5.3 Earnings and Employment Value Inequality

Figure 9 presents various quantiles of earnings and labour value distributions with the indices of the associated inequality measures. Absolute values of the inequality measures are shown in Figure 10. The unemployment value distribution is defined over unemployed workers, whereas the underlying population for two other distributions consists of employed workers. When comparing the patterns of employment value and earnings distributions, one should take into account the changing sample composition over time and its different impact on these two distributions. Recall that the fraction of workers with over 25 years of experience and that of workers with the highest level of education are increasing strongly over the sample period. Since workers with a university degree tend to be located at the higher end of both distributions, the increasing share of them in the data is likely to affect trends in both distributions to the same direction. However, since more experienced workers tend to earn high wages but the employment value decreases with experience by construction, the increasing presence of the most experienced group is mainly affecting the opposite parts of employment value and earnings distributions.

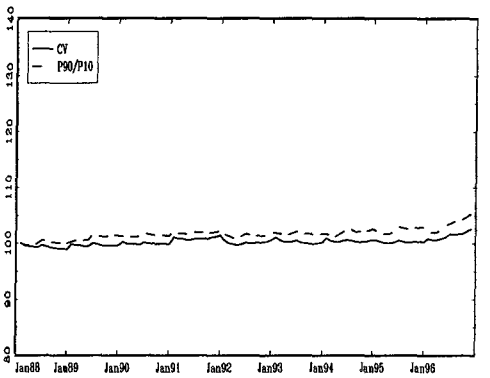
The overall pattern of earnings in Figure 9a seems very sluggish: the distribution is slowly shifting upwards without observable changes in dispersion. Figure 9b confirms us that the dispersion of earnings has been approximately constant over the observation period. Consequences of the recession are clearly seen from the distributions of employment and unemployment values, both of which shift down for the recession period, reflecting reductions in the expected life-time welfare. A relatively smooth pattern of the highest percentiles of the employment value distribution over the recession years is attributed to increasing numbers of highly educated workers in the labour market. Since the upper end of the employment value distribution consists almost entirely of workers with upper vocational or university education, the increasing presence of them weakens the negative impact of the recession on the upper end of the distribution by increasing the mass around the mean values of

Figure 9: Distributions of Wages and Labour Values

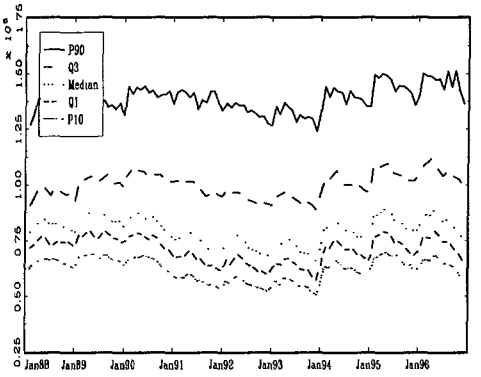
(a) Quantiles of the wage distribution



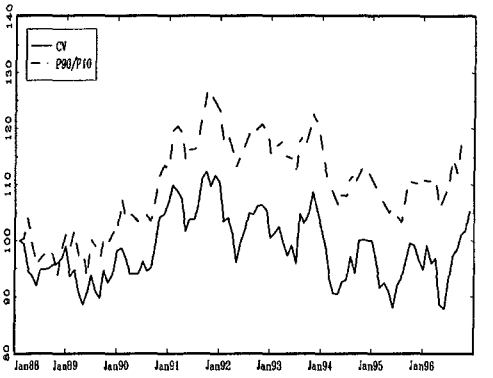

(b) Inequality indices for wages (January 1988 = 100)



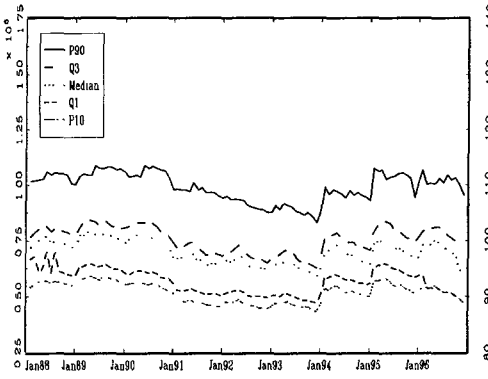

(c) Quantiles of the employment value distribution




(d) Inequality indices for employment values (January 1988 = 100)




(e) Quantiles of the unemployment value distribution




(f) Inequality indices for unemployment values (January 1988 = 100)

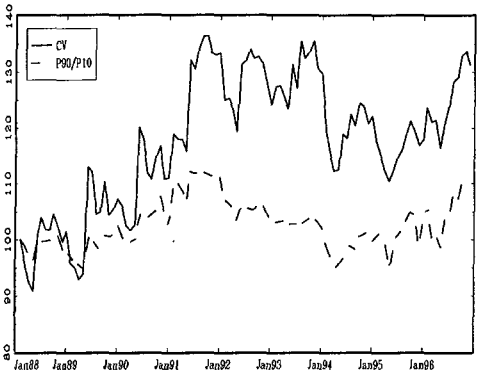
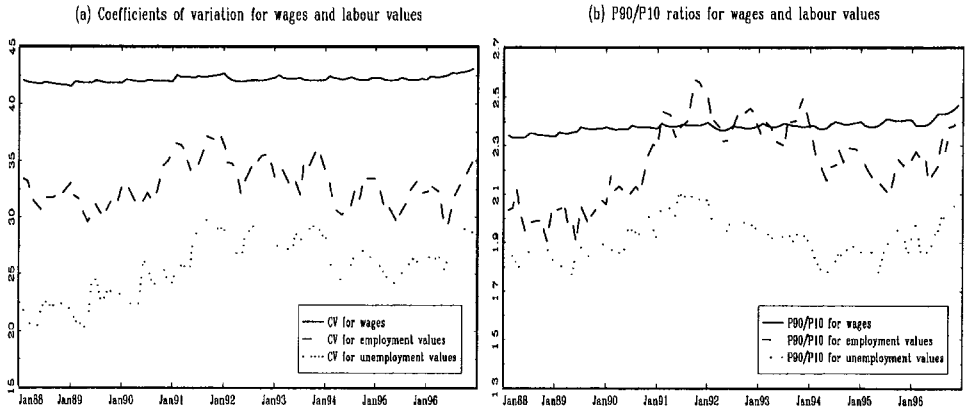


Figure 10: Inequality Indices for Wages and Labour Values




groups with the highest employment values.

Two alternative measures of variation give somewhat different insight about the pattern of employment value inequality. When measured by the 90/10 percentile ratio, it seems that the recession period is marked by an increase of some 20 per cent in employment value inequality, after which the employment value distribution compresses a little bit. On the other hand, the CV suggests a less dramatic trend without persistent changes in inequality, albeit it also displays some increase in employment value dispersion for the recession period. Slight differences in the inequality patterns of employment and unemployment value distributions are driven by divergent trends in the composition of the unemployed and employed stocks.[42]

In terms of the CV, employment value inequality is some 20 per cent lower than the corresponding wage inequality on average, while there is no clear difference during the early 1990s when measured by the 90/10 percentile ratio. In any case it is interesting to note that Bowlus and Robin (1999) find inequality in employment values to be only half of wage inequality in the U.S., pointing to a much larger discrepancy in the variation between the two distributions. Compared to our results, their findings imply that wage inequality in Finland is approximately half of that in the U.S., but the levels of employment value inequality are very close to each other

[42]If we reconstruct the unemployment value distribution by weighting education-experience groups by the number of employed workers instead of the number of unemployed workers in the cells, we will observe an inequality pattern for the unemployment values similar to that of the employment values.

in both countries, having been perhaps some 15 per cent lower in Finland at the end of the 1980s and vanishing thereafter.[43] Our results are further in line with the cross-country findings of Flinn (1997) and Cohen (1999), both of which use life-time welfare measures to compare inequality levels between the labour markets. Despite much lower wage inequality among young Italian males than young Americans, Flinn recovers a less dispersed distribution of life-time welfare for the U.S. labour market. Likewise, Cohen estimates welfare differentials within the U.S. and French labour markets to be much lower than the corresponding wage differentials. Overall, it seems that a higher degree of wage and employment mobility in the U.S. labour market can compensate for higher wage inequality, leading to relatively low levels of life-time welfare inequality compared to more rigid labour markets.

Turning to inequality within groups, Table 1 shows inequality measures for earnings and employment values within different education and experience groups. It is found that dispersion in earnings is much lower among less educated workers than among their more educated counterparts. With respect to experience, the levels of within-group earnings inequality are more similar across different groups. Earnings inequality exhibits increasing trends among workers with a university degree and those with upper vocational education, while earnings inequality in the less educated groups has not changed notably from 1988 to 1996.[44] The increasing trend in earnings dispersion among workers at the higher levels of education may partly reflect their increasing numbers in the labour market as new entrants into the labour market are likely to be paid less than workers in the same group on average. On the other hand, dispersion in the quality of higher education may be increasing over time since increases in the amount of higher education have been carried out essentially by introducing new study schedules. With respect to experience, the inequality patterns in earnings do not display clear trends over time. Recall that dispersion in earnings as a whole was found to be relatively stable over time. Thus it seems that increasing earnings inequality within the groups of highly educated workers has compensated for decreases in educational differentials.

Levels of inequality in employment values within education groups are much

[43] According to Bowlus and Robin (1999), the average 90/10 percentile ratio is 2.3 for employment values and 4.2 for wages in the U.S. over the period 1978-1994. Since they find the variation in both distributions to be increasing over the period, the relevant values to be compared with our figures must be higher. Simple assessment based on their graphs suggests that for the period 1988-1994 the average 90/10 ratio might be some 2.4 and 4.4 for employment values and wages respectively.

[44] Changes from 1988 to 1996 in the inequality measures in the table are computed by comparing the annual average of 1998 with the annual average of 1996.

Table 1: Inequality Indices by Education and Experience

| | *Wages* | | | | *Employment values* | | | |
|---|---|---|---|---|---|---|---|---|
| *Education:* | CV | ΔCV | P | ΔP | CV | ΔCV | P | ΔP |
| Comprehensive | 27.7 | 2.4% | 2.0 | 3.5% | 11.9 | 12.5% | 1.4 | 3.7% |
| Lower vocational | 26.0 | -3.0% | 2.0 | 0.5% | 9.4 | 22.6% | 1.3 | 6.4% |
| Upper vocational | 38.4 | 9.6% | 2.7 | 10.9% | 10.6 | 6.0% | 1.3 | 2.4% |
| University | 43.4 | 10.1% | 2.8 | 11.3% | 13.5 | 2.2% | 1.4 | 1.5% |
| *Experience:* | | | | | | | | |
| 5 years or less | 35.1 | 0.0% | 2.5 | 7.8% | 23.5 | -11.6% | 1.9 | 5.9% |
| 6-15 years | 35.4 | 0.5% | 2.2 | 3.7% | 28.8 | -6.5% | 2.0 | -2.2% |
| 16-25 years | 42.2 | -1.1% | 2.4 | 3.9% | 32.2 | -2.5% | 2.1 | 0.0% |
| Over 25 years | 41.7 | 1.5% | 2.2 | 2.7% | 31.4 | 11.7% | 1.8 | 19.6% |

Notes: CV = average CV over the observation period; ΔCV = percentual change in CV from 1988 to 1996. P = average P90/P10 ratio over the observation period; ΔP = percentual change in P90/P10 ratio from 1988 to 1996.

lower than the corresponding inequality levels in earnings. It is interesting to note that the ranking of the inequality levels in employment values is very different compared to the inequality levels in earnings: more educated workers display much higher earnings inequality, while there are no clear differences in the levels of employment value inequality between education groups. In particular dispersion in employment values within the two most educated groups is only one fourth of the corresponding earnings dispersion within these groups when measured by the CV. This means that variation in the structural parameters of the model with respect to experience compensates for high earnings inequality within the more educated groups. Over time inequality in employment values perhaps increases (in terms of the CV) among workers with lower vocational education and those without any degree, whereas there are no clear trends within the higher educated groups. Employment value inequality within experience groups is in general higher than within education groups but is lower than the corresponding earnings inequality.

# 6 Conclusion

We have studied how the recession of the early 1990s hit different worker groups in the Finnish labour market. We begun with the description of the patterns of earnings and labour market transitions for various categories of private-sector males over the period 1988-1996. As expected, hiring and layoff rates have been changing dramatically over the period. The recession was found to have smoothed down differences in the likelihood of becoming unemployed, leading to a more compressed distribution of layoff rates. In contrast, dispersion in the hiring rate distribution has been increasing over the observation period. In terms of unemployment rates, the early 1990s was found to be marked by increasing educational differentials.

Except for the recession years, average earnings were found to be increasing slowly with smoothly decreasing educational differentials. It appeared that less educated and more experienced workers have faced with relatively smaller declines, if any, in their real wages during the recession years. While variation in wages has slightly increased within highly educated groups, wage inequality as a whole has not changed notably over the observation period. Overall, the respond of wages to the demand shock has been very limited, especially as the wage adjustments have occurred only in the worker groups of the smallest size. Thus, the adjustment seems to have occurred mainly through the transition rates between employment and unemployment, i.e. the incidence and average duration of unemployment.

To put the patterns of wages and transition probabilities together, we used search theory to derive value functions for different positions in the labour market. Along the lines of Bowlus and Robin (1999), we then analysed the evolution of inequality in the cross-section distributions of life-time labour values. We found the average levels of employment values to have shifted down for the recession period in all worker groups, indicating losses in the expected levels of life-time welfare. These losses caused by the recession turned out to be mainly temporary, however. The average welfare discrepancy between employed and unemployed workers was found to be slightly increasing over the early 1990s, especially within education groups and among workers with over 25 years of experience. Contrary to the earnings patterns, we found educational differentials in life-time labour values to be increasing during the recession period. Thus, the impact of decreasing educational differentials in earnings on the welfare differentials has been offset by changes in the transition probabilities across groups.

We found also some evidence that the recession period was marked by increasing inequality levels, though it remains a little unclear to which extent these increases disappeared during the period of recovery. Inequality in life-time employment values was found to be only slightly lower than the corresponding wage inequality, which is in contrast to the recent findings from the U.S. data. While wage inequality in Finland is approximately half of that in the U.S., employment value inequality seems to be very close to the U.S. level, having been perhaps some 15 per cent lower in Finland at the end of the 1980s and vanishing thereafter. This suggests that higher labour turnover and wage mobility in the U.S. labour market can compensate for higher wage inequality to a great extent.

The use of dynamic structural modelling gives us a coherent way to consider the different forces affecting inequality in the labour market. In particular it provides a way to associate changes in the labour market environment with the distribution of expected welfare outcomes. However, there are also some cautionary points in our approach. First, the model on which our analysis relies is obviously a very stylised one, ignoring a number of real-life features of the labour market. Second, our measure of life-time welfare omits taxes and income transfers, both of which are used to decrease welfare differentials. This is a relevant concern especially in the case of Finland as income transfers can occasionally account for a substantive part of household income and their impact is heavily dependent on the current labour market state, household composition and other incomes. One should bear this point in mind when comparing our results with the findings from the U.S. data. Third, the worker groups used were very broadly defined, suggesting that aggregation might hide some sorts of underlying inequality patterns from us. The results presented in this study should be interpreted in the light of these remarks.

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# A Annual Promotion and Demotion Rates

Promotion and demotion rates are computed separately for each education-experience group. Details of the promotion and demotion rate calculations can be found from Section 4.1. Figures in the tables below are weighted averages.

Table 2: Annual Promotion Rates by Education and Experience

| *Education:* | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
|---|---|---|---|---|---|---|---|---|---|
| Comprehensive | .19 | .19 | .15 | .09 | .10 | .09 | .14 | .15 | .12 |
| Lower vocational | .21 | .22 | .17 | .10 | .10 | .10 | .14 | .17 | .12 |
| Upper vocational | .24 | .26 | .20 | .14 | .11 | .11 | .17 | .22 | .19 |
| University | .26 | .26 | .20 | .14 | .11 | .12 | .18 | .24 | .21 |
| *Experience:* | | | | | | | | | |
| 5 years or less | .47 | .46 | .40 | .30 | .29 | .30 | .36 | .44 | .39 |
| 6-15 years | .24 | .26 | .20 | .12 | .11 | .11 | .18 | .23 | .19 |
| 16-25 years | .17 | .18 | .13 | .08 | .09 | .08 | .13 | .16 | .12 |
| Over 25 years | .15 | .15 | .11 | .08 | .08 | .08 | .12 | .14 | .10 |

Table 3: Annual Demotion Rates by Education and Experience

| *Education:* | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
|---|---|---|---|---|---|---|---|---|---|
| Comprehensive | .05 | .06 | .06 | .05 | .05 | .04 | .03 | .02 | .03 |
| Lower vocational | .05 | .06 | .06 | .05 | .05 | .04 | .02 | .02 | .03 |
| Upper vocational | .05 | .05 | .06 | .06 | .06 | .05 | .03 | .03 | .03 |
| University | .04 | .05 | .06 | .06 | .08 | .07 | .03 | .03 | .03 |
| *Experience:* | | | | | | | | | |
| 5 years or less | .04 | .06 | .06 | .04 | .04 | .03 | .02 | .03 | .03 |
| 6-15 years | .05 | .06 | .06 | .06 | .06 | .05 | .03 | .03 | .03 |
| 16-25 years | .05 | .06 | .06 | .05 | .06 | .05 | .03 | .02 | .03 |
| Over 25 years | .05 | .06 | .06 | .05 | .05 | .05 | .03 | .02 | .03 |

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