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FROM CREATIVE DESTRUCTION TO HUMAN CAPITAL GROWTH: WAGE DISPERSION EFFECTS IN FINLAND

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ABSTRACT: In Finland the shifts in compensation have been of a similar kind compared to those in the US, but moderate with increasing wage variance between plants, an increasing gap between average non-productive and productive worker wages and an increasing share of non-production workers. In the deep recession and intense restructuring at the beginning of the 1990s the returns on unobserved human capital rose. In the boom period of 1995-1998 the education premium rose. Despite the rise in individual heterogeneity there has been no major increase in wage dispersion. The entire rise in wage dispersion has taken place between plants, while education premium dispersion has risen mainly within plants. At the same time, the distribution of capital and R&D investment across firms has worked in the direction of mitigating wage inequality.

Keywords: income distribution, human capital, compensation policy

JEL Classification numbers: O15, J31, J21, J50, C23

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TIIVISTELMÄ: Tutkimus tarkastelee korvauksia osaamispääomalle viimeisen kahden vuosikymmenen aikana. Globalisaation ja yritysten toimintaympäristön muutokset selittävät palkanmuodostuksen muutoksia, kun työmarkkinainstituutiot ovat muuttuneet vain vähän. Suomessa palkat ovat kehittyneet samansuuntaisesti kuin Yhdysvalloissa, mutta muutokset palkkahajonnassa ovat olleet suhteellisen vähäisiä. Palkkahajonta on kasvanut toimipaikkojen sisällä ja toimihenkilöiden, työntekijöiden välinen palkkaero on kasvanut jonkin verran ja toimihenkilöiden osuus kaikista työntekijöistä on kasvanut. 1990-luvun alun syvän laman aikana korvaukset ei suoraan havaittavalle osaamispääomalle kasvoivat. Tämän voi päätellä korkeista palkoista, jotka eivät selity koulutuksesta eivätkä myöskään perustu työkokemukseen tai yrityskohtaiseen palkkaukseen. Kasvun kautena 1995-1998 koulutuksen tuotto kasvoi. Huolimatta työntekijöiden heterogeenisuuden kasvusta palkkahajonta ei ole suuresti kasvanut. Palkkahajonnan kasvua selittää pääosin toimipaikkojen keskimääräisten palkkojen erojen kasvu, mutta samalla koulutuksen tuotto on kasvanut lähinnä yritysten sisällä. Samaan aikaan pääoma ja tutkimus- ja kehitystoiminta ovat jakautuneet entistä tasaisemmin yritysten välillä, mikä on tasannut tuloeroja. Yhdysvalloissa tuottavuuserot yritysten välillä ovat kasvaneet (tosin 1990-luvun jälkipuoliskolta ei ole paljon tutkimusta asiasta). Sen sijaan Suomessa yritysten väliset tuottavuuserot kaventuivat laman jälkeen.

1. Introduction

This paper examines compensations for human capital paid since the end of the 1980s, using large linked employer-employee data covering the whole of the private sector in Finland. The stylized facts of the recent wage formation and wage dispersion have followed general regularities, but with some variation between Europe and the US[1]:

1. The education premium has been on the rise since the late 1970s (see Goldin and Katz, 1995, 1998 and Autor, Katz and Krueger, 1998). In some countries, however, low wages have increased relatively more than high incomes (Germany, Finland, and Canada) or the wage dispersion has stayed relatively constant (other Nordic countries).
2. Checchi and Peñalosa (2005), among others, find increasing income inequality in the US and the UK also during the 1990s. Wage dispersion in the 1980s and the 1990s rose between plants within industries in the US. Wage variation within plants was relatively unaffected (Davis and Haltiwanger, 1991, Dunne et al., 2000, Autor, Katz and Krueger, 1998). In the 1990s the Nordic countries exhibited a moderate increase in wage variation between plants (see Hibbs and Locking, 2000, this paper).

Despite some country variation in returns to education it is evident that some common technological progress in all developed markets explains a rise in the demand for educated workers. Berman, Bound and Machin (1998) show that the Nordic countries (Denmark, Finland and Sweden) have similar within-industry changes in the proportion of non-production employment to those in the US. The technology-skill complementarity has also been an appealing explanation for changes in wage dispersion. Breshnahan (1999) and, to some extent, Autor,

[1] For recent studies, see Katz and Murphy (1992), Juhn, Murphy and Pierce (1993), Gotthschalk (1997) and Autor, Katz and Krueger (1998), and OECD (1996) for a comparison of low-income earners in 13 countries.

Katz and Krueger (1998) also stress organisational complementarity between ICT and the noncognitive skills of the highly educated.

An important part of the innovation process takes place in recessions that revitalize the economy, a prominent view indeed in pre-Keynesian economics (see, for example, De Long 1990). In the Schumpeterian view, production factors are allocated away from contracting activities and into newly expanding ones (see, for example, Cabarello and Hammour, 2000, Aghion and Howitt, 1998, Aghion, 2002). We argue that in this Schumpeterian approach a rise in compensation for unobserved skills, naturally, precedes the rise in the education premium. This explains why Juhn, Murphy and Pierce (1993), hereafter JMP, find that the skill premium in the unexplained part has been operating since the late 1960s, while returns to observable skills started to rise in the 1980s.

At the beginning of the 1990s the Finnish economy faced the deepest recession experienced in any OECD country in the post-war period. A boom period in 1988-89 was followed by a severe recession with a drop in GDP of 14 per cent in 1991-1994. (For a description, see Honkapohja and Koskela, 1999.) Another driving force has been European Union membership in 1995 and the opening of the domestic market for foreign firms and competition. We can think of at least four different factors affecting wage inequality trends in Finland that may differ from those in the US in the 1990s. To begin with, the restructuring and reallocation of human capital and fixed capital across industries was probably more intense in Finland than in the US in the 1990s. Second, labour shares, compensations to employees per GDP, have remained steadily at around 57% in the US since 1960, while the labour share decreased from 60% to around 50% in Finland in the 1990s; see Checchi and Peñalosa (2005). We measure only wage inequality which is likely to underestimate the actual rise in income inequality (also including employment and capital income). Third, the very rapid improvement in the educational level in Finland may have inhibited supply-side constraints for skilled workers (see for example comparisons across countries at the NUTS-2 level in Badinger and Tondl, 2002). Finally, Fortin and Lemieux (1997) list some unique institutional changes in the US that can explain about a third of the rise in equality in the 1980s that may partly hold for the 1990s. These include the decline in minimum wages, the decline in the unionisation rate and economic deregulation in transportation, communications and the financial and energy industries.

Finnish centralised wage setting has not been reformed as in Sweden and Denmark, either.[2] Labour market institutions were unlikely to adapt rapidly enough to the production shocks in the recession of the early 1990s. It is difficult to cut the wage level below the tariff levels at different job-complexity levels stipulated by collective agreements. Local bargaining at the firm level is used very little in the setting of tariff wages, see Heikkilä and Piekkola (2005). On the other hand, in the recovery period with rapid growth since 1994 the evident but slack response on the part of the unions to massive unemployment was to accept wage moderation. Thus, wage-setting institutions have been an important reason for strong recovery being associated with a moderate rise in wage dispersion. It should be noted, though, that negotiated wages set only lower bounds for wage rises. The wages of upper white-collar workers are, to a large degree, individually set.

The aim of this paper is to study the changes in the wage dispersion and relate this to the evolvement of human capital at the plant level. The empirical analysis is made by using the linked employer-employee Statistics Finland data of the labour market covering the entire private sector in 1987-1998. The frequency of job-to-job flows enables the separation of person-effects and firm-effects in compensations. The person-effect in compensations can be further

[2] For a description of reforms, see Andersen (2003) for Denmark and the Confederation of Swedish Enterprises (2001) for Sweden or for the effects of centralised bargaining on firm deaths, see Moene and Wallerstein (1997).

explained by educational field and educational degree, depending on the age cohort. Compensations for unobserved human capital are referred to as the wage component throughout an individual's work career that is not explained by education, experience or sex. The JMP full distribution accounting method is used in the next stage to analyse the role of quantitative and price changes in human capital and other firm assets. This shows dynamic implications of restructuring and technology-skill complementarity and allows us to control for the segmentation of plants with regard to the amount and quality of capital (for segmentation, see Caselli, 1999, Kremer and Maskin, 1996).[3]

Section 2 presents the data. Section 3 shows the dispersion in human capital payments since the end of the 1980s and Section 4 the decomposition of wages and related results. Finally, we conclude in Section 5.

2. Data and Wage Components

The aim of this paper is to study the changes in the wage dispersion and its different components in Finland in 1987-1998. The period covers a very severe recession (in the early '90s), which is expected to have an effect on wage dispersion and returns to human capital. The study uses register-based employee data of Statistics Finland, which covers the entire Finnish economy. This is a large database that combines various registers kept by Statistics Finland and other authorities. It includes information on annual earnings, working months, unemployment periods, education level and person- and plant-identity codes including the first year of service in the firm. The annual wages used in this study are real compensation (wage) di-

[3] See also Galor and Tsiddon (1997), Acemoglu (1998), Caselli (1999), Galor and Moav (2000) and Dunne et al. (2000).

vided by months worked and multiplied by 12 (deflated by the consumer price index, 1990=1.00).

The Employment Statistics data used in this study consist of 23,776,631 observations from individuals that, during 1989-1998, worked at least one year in the private sector. To this is linked plant-level data on investment, sales, R&D investment from the sample of firms that belong to financial statements data of Statistics Finland. The sample covers all large firms and includes a representative sample of small firms. Person- and firm-effect calculations are based on 12,824,574 observations, where the firm code is non-zero and the person has been employed. Plant-level analysis is done in 9,553 firms. The formation of linked employee-employer data is explained in more detail in the Appendix.

We are interested in estimating both individual and firm heterogeneity in wage formation. Individual heterogeneity, as captured by person-specific fixed effect, can subsequently be used to assess the returns to education. The remaining part of the person-specific fixed effect is the part of wages that cannot be explained by observed characteristics (to the econometrician). We refer to this as unobserved human capital of the individual. We explain wage dispersion by changes in human capital compensations in existing plants/firms. For example, Abowd, Haltiwanger et al. (2001) find that new and exiting business generally contribute little to aggregate human capital change in the state of Illinois during the 1990s.

We are faced with the challenge of how to measure change in the time-invariant human capital components of individual human capital. We solve the problem by doing the estimation in two periods, the years 1987-1992 and 1993-1998. The primary reason for splitting data into a five-year period, 1987-1992, and a six-year period, 1993-1998, is to have the maximal amount of job mobility across firms within the period. This is because the estimation of person- and firm-effect requires mobility of workers across firms within the period. The period 1993-1998 is one year longer, as hirings were lower in this latter period, see Böckerman and Piekkola (2001). The two periods also split the recession period 1991-1994 with negative GDP growth equally to both periods. We can thus consider structural changes over the years and are not simply analysing two periods of very different economic cycles.

The logarithm of wage for individual i in firm j at time t is explained by person-specific fixed effect (reflecting permanent observable and unobservable differences between individuals), firm-specific fixed effects, and by time-variant observable characteristics. The only time-variant variable is experience. This is measured by age minus years of education and age when school started. The empirical formulation follows Abowd, Kramarz and Margolis (1999) in such a way that in the wage regressions the person-effects are estimated before the firm-effects instead of analysing them simultaneously.[4] The person-specific component is further decomposed into non-time varying measurable personal characteristics and into a part that is unobservable to the statistician.

To compute these components we estimate a wage regression, which includes only time-varying characteristics as deviations from their means and take into account the firm-specific fixed effects through the interaction of individual to firm characteristics. Seniority is duration of job measured in years. The dependent variable is the log of the wage $\ln(w_{\mathrm{ijt}})$ of a person *i* working in firm *j* at time *t* measured as a deviation from individual mean μ_{wi} (in difference Abowd et al., 1999, estimates deviations from the grand mean). This is expressed as a function of individual heterogeneity, firm heterogeneity and measured time-varying characteristics

[4] Abowd, Creecy and Kramarz (2002) develop a numerical solution to deal with the large set of firm dummies when evaluating both person and firm-fixed effects at the same time. Andrews, Schank and Upward (2004) alternatively suggest a two-step method, where the first step estimation covers only individuals that move from one firm to another to capture the firm-effects. These are subsequently plunged into the second-stage estimation of all workers, see Piekkola (2005) for adaptation of this approach.

$$\ln(w_{\mathrm{ijt}})\text{-}\mu_{wi} \;=\; \theta_i + \psi_{J(i,t)} \;+ \beta(x_{it} - \mu_{xi}) + e_{ijt}\,. \qquad (9)$$

θ_i is the time-invariant compensations for human capital (individual fixed effect). ψ_j captures the effect of unmeasured employer heterogeneity, where $J(i,t)$ indicates the employer of *i* at date *t*. $\beta(x_{it} - \mu_x)$ shows compensations for time-varying human capital stated as a deviation from the individual mean: hence, it contains time dummies and experience up to the fourth power. e_{ijt} represents a statistical error term. The wage model at the first stage includes only time-varying characteristics as deviations from their means: βx_{it} and $\overline{x}_i \overline{y}_j$ showing interactions of person average $\overline{x}_i$ and firm characteristics $\overline{y}_j$ (interactions of average experience with the average number of workers and its second power, with the average number of workers times seniority and its second power, with 45 industry dummies and with 45 industry dummies times seniority).

The person specific fixed effect can be calculated as the person average of the residual from the wage equation: $\theta_i = mean_i(\ln(w_{it}) - \hat{\beta}_1 x_{it} - \hat{\beta}_2 \overline{x}_i \overline{y}_j)$, where $\hat{\beta}_1$ and $\hat{\beta}_2$ are the estimated values of the coefficients. The decomposition of the person effect θ_i for the two periods 1987-1992 and 1993-1998 uses the weighted least square estimates of

$$\theta_i = \alpha_i + u_1\eta_i + u_2 d_i + \varepsilon_i\,, \qquad (10)$$

and using the variance of $\ln(w_{it}) - \hat{\beta}_1 x_{it} - \hat{\beta}_2 \overline{x}_i \overline{y}_j$ for each individual i as the weight. α_i is the intercept (unobserved person effect), η_i is the education level, d_i is the sex dummy and ε_i is the statistical error. Six education grades are separated according to five fields ((i) general education, humanities, aesthetics, medical and health, field unknown, (ii) commercial and clerical work, law, social science, (iii) technology and natural science, (iv) transport and communication and (v) agriculture and forestry (no field for elementary and doctorate and also unspecified field for vocational). Furthermore, until 1993 those of less than 34 years of age and others are separated and in 1993-1998 those of less than 37 years of age are separated from others using dummies. The reason is the reforms in the education system that took place, particularly in the 1980s, so that the same educational degree for young and old may not be comparable. This leads to 45 education dummies.

The firm-effect ψ_{jt} is the difference between $\ln(w_{it}) - \hat{\beta}_1 x_{it} - \hat{\beta}_2 \overline{x}_i \overline{y}_j$ and person-effect θ_I, which we do not analyse in the subsequent analysis. The estimation procedure raises the identification problem of separating person- and firm-effects. The data suggests that the time period of ten years (or the two sub periods) is long enough for workers to experience job switches and in each firm there is at least one person leaving or entering the firm (See the discussion of the identification problem in Abowd et al. 1999.) As discussed, condition effects through interaction terms have also been used to provide an approximate solution to the simultaneous analysis of person-effects and firm-effects. The two-stage approach used gives a very low correlation of the person- and firm-effects (below 0.006, not shown).

3. Dispersion of Wages and Its Components in 1989-1998

This section describes the evolution of wages and human capital compensations in Finland in 1989-1998 and explains how these can be decomposed into within- and between-plants components. The period includes the record deep recession with a 14% decrease in GDP in 1991-1993 and unemployment reaching a peak of 16% in 1994 (for labour mobility fluctuations, see also Böckerman and Piekkola, 2001). Figure 1 shows changes in compensations in annual earnings in Finland over a ten-year period for all, and for highly and low educated workers, variance in 1993 as an average of 1992 and 1994 due to outliers in 1993). The variation in wages is decomposed further into within- and between-plants components in Figures 1b-1c. [5]

Figure 1 a-d: Variance of Average Earnings in 1989-1998

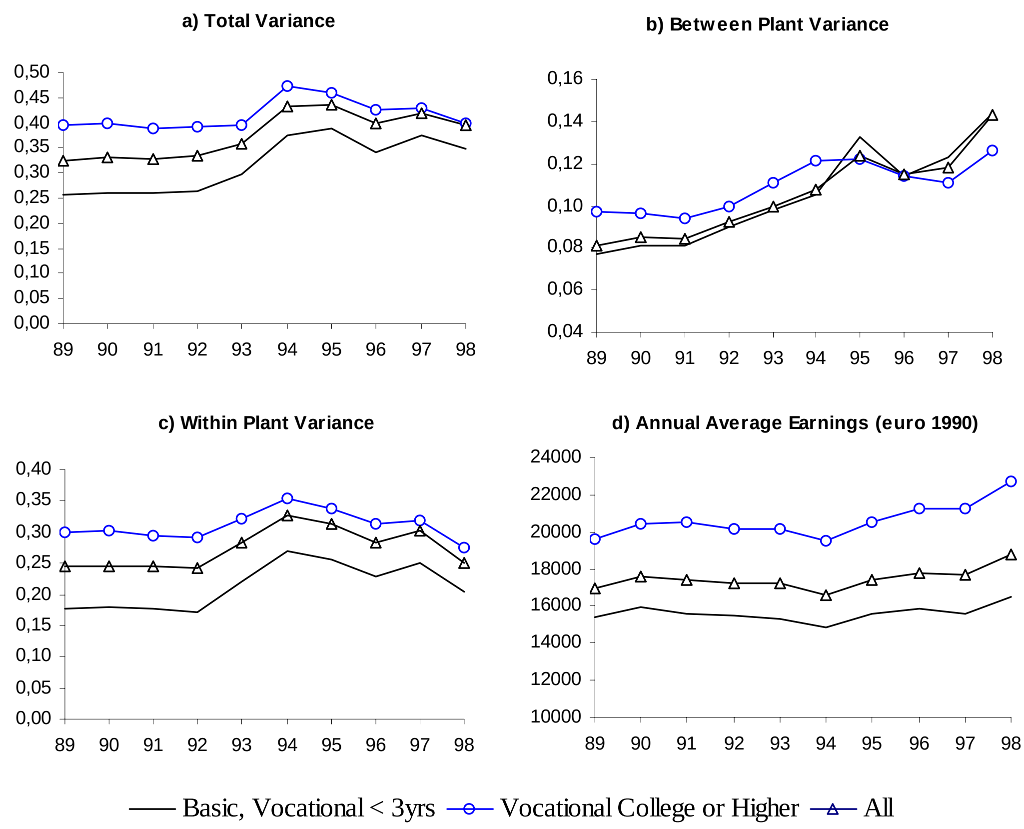

Figure 1a shows some rise in wage variance over the period. However, there is no clear US-style trend of increasing wage dispersion among those with vocational college education or higher. Maliranta and Vainiomäki (2002), though, find in the period a rise in wage dispersion for workers with higher university-level education. The wage variation among the low educated has increased a little, which is similar to that in Sweden (see Hibbs and Locking, 2000). Note

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5 The variance components of total variance V, within plant variance V_{WI} and between plant variance V_{BE} are decomposed as follows: total $V = uV^U + (1-u)V^{NU} + u(1-u)(W^U - W^{NU})^2$, within $V_{WI} = uV_{WI}{}^U + (1-u)V_{WI}{}^{NU} + u(1-u)(W_{WI}{}^U - W_{WI}{}^{NU})^2$, between $V_{BE} = V - V_{WI}$, $V_{BE}^U = V^U - V_{WI}^U$, $V_{BE}^{NU} = V^{NU} - V_{WI}^{NU}$, where u = the share of highly educated workers and within effects are aggregated by using firm sizes as weights.

that we would have found a substantial increase in the wage dispersion of the excluded low educated group. We, however, rely on wages dispersion for workers with more than elementary education, since the excluded segment is heterogeneous. (This workforce with a missing education code, also due to lack of data, consists of around 30 per cent of the total workforce.) [6]

Figure 1b shows that the between-plant variance has increased steadily in the period. Figure 1c shows that the within variance of wages increased in the deep recession at the beginning of the 1990s and decreased towards the end of the 1990s. Thus, the relatively moderate increase in wage variation is primarily due to no increase in variation within firms. As argued in the introduction, one reason for this can also be the centralised wage agreements, where rises in negotiated wages were moderate, to improve employment after the peak 16.6% unemployment rate in 1994.

From Figure 1d the wage increase over the period has been 7 per cent for the low educated and 16 per cent for the highly educated, leading to an increase in the wage difference of around 20 per cent (equivalent to 2,000 € in 1990 CPI prices). This is equivalent to an increase in the wage ratios from 1.27 to 1.37, which is not a very dramatic increase.[7] But the well-known fact of the increasing share of highly educated workers with a higher wage variance has also somewhat contributed to the overall rise in wage dispersion. This can be seen from the wage variance of the highly educated approaching that for everyone in Figure 1a. It can be said that the shifts in compensations have been of a similar kind to those in the US with increasing wage variance between plants, an increasing gap between average non-productive and productive worker wages and an increasing share of non-production workers (Dunne et al.

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6 Heterogeneity has also changed since the inclusion of a large number of small firms in the latter part of the 1990s in the employee statistics. Employees in these small firms mostly have a missing education code and are therefore categorised in the workforce with less than 3 years of vocational education.

7 In the detailed manufacturing data of the Confederation of Finnish Industry and Employers (2002) there is no change in the wage ratios of the lowest and highest deciles for production workers and a slight decrease for non-production workers, which supports our results.

2000). But the overall changes in wage dispersion have been moderate (see for a similar finding for Sweden in Hibbs and Locking, 2000).

The fact that the total wage variation has been increasing, but not substantially, does not lead to the conclusion that individual heterogeneity in human capital compensations may not have changed considerably. Consider next the compensations for education, unobserved human capital based on the estimation of (10) and plant-level wages from the estimation of (11) as shown in Figure 3. Remember that unobserved human capital and education are time-invariant person effects within the two estimation periods of 1987-1992 and 1993-1998. Within these periods the only source of variation is employees entering or exiting the labour force.

Figure 2 a-d: Variance of Human Capital in 1989-1998

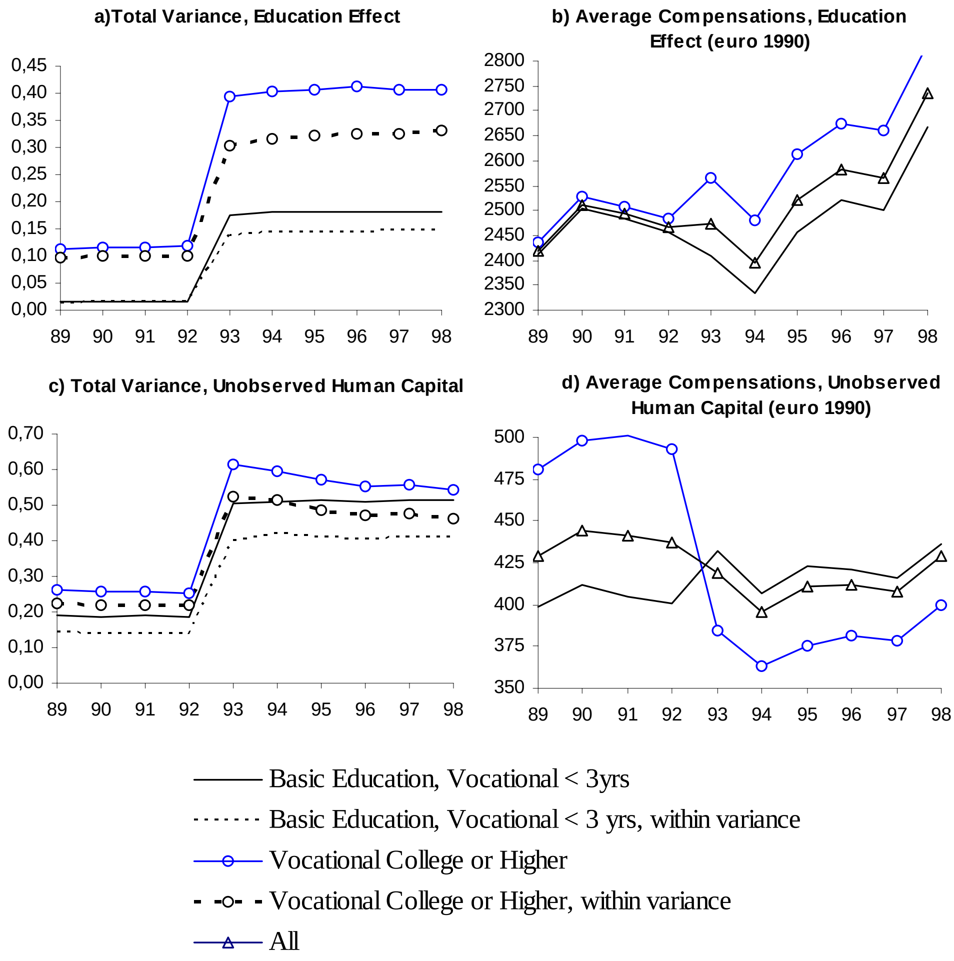


Figure 2a shows an increasing variation in the education premium paid between the 45 education categories (with five education fields and separate dummies for younger and older age cohorts). One good explanation here is the demand for workers only with education from a particular field (engineering, business fields). The major factor for the changes in the total dispersion is the within-plant variance. Thus, the varying share of educated workers in different plants (determining the between-plant effect) is not the driving force. Andersen (2003) in Denmark and Ohlsson (2002) in Sweden observe a similar kind of rise in wage dispersion in highly qualified jobs. Figure 2b shows that the education premium has risen, particularly in the latter period of 1993-1998. (The education effect here is the share of the educated effect from log wages multiplied by the average annual wage level.)

Figures 2c also shows a clear rise in the variance of unobserved human capital in the second period of 1993-1998. Figure 2d, instead, shows a clear decrease in the return for unobserved human capital for the highly educated. It is clear that the changes in unobserved human capital capture much of the changes in structural variables that are missing in the model. However, this also agrees with the Schumpeterian framework with a rise in compensations for unobserved skills and some structural changes preceding the rise in the education premium.

4. Explaining Wage and Human Capital Dispersion

This section aims to explain changes in wage dispersion, where the biggest change took place between firms according to Figure 1b. The analysis focuses on the variation of human capital and skill intensity across plants/firms such as R&D, capital intensity, market share etc. The firm-average value of wages and human capital components is linked to the Financial Statements Data (consisting originally of 9,553 firms in the period). The final analysis of changes is made between the years of 1996-1998 and 1989-1991. JMP decomposes the changes over time in the distribution (dispersion measure) of a variable into three components: 1) changes that are due to changes in the distribution of the observable characteristics of workers, 2) changes that are due to changes in the compensation for observable characteristics (price effects or regression coefficients), and 3) changes that are due to changes in the distribution of unobservable human capital (wage residuals). The basic model for average compensations y_{it} (the wage or human capital component) is

$$y_{it} = X_{it}\beta_t + \omega_{it} \ , \qquad (12)$$

where X_{it} is a vector of employee and firm characteristics and β_t is a vector of parameters representing the prices attached by the market to those characteristics. Residuals ω_{it} capture unobserved factors and have distribution F_t. Let $\omega_{it} = F^{-1}(\Phi_{it})$ show the inverse cumulative distribution function, where Φ_{it} shows the rank of individuals in firm i in the cumulative residual distribution. Eq. (12) can be rewritten as

$$y_{it} = X_{it}\overline{\beta} + \overline{F}^{-1}(\Phi_{it}) + X_{it}(\beta_t - \overline{\beta}) + (F^{-1}(\Phi_{it}) - \overline{F}^{-1}(\Phi_{it})) \, , \qquad (13)$$

where $\overline{\beta}$ is the average effect of the observable on the dependent variable over the whole period and $\overline{F}^{-1}(\omega_{it} \mid X_{it})$ is the average inverse cumulative distribution function. The first two terms capture the impact of changes in the distribution of observable characteristics. The third term captures changes in the differentials associated with the coefficient. The last term shows the contribution of changes in the distribution of regression residuals that are not explained by changes in βs and Xs. Analysis is done in three steps.

(i) We allow X variables to change and obtain coefficients (sample average $\bar{\beta}$ s) from this pooled estimation and find the residual for a plant with rank Φ_{it}.

(ii) We make yearly estimations (both X variables and βs vary). The predicted wages and the stage (i) residual for a plant with rank Φ_{it} are used to compute the differential between 9^{th} decile and 1^{st} decile plants attributable to both X and β variables. This difference attributable to both X variables and β variables and the one attributable to X variables alone is the differential attributable to coefficient β.

(iii) We calculate the average values of the differential between 9^{th} decile and 1^{st} decile plants for the years 1989-1991 and 1996-1998 for observed changes and for those attributable to coefficient X and to both X and βs. In this analysis, changes attributable to coefficient β are the average differential between 9^{th} decile and 1^{st} decile plants explained by X and βs less the average differential explained by X variables alone, as before. The residual is the unexplained part of the observed change.

The first set of explanatory X variables includes human capital like the average estimated compensations for education and gender at the plant level. The second set also includes plant characteristics such as average seniority in the plant, average seniority squared and the difference between 8^{th} and 2^{nd} decile log wages. Firm characteristics also include R&D intensity (R&D investments over sales), a multi-plant firm dummy, log capital per employee, firm size dummies (three categories) and industry dummies.

Table A.1 in the Appendix shows the summary of the variables. In the estimation we use weighted plant-level regression, where employment forms the weights. Firms are also divided into four categories in terms of average R&D intensity: no R&D, 0-1%, 1-4% and over 4%. It is first useful to show the regression results in the pooled estimation for the period 1987-1998:

Table 1. Pooled Plant-Level Estimates of Average Wages

	Partial Model				R&D Per Sales 0-1%		R&D Per Sales 1-4%	
Variable	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**
Intercept	8.610	(0.025)***	9.197	(0.034)***	8.561	(0.106)***	10.474	(0.116)***
Compensations on								
Experience	0.267	(0.009)***	0.278	(0.013)***	0.443	(0.029)***	-0.538	(0.049)***
Education	0.260	(0.002)***	0.192	(0.003)***	0.248	(0.007)***	0.108	(0.012)***
Gender	0.543	(0.007)***	0.458	(0.007)***	0.365	(0.015)***	0.619	(0.032)***
Seniority			0.006	(0.00047)**	0.007	(0.00126)**	0.009	(0.002)***
Seniority Squared			0.000	(0.00001)**	0.000	(0.00003)**	0.000	(0.00004)***
Log 8^{th} and 2^{nd} Wage Dif			0.244	(0.005)***	0.204	(0.011)***	0.194	(0.0174)***
Log(Capital) per Capita			0.057	(0.046)	-0.094	(0.067)		
R&D per Sales *10			0.020	(0.001)***	0.137	(0.016)***	-0.001	(0.005)
Firm size <20 Dummy			0.056	(0.031)*	0.115	(0.563)	-0.112	(0.149)
20<Firm size <100 Dummy			0.082	(0.011)***	0.063	(0.087)	-0.081	(0.031)**
Multiunit Plant Dummy			-0.040	(0.016)**	-0.050	(0.08)	0.032	(0.028)
No. Observations	85932		85932		15569		6168	
D.F.	3		50		44		44	
R^2	0.18		0.34		0.34		0.27	

Note. The table reports coefficients and standard errors. Regressions include 40 industry dummies and interactions of industry dummies and Log(Capital per Capita). The base for employment size is plants with more than 100 employees. R&D intensity refer to average R&D per sales over the period.

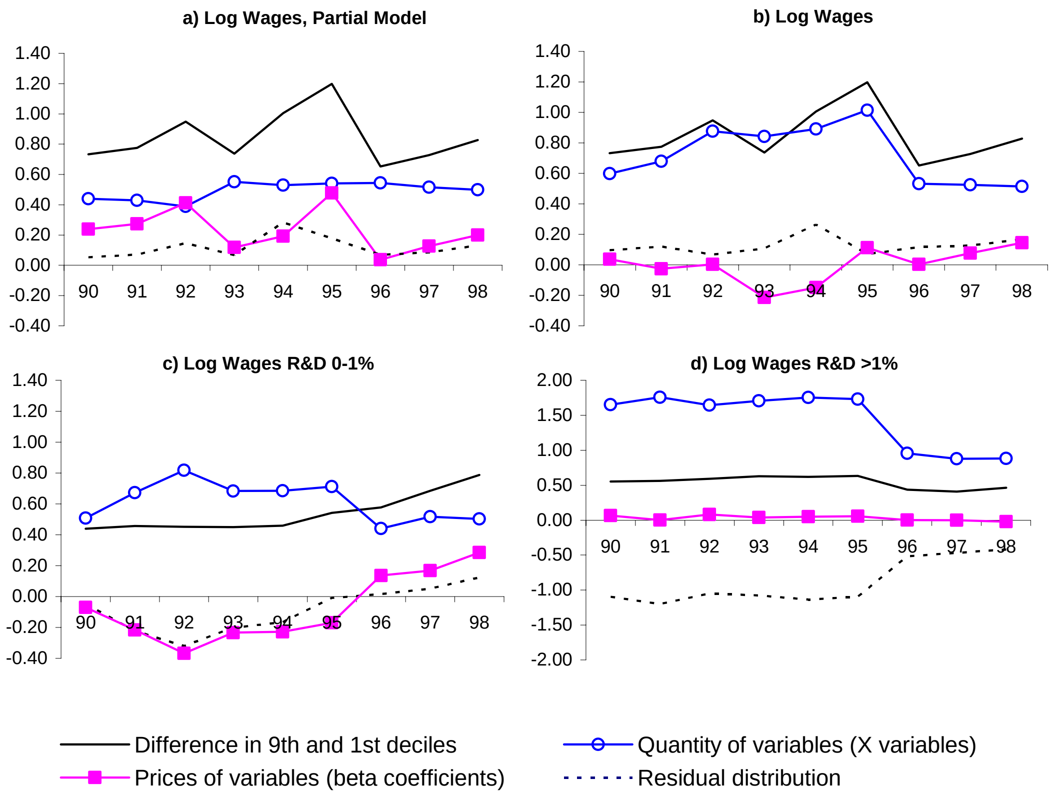
* Significant at 90% level, ** Significant at 95% level, *** Significant at 99% level.

It is seen that experience and education human capital explain a substantial share of the variation in the average wage level across plants. One standard deviation (0.58) increase in education human capital explains 0.11 of the variation in logarithmic wages. This is a substantial share of the total variance of log wages 0.39. The coefficient is of similar magnitude for experience human capital (which has a lower standard deviation of 0.11). The average wage level is positively related to the capital and R&D intensity, while among the plants in the most R&D-intensive firms these no longer explain the wage variation. Plants with higher differential between 8^{th} and 2^{nd} decile wages clearly have a higher average level of wages.

Experience human capital and education human capital take the most prominent role in R&D intensive firms, where R&D investments per sales are on average 0-1%. (These plants represent 18% of all plants.) Plants in firms with R&D intensity between 1-4% typically have a younger workforce with less work experience. Similar findings apply to the 1946 plants in the most intensive R&D firms. (We do not report the differential analysis for these relatively few observations where R&D intensity is over 4%.) Pakes and Nitzan (1983) and Moen (2005) show that in R&D-intensive firms young workers accept lower starting wages, given the possibility of higher human capital accumulation later in the career. Piekkola (2001) similarly shows a steeper seniority wage curve in R&D- intensive firms and profit sharing targeted at older age groups. It is seen that high-wage plants in R&D-intensive firms are characterised by high average seniority.

Figure 3 shows stage (i)-(ii) results for log wages. The residual is the difference between that observed and that explained by stages (i) and (ii).

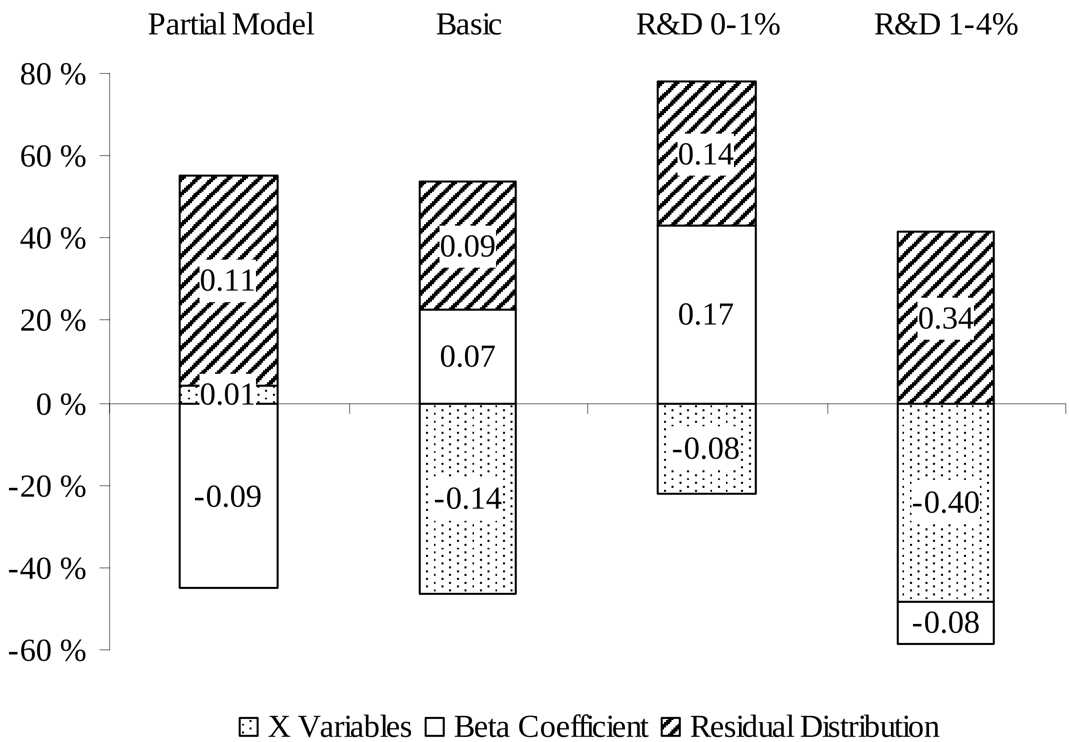
Figure 3. Plant-Level Decompositions for 9th-1st Decile Differential for Annual Wages and Labour Productivity in 1989-1998 (same sample of plants)



It is seen from Figures 3a-b that the distribution of observables (X variables) in a pooled regression explains the 9th-1st decile differential in wages fairly well. This is also true in the partial model that is similar in spirit to the approach in JMP. JMP, instead, find at their individual level analysis that the distribution of observables explains very little of the rise in wage inequality. In the basic model in Figure 3b the differential tracks the total 9th-1st difference very closely. Price effects appear to vary, depending on economic cycles. In the periods of slowdown of GDP growth in 1992 and 1995 the price effects have the biggest positive influence on wage differentials. Maliranta and Vainiomäki (2002) applied JMP decomposition to plant-level data. They do not observe any clear positive trend in price effects in the 1990s either, which again contrasts JMP findings in the US over a longer period. Here, it is interesting to see from Figure 3c that among the plants in R&D-intensive firms between 0-1% the differentials associated with the price effects steadily increased. Plants have a high skill level and capital intensity, and the price effects are more pronounced. On the other hand, the positive trend in price effects is again absent for plants in R&D-intensive firms between 1-4%.

JMP analysis of Maliranta and Vainiomäki (2002) in the manufacturing industry and with the inclusion of worker characteristics is comparable to the partial model. They find a decrease in the log wage difference of -0.022 in the five-year averages between 1994-1998 and 1984-1989. We similarly find a modest 0.02 increase in the log wage difference between 1996-1998 and 1989-1991. The following figure, Figure 4, shows the changes in differential between 9th and 1st decile plants and its components following stage (iii).

Figure 4. Components for Change in Log Wage Differential Between 1996-1998 and 1989-1991



The area of the pillars above the zero horizontal line shows factors contributing to wage dispersion (and vice versa for the area below the zero horizontal line). The first two pillars show the partial and basic model decompositions for the 0.02 increase in the log wage difference between 9th decile and 1st decile firms. It is seen that changes in the distribution (X variables) do not increase log wage difference, but rather the opposite in the basic model. The distribution of capital, R&D investment and the 8th and 2nd decile wage differential within plants have worked in the direction of mitigating the rise in wage dispersion between plants.

In the partial model the price effects are negative and in the basic model, positive. The partial model suggests that the price effects of experience human capital and education human capital have decreased wage differentials since 1995. This is despite the increase in variation of education human capital across plants, as is clearly seen in the summary table A.1 in the Appendix. This is also compatible with our earlier finding in section 3 showing that the major factor for the changes in the total dispersion is the within-plant variance. Finally, the change in price effects is largest between plants in R&D-intensive firms 0-1% as well as the total increase in the wage differential, 0.22.

5. Conclusion

In Finland the shifts in compensations have been of a similar kind to those in the US with increasing wage variance between plants, an increasing gap between average non-productive and productive worker wages and an increasing share of non-production workers (Dunne et al. 2000). But the overall changes in wage dispersion have been moderate. It is evident that technical change, the severity of the recession and the opening of domestic market to foreign competition have led to restructuring among the Finnish firms that has not substantially increased wage inequality. On the other hand, technical change and restructuring in the deep recession period in 1991-1993 can explain higher returns on compensations for unobserved human capital. In the boom period in 1994-1998 the return on education rose. The sequence with a higher return on unobserved human capital preceding the higher education premium is natural in a Schumpeterian framework.

Dunne et al. (2000) find changes in the wage differential between firms to have been the major factor in explaining a rise in wage dispersion in the US. In Finland, the entire rise in wage dispersion has also taken place between plants. However, it is shown here that the increase in the wage differential between 9th and 1st decile plants has been very modest. In the analysis of between-plant wage variation, the price effects of experience human capital and education human capital have actually decreased wage differentials since 1995. The education and experience human capital thus contributed to a decrease in the wage differential between 9th and 1st decile plants. The changing returns on human capital have had a larger effect on within-plant variation than on between-plant variation.

The lack of the price effects of human capital differs from the findings in the US in the period 1960-80. Among all the factors discussed in the introduction, it is especially the different labour market institutions and rapid upgrading in the education level in Finland that can explain these differences. Capital and R&D is also evidently used more efficiently than before. The returns to this kind of untangible capital have increased, but in a way that wage differences across plants have narrowed.

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Appendix. The Linked Employee-Employer Data

The plant level job and worker flows are based on 20,909,731 person-year observations after deleting (i) 71,073 observations with an inconsistent establishment or firm code, (ii) 47,194 with missing observation years, (iii) 1,838,647 with a missing industry code, (iv) 62,648 with no sex code and (v) 697,995 observations when wages deviate more than five standard deviations from the predicted value. (The OLS regression was similar to Abowd et al., 1999, p. 326, with explanatory variables work experience up to the fourth power, six education class dummies and sex.)

An individual is recorded for the first time in the firm in nearly a third of observations (6,136,985) and 556,835 observations had a missing seniority starting date in the firm. For these observations, seniority is set at 1 based on the observed firm switches. Seniority also receives the value of one if the missing date is from 1987. Therefore, since 1989 (the record starts at the year 1987 but employer statistics start at the year 1989) 117,572 individuals have a seniority of 1 in the year 1989, 86,557 have a seniority of 2 in the year 1990, 63,538 have a seniority of 3 in the year 1991 etc.

Following the method by Baldwin et al. (1992), the birth and death of firms is not considered real when persons employed either in the old firm at date *t-1* or in the new firm at date *t* amount to more than 60 per cent of all persons working in these firms at dates *t-1* and *t.* Using this criterion, unreal deaths and births are less than two per cent of all firm births and deaths and these firms are linked as the same firm (even though the firm code differs). The worker reallocation rate (the sum of the hiring and separation rates) is around 0.5 per cent lower after this correction.

In the estimation, 47 industry dummies at the two-digit level or at the three-digit level used in construction and services have been used. Finally, in the calculation of the firm effects, we pooled 172,796 firms (659,708 observations) that had fewer than 10 observations into a single firm in the 8 main industries. The firm effects were then estimated in 65,643 firms, of which 13,530 had no workers with higher education.

The 9,553 firms in the linked employee-plant data are from the following industries: mining (nace 10-14) 23, consumer goods (nace 15, 17-19) 481, other manufacturing (nace 20-25) 605, non-metallic mineral products (nace 26, 36-37) 605, metals and machinery (nace 27-29) 807, energy and water (nace 40-43) 99, construction (nace 44-45), trade (50-55) 1594, transport and business services (nace 30, 71-72, 741-745, 60-67) 684, household services (nace 746-747, 93-99) 194, education and health 44.

The values of variables used in the JMP analysis at plant level are as follows:

Table A.1 Summary of Variables in Plant-Level Estimation

	Means	Standard Deviation	10th Decile	90th Decile
Log Wage	11.49	0.39	11.06	11.92
Experience Human Capital	0.33	0.11	0.20	0.46
1987-1992	0.35	0.11	0.23	0.47
1993-1998	0.33	0.11	0.21	0.46
Education Human Capital	10.07	0.58	9.33	10.78
1987-1992	9.40	0.14	9.29	9.58
1993-1998	10.33	0.48	9.84	10.96
Gender Human Capital	0.16	0.15	0.00	0.38
1987-1992	0.03	0.02	0.00	0.06
1993-1998	0.21	0.14	0.00	0.38
Unobserved Human Capital	1.89	0.50	1.32	2.50
1987-1992	1.70	0.34	1.36	2.06
1993-1998	1.95	0.54	1.29	2.58
Seniority	16.6	9.3	4.0	28.7
Seniority Squared	362	334	16	822
Wage Difference 8th-2nd Deciles	0.26	0.28	0.00	0.71
Log Capital/Labour	-0.63	1.49	-2.60	1.12
R&D per Sales*10	0.39	4.26	0.00	0.67
MultiUnit	0.76	0.43		

Education human capital shows considerable variance relative to the variance of wages. The variance has also been greater in the latter period 1993-1998. The within-plant log wage difference between 8th and 2nd deciles is on average 0.26.