Sources of Earnings Dispersion in a Linked Employer-Employee Dataset: Evidence from Norway

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Abstract: We estimate a standard human capital earnings model, augmented to allow for different firm-specific wage premia. The earnings of an individual depend on her human capital bundle and the earnings mark-up of the firm she is currently working for. We use linked employer-employee data from Norway which allows us to directly estimate the skill premium as a function of firm specific variables such as plant size, the capital/labour ratio, market share, unionisation and openness to trade. We document the impact of job reallocation and skill sorting on earnings dispersion. We find a large potential effect of labour reallocation on earnings dispersion.

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1. Introduction

The sources of changes in earnings dispersion have been the subject of much research in recent times, prompted in large measure by the rise in earnings inequality observed in the US, the UK and a few other countries[1]. Most of the debate has focused on the well documented rise in the price of skill in those countries as the main proximate cause, with deeper roots in changes in «technology and/or trade».

In this paper we focus on the effect of job and worker reallocation on earnings dispersion. We think of the labour market as not fitting perfectly into the perfect competition mould[2]; this implies that the same worker may earn different amounts at different firms. Consequently, the assignment of workers to firms matters for the earnings distribution in a way that it does not in a perfectly competitive framework. The sources of earnings dispersion in this context are the distribution of human capital bundles among workers, the distribution of valuations placed on those by firms, and the nature of the association of workers to firms. Changes in earnings dispersion arise from changes in those valuations but also from the reallocation of labour: Gross job reallocation and the churning of workers.

We have set out this idea in some detail elsewhere (Burgess, Lane and Stevens, 1997). We extend it in the current paper by exploiting a rich linked employer-employee data set that has detailed information on workers and on the characteristics of the establishments and firms that employ them. This data derives from Norway and covers the manufacturing sector in the first half

[1] See, for example, Juhn, Murphy and Pierce (1993); Gottschalk and Smeeding (1997) Levy and Murnane (1992).
[2] For a variety of possible reasons that we do not examine here - efficiency wage models are likely as are union

of the 1990s Despite the important role played by centralised wage bargaining in Norway and the narrow dispersion of wages in general, job turnover in Norway is very similar to most other countries, i.e. about 20 percent, although worker turnover, at twice this, is slightly lower [Salvanes (1997, 1998)]. In common with other studies, we find significant employer effects on wages. But unlike other studies, we go on to quantify the implications of such effects for earnings inequality. We find that they play a substantial role; the implication is that quite modest changes in the rate or nature of labour reallocation will have a significant impact on earnings dispersion. We document the impact of job reallocation and skill sorting on earnings dispersion.

The rest of the paper is organised as follows: section 2 sets out the model and section 3 describes in some detail the nature of the data set. Section 4 presents the results and section 5 concludes.

2. Model

Explanations of the dispersion of earnings must start from a model of earnings. The standard approach is a human capital model; for individual *i*:

$$\log w_{it} = b_{0\mathrm{i}} + b_1 S_{it} + f\,(t_i) + e_{it} \tag{1}$$

where w_i denotes earnings, S_i refers to years of schooling, $f(t)$ is a polynomial in age, and b_0 captures time invariant characteristics of the individual. In this framework, a change in the dispersion of individual earnings must stem from changes in one of these components, namely changes in the weights given to individual characteristics (b's) and changes in f(.), or a change in the residual variance. The latter is equivalent to a change in within-group variance, a feature that

bargaining models in the Norwegian context.

has characterised developments in the US and the UK (with groups typically defined by gender*age*education). This is the approach that has been taken in explaining the rise in earnings dispersion in the US and other countries, with the emphasis being on a rise in the return to skill (b_1 rising over time).

The implicit assumption underlying this approach is that all firms pay the same wage to a given worker. However there is a large literature (for example, the efficiency wage literature) which relaxes this by introducing incentive or information problems (Groshen, 1991). We therefore reformulate model (1) to include different firm-specific wage premia. We allow for two effects: first, particular firms (for example, large, profitable or unionised firms) may simply pay a premium (positive or negative) to all their workers, regardless of characteristics - this would appear as an intercept shift in (1). Second, some firms may value skill more highly than others, and this would appear as a difference in the slope coefficient b_1. We think of these firm premia as driven by a set of variables, denoted Z. These are discussed in detail below, but include measures of size and openness to trade, characteristics of product markets, and proxies for technology. We allow them to have both an intercept effect and also to change the return to skill.

$$\log w_{ij(i)t} = a_{0j(i)t} Z_{j(i)t} + (b_{1t} + a_{1j(i)t} Z_{j(i)t}).S_i + b_t' X_i + e_{ij(i)t} \quad (2)$$

where $a_{0j(i)t}$ is the intercept shift and $a_{1j(i)t}$ is the slope shift, and X contains all the individual characteristics other than education. Clearly, in the general case we would want to allow the value of all the individual characteristics to vary with firm characteristics, but we do not pursue that here[3]. We work with two versions of this equation - one with education as a continuous variable,

[3] We did do this in some preliminary work, but the results were very messy and difficult to interpret; but certainly the skill differences were the most important feature of those results.

and one with three discrete skill levels.

If either form of firm-specific wage premia appear in the data, then reallocation of workers across firms will change earnings dispersion. This role will be muted by the extent to which wages adjust in order to effect the reallocation: we make no attempt to address this issue here.

3. Institutional setting, variable definitions and data.

We will base our choice of which variables to include on the existing literature and we only briefly explain which employer variables are included in the wage equation, although it is worth noting some institutional features of the Norwegian wage setting process in the discussion of the plant specific variables.

Institutional structure of the Norwegian labour market.

Although the wage setting in the Nordic countries is often thought to be highly centralized., the wage setting process actually takes place at two levels, nationally or by industry (centralized), and at the firm level (wage drift). For the last three decades the two have been of roughly equal importance, although in some years wage drift has accounted for up to 70 percent of wage changes [Holden (1989)] Thus firm specific effects can potentially play a part in wage determination. Indeed, work by Johansen (1996) and Wulfsberg (1997) has demonstrated that inside effects (which could be productivity and other firm specific characteristics) are important in explaining wage determination.

Plant Specific Variables included in the wage regression

A number of empirical studies have established that firm characterisitics affect wages.[4] Although a great deal of attention has been focussed on the firm size effect [Brown and Medoff (1989), Davis and Haltiwanger (1991), Dunne and Schmitz (1995) and Troske (1997)], theory also suggests that such measures as product market power, unionisation and capital intensity should also affect worker earnings, although these variables are not typically available at the firm level. We do have them available, and hence include the following variables in the analysis.[5]

Employer size is defined as the number of people employed in the establishment as an annual average.[6]

The **Capital-labour ratio** at the plant level is included using the flow of capital divided by the number of work hours.

Product market competition has been found to be important by, among others Weiss(1996), and is measured here by both **Company market share** which is the market share of the firm the plant belongs to.[7]; and **Export/Import** variable. The first measure has the drawback that the market for products is only based on the production of the firms in Norway; the second compensates for this by including a dummy variable for whether the sector is open to imports and exports.

In Norway as in many countries, wages negotiated by unions both at the central and firm level are paid to all workers independent on union membership. Thus **union density** at the plant

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[4] This literature goes a long way back. Groshen (1991) contains an overview of both early and more recent contributions.

[5] We use interchangeably the terms firm, establishment and plant. The precise definitions of variables used are given in the text.

[6] See the Appendix A for detailed definitions of the variables included.

[7] A Herfindahl index at the firm level was also constructed and tested but it did provide anything in addition to the firm market share. When used alone instead of the firm market share it gave very similar results as the market

level is a relevant plant specific variable and has been found to be an important determinant of wages by Barth, Naylor and Raaum (1998).[8]

Data

The empirical analysis is based on a linked employer-employee data set from Statistics Norway. Our database contains yearly information for all employed individuals between the age of 16 and 74 from different administrative register files. The data is in addition supplemented with economic information at the plant level from the "Time Series Files" for manufacturing based on the annual censuses (For a description of this data, see Halvorsen, Jensen and Foyn, 1991). The dataset covers the manufacturing sector (exclusive of mining and oil), from 1986 to 1995. However, only data for the period 1991 to 1995 will be used because important variables are only available from 1991 onwards. We focus on manufacturing because financial information at the plant level is not available for the public and private service sector.

In the administrative register, individuals are characterised by their personal identity code and plants with an identification code. In the second quarter each year every worker is matched to the individual's main employer. The start date of this match is provided by the main employer, as well as stop date for the match if it finishes within the year.

For each worker the following information is available for the period 1991 to 1995: working time per week, union membership, whether the worker holds multiple jobs, annual income, education, and basic demographic background variables. Working time per week is only reported in three discrete categories; 4-19 hours, 20-29 hours and 30 hours or more. We measure

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share.

[8] An alternative rationale for including union density is that large firms may have a higher tendency to follow a

education first by a continuous measure of the years of completed schooling. We also used the highest level of education attained, including all formal education courses exceeding 300 hours.

The employers are defined at the plant level by an identification code dependent on geographical location and independent of ownership conditions. We restrict our attention to plants with an average size of at least five employees since most plant specific information is not available for plants below five employees. When merging in the data from the "Time Series Files" for the econometric analysis the match by plant numbers is about 90 percent. A number of plant specific variables are available to our study: plant size, value of production, insurance value of capital, value added, the age of the plant, and investment. Further the plants are categorized into sectors defined as export-oriented, a protected sector, and a sector open to import competition.

We made a number of exclusion restrictions. Only workers with full-time jobs (30 hours or more per week) were included in the estimation, and workers who held more than one job were excluded. The data also forces us to include in any one year only those workers who had worked the whole year at a single plant. Thus any short matches or long term matches that happen to end in one of the years we study will be deleted. This is because earnings are only available at an annual frequency, and so to correctly associate earnings with particular plant characteristics we can only include people who earned all their annual labour income at the plant we know about.

See Appendix A for precise definitions of how the variables are defined and descriptive statistics of the data set before and after exclusion of variables.

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strategy of union avoidance by offering better pay and conditions in general to workers in order to avoid unionism (Freeman and Medoff, 1994). Conditioning then on union and non-union firms may then explain the wage-size effect.

4. Empirical Results

We set the scene by briefly describing the nature of earnings dispersion in Norway in the 1990s. We then present the results of estimating the wage equations noted above. The main part of the section is then devoted to analysing the implications of these regressions for earnings dispersion.

(a) Earnings Inequality in Norwegian Manufacturing

Table 1 presents Gini coefficients for earnings across the two years. The first thing to note is that earnings inequality is remarkably low and stable in Norway and in line with results from previous studies (see Aaberge *et al*.(1996)) – the increases which have been evident in the United States and the UK are not repeated here. The low level of earnings inequality is perhaps not surprising. Kahn (1998), Moene and Wallerstein (1997) and Freeman (1996) argue that the centralised wage determination is important in explaining this while Hægeland, Klette and Salvanes (1998) focus on the role of the expansion in the education system in Norway. However, it is clear that this centalised wage bargaining combined with firm level bargaining does not wipe out firm-specific effects in wages: «wage drift» or local wage negotiations accounts for some 50 to 70 percent of annual wage increases in Norway (see Holden, 1989). The stability of the earnings variance is not surprising, being the norm in Europe (see OECD, 1996).

Two interesting results emerge from the table. One is that earnings inequality increases with skill level: this can be interpreted as showing that the level of unoberved ability is positively correlated with observed ability. Second, there is higher inequality when the sample includes workers who change plants over the 5 year period rather than restricting it to those who stay with the same plant. This is to be expected as generally some portion of earnings growth arises from bertween-firm movement. It serves to provide a first illustration of the importance of labour reallocation in explaining earnings dispersion.

(b) Wage Regressions

The key issue we investigate is not the level of earnings inequality, but rather, the potential for changes in the dispersion in earnings as a result of worker reallocation. As noted above, this is dependent upon workers with the same characteristics being paid different amounts by different employers. We investigate this by estimating equation (3) for the cross-section of workers in 1991, and again in 1995 as a separate cross-section. We estimate three versions for each year – one with a standard human capital model, one adding firm effects in the intercept only, and one which allows for firm effects in both the intercept and in the premium paid for education.[9] The results are reported in Table 2. Note that all the plant specific variables are dichotomised into «low» and «high». The cutoff point is the 50th percentile (median) of the distributions of each variable. The reported coefficient is for the high category against the reference category of the small one.

Using dichotomized firm specific variables is very convenient for our purpose of examining changes in wage premia following worker movement over categories of firms. However, this procedure also puts restrictions on the data variation. In addtion, the results may not be easy comparable to previous studies measuring firm effects on earnings. Hence, in Appendix B we report results for the model in Table 2 (Table 2B) using continuous variables (second order polynomials) to compare to the results using dichotomized variables. This also serves to check whether the reported results in Tables 2 and 3 are artefacts of the cut-off points. In order to

[9] We tested for heteroscedasticity and found clear evidence of its presence. We consequently estimated the models using Huber-White corrections, and allowing for firm specific clustering in the variance-covariance matrix.

compare the results from other studies, we also report in Table 1B in Appendix B regressions in the tradition of Brown and Medoff (1989) and Troske (1997), where the effect on earnings of the establishment size (logsize) is evaluated with and without controlling for labour quality differences and other firm specific factors. The years 1991-95 are used in this latter model.

From Table 1B in Appendix B, it is clear that the effect of establishment size is comparable to results obtained for other countries. The parameter estimate of 0.053 in the case of no human capital controls (column 1), indicates that workers in establishments with log employment one standard deviation (1.48) above mean log employment (4.82) receive 15 percent higher log wage than workers in plants with log employment one standard deviation below mean. This result is very similar to the impact of establishment size reported in Brown and Medoff (1989) and Troske (1997) for the US where the latter study report 18 percent difference using a similar data set for 1989. Now, controlling for worker characteristics, the size-wage premium is reduced but still quite pronounced as the estimated logsize coefficient is now reduced to 0.386 as shown in column 2. These results clearly support the view that plant level wage policies may well be important in the Norwegian two-tier wage bargaining system where local negotiations play an important part.

Turning now to the results which are the focus of this paper presented in Table 2, several interesting results are immediately obvious. The first column both for 1991 and 1995 conforms to other studies of the Norwegian economy (see for example Barth, 1997; Kahn, 1998; Hægeland and Klette, 1997; Hægeland, Klette, Salvanes, 1998) – notably that the return to education in manufacturing is about 6.6%, and that women earn about 20% less than men.[10,11] The second

[10] As has been pointed to by numerous authors, notably Griliches (1977), «innate ability» may be correlated with the choice of education causing a potential positive or negative bias in the estimated returns to education if not corrected for. Hægeland, Klette and Salvanes (1998) used an instrumental variable technique to control for selection into education and into full-time work. The results indicated that the returns to education when correcting for both

column confirms that plant characteristics have significant effects on earnings, though they do not add a great deal more explanatory power on top of the individual's characteristics. This has been known in general since at least Dunlop's work on truck drivers in Boston in 1957.

In our sample, workers who work in large plants earn between 2% and 3% more than workers with the same characteristics working in smaller plants. Similarly, workers in in firms with high market shares earn between 4% and 6% more, and workers in the competitive sectors also earn between 3% and 6% more. Establishments with a high capital labour ratio earn a wage premium up to 6 %. Hence simple changes in the size, market share degree of competition of firms have the potential for changing the earnings distribution, regardless of the demographic characteristics of the workforce. Similarly, simple changes in the matching of workers to firms can alter the earnings distribution.

The third column for each year shows the results of interacting plant characteristics with education, thus changing the earnings premium associated with working for a firm of a particular type. One striking result with this specification is that the effect of union density becomes clearer. Unionised plants act to depress the earnings of the more educated, while increasing the earnings of the less educated workers by between 11 - 15%, depending on the year. Another result worth mentioning is that for 1991 big firms do not pay more for educated workers.

Comparing the results with dichotomized establishment variables to regression with a more flexible specification of firm specific variables reported in Table 2B in Appendix B, show that a great deal is lost using dichotomized variables. Union density is positive and significant both in

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factors are not very different from OLS results used in the present study.

[11] An alternative to the linear specification in education were tested by adding a second order term. A negative first order term and a positive second-order effect were obtained. However, within all relevant levels of education the

1991 and 1995 using a continuous variable, otherwise the results are very similar.

Table 3 investigates the effect of firm characteristics on earnings premia in more detail by breaking workers into three skill categories (see Appendix A for details) and rerunning the basic regressions, but only reporting the equivalent of the first and third columns in each year from Table 2.

We first note that, as expected, skill category 2 earns 18-19% more than the lowest skill level, while the highest skilled workers earn at least 50% more in both years. We then note that, in general, the effect of firm size gives positive returns to low skill workers but no returns to medium or high skilled confirming the result from Table 2. Market share is a much bigger factor in increasing earnings for more educated workers than is (the admittedly correlated) effect of size. However, highly productive firms (in terms of the capital/labor ratio) provides an increase in earnings only to low skilled workers but only for 1991. There is an intriguing result for firms operating in international markets or competing with imports, which suggests that they tend to depress the earnings of mid skill workers. Finally, the result of the effect of union status on the return to skill is robust – earnings are reduced by about 2-5% for mid level workers and 4-6.5 % for educated workers in unionised firms.

(c) The Effect of Firm Characteristics on Earnings, Reallocation and Earnings Dispersion

The analysis so far has investigated the impact of firm variables on the level of earnings. We now want to move on to consider the main issue: the impact on the dispersion of earnings, and

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returns were positive and very similar as in the reported results.

further, changes in dispersion. In order to do this compactly, we group plants into all possible subsets of the categorical variables and calculate the overall earnings premium associated with being in each firm type, holding worker characteristics constant, based on the coefficients in Table 3. Reading down the first column in Table 4, the »baseline» for skill category 2 for instance thus refers to the estimated coefficient on skill with all firm characteristics set to zero (.180); the next line keeps everything else constant but assigns the worker to a large firm, which then would increase earnings by .004 over the baseline, for a total premium of .139. Hence, moving down a given column in Table 4 captures the effect of moving across all possible firm types in our typology. Moving from the 1991 to 1995 column demonstrates the stability (or instability) of the effects over time. Moving across skill categories shows the impact of firms on between group earnings inequality.

These results certainly suggest the potential for earnings to change as workers move to firms with different set of characteristics. In fact, as Tables 3 documents, the earnings premium for skill level 2 can change from as little as 10% to about 25% as s/he moves between different firm types, while the earnings premium for skill level 3 can change from 40% to over 60%.

What is the potential effect of this on earnings inequality? In order to simulate this, we perform the following exercise and report the results in Table 5. We first set all firm characteristics to zero, and calculate the standard deviation of predicted worker earnings, in each of the two years for the three skill levels, and report those in row 1. This clearly has the effect of setting variation due to differential firm assignment to zero.

We then calculate the effect of differential firm assignment by setting worker characteristics to be zero (within skill class) and reporting the standard deviation across plant types for the two years first weighted by 1991 employment shares (second row) and also weighted by 1995 employment shares (third row). Thus looking *across* either row holds constant the distribution of plants across the different types we have defined, and focuses on the effect on earnings of changes in the *value* of the earnings mark-ups for given firms. This exercise therefore takes out the influence of gross job reallocation but allows plants of different types to change their optimal premium. Looking *down* any column between rows two and three keeps the mark-up values the same and therefore gives the influence of changing employment shares (job reallocation). Thus, going diagonally from the first cell in the second row to the fourth cell in the third row captures the total change in variance for the low skill workers due to both gross job reallocation and changes in the value of the mark-up.

What does this tell us? First, that the most important factor in this exercise is the variation in observable individual characteristics. The absolute size of earnings dispersion is greatest in the first row. It is interesting to note, however, the increase in earnings dispersion among middle and high skill workers in the second half of the table provides some, albeit weak, support for the notion of the increasing importance of payments to unobservable characteristics correlated with skill.

Second, firm characteristics are at least as important as worker characteristics in explaining differences in within group inequality. In particular, the difference in dispersion between high and low skill workers for each year in the first row is less than the absolute value of difference in dispersion between the two groups due to firm characteristics, reported in the second and third rows. While this compares differences in earnings dispersion within skill groups within a given year, an alternative way of looking at this is to compare changes across years. Thus a comparison of each 1991 cell with its 1995 counterpart reveals that within group dispersion between the two years are greater when looking at firm characteristics than when looking at worker characteristics (for all except the high skill category). The size of these differences is all the more surprising in that the amount of worker and job reallocation in this dataset is much less than the economy at large, since all short job matches are perforce excluded.

Finally, the dispersion of firm effects is much greater for high skill workers than for low skill. This reflects both the difference in the spread between premia (the range is between 0 and .14 for low skill workers; .10 and .25 for medium skill workers and .32 and .73 for high skilled workers) and the allocation of workers across these firms.

As emphasised above, the variance of earnings depends on the variance of worker effects (the human capital bundles), the variance of firm effects (the firm mark-ups) and the covariance of the two. The previous exercise tells us about the first two of these, about the *scope* for reallocation to have an effect on earnings dispersion. We now need to examine the covariance factor, or in terms of economics rather than statistics, the nature of the sorting process assigning workers to plants.

For each of the plant types, we calculated the mean value of the human capital bundle across all three skill groups and the mean earnings premium. The former is simply the mean value of each *X* variable within each plant type, multiplied by its coefficient and summed. The latter is the weighted average mark-up across the three skill groups. These are then graphed against one another in Figures 1 and 2. The pictures show a slight negative relationship[12]. This is less surprising than it first seems. In theoretical terms, firm mark-ups arise for monitoring or sorting reasons. There is no *a priori* reason for believing that this will apply more to high skill workers than low skill workers. In empirical terms in this dataset, we have seen above that a number of factors generating the firm mark-up are negatively associated with skill (unionisation for example).

The point we wish to emphasise is that even if the distribution of the worker effects remains fixed and even if the distribution of the firm effects stays fixed, changes in the allocation of one to the other (i.e. the covariance) will change the dispersion of earnings.

We can illustrate this in a very extreme form by sorting all the workers perfectly. In Table 6, we show that this has a dramatic impact on earnings dispersion. We assign high skill workers to the best plant type for them[13], low skill workers to the worst plant type for them, and medium skill to their median plant type. The negative sort does the opposite. Whichever measure of dispersion is used shows a large change. This shows the large scope for reallocation to change the earnings distribution.

Clearly, this degree of reallocation is not meant to be descriptive of the Norwegian labour market. Turning to our data on actual labour reallocation, in Figure 3 we plot out by plant type the change in the mark-up against the change in mean human capital. There is a clear negative relationship: plant types that are increasing the quality of their workforce (in terms of hiring more skilled workers) are simultaneously reducing their mark-up on those workers. In future research we will further investigate the amount and nature of the reallocation of workers between plant types.

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[12] This fits with our previous findings for US data (Burgess, Lane and Stevens, 1997).

[13] By which we mean, we add the highest firm premium available to that skill group to their mean human capital bundle.

5. Conclusions

This paper has examined the potential role of job reallocation in influencing earnings dispersion. We confirm and extend an ongoing literature that firm factors do affect earnings, even after controlling for observable individual characteristics, and furthermore that this firm markup can have quite a large effect on the return to skill. Although worker characteristics are much more important than firm characteristics in determining the level of earnings, variation in firm effects are quite large, particularly across skill levels.

These earnings differences can thus potentially affect earnings inequality as workers shuffle and are shuffled across firms. The effect of this on the level of earnings dispersion is much less than the effect of worker characteristics; but the effect on changes in earnings dispersion is greater. Thus the potential role of job reallocation is extremely large, despite the fact that we use a rather stable set of workers in a relatively homogeneous country, and within a well defined industry sector, manufacturing.

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Table 1. Earnings Inequality Measures (Gini coefficient).

	1991			1995		
	(1)	(2)	(3)	(1)	(2)	(3)
Overall	0.18	0.17	0.15	0.18	0.17	0.15
Skill 1	0.15	0.14	0.14	0.15	0.14	0.14
Skill 2	0.18	0.16	0.16	0.18	0.16	0.16
Skill 3	0.20	0.18	0.18	0.20	0.18	0.18
Female	0.16	0.14	0.14	0.17	0.16	0.15
Male	0.17	0.16	0.16	0.18	0.17	0.16
Big firm	0.18			0.18		
Small firm	0.19			0.19		
High K/L	0.18			0.17		
Low K/L	0.18			0.20		
High MS	0.18			0.18		
Low MS	0.19			0.19		
High Union	0.17			0.16		
Low Union	0.21			0.20		
High Comp.	0.14			0.15		
Low Comp.	0.19			0.19		

Note: Cutoffs for size, capital labour ratio, market share and unionisation are at the median of their distributions. (1)All workers (2) Same workers in both years (3) Same workers, working in the same plant in both years.

Table 2: Wage regressions by year with continuous education variable.

	1991			1995		
	(1)	(2)	(3)	(1)	(2)	(3)
Female	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22
	(123.64)	(42.38)	(42.20)	(124.62)	(44.86)	(45.15)
Education	0.067	0.066	0.063	0.070	0.070	0.055
	(183.45)	(58.56)	(13.00)	(191.42)	(55.70)	(12.71)
Size		0.023	-0.005		0.031	-0.11
		(1.91)	(0.09)		(2.85)	(1.86)
Capital/		0.011	0.072		0.031	0.033
Labor		(1.14)	(1.41)		(3.34)	(0.67)
Market Share		0.061	-0.086		0.041	-.032
		(4.88)	(1.31)		(3.81)	(0.52)
Comp.		0.059	0.057		0.042	0.044
		(4.79)	(2.38)		(3.10)	(1.85)
Union		-0.013	0.149		0.010	0.11
		(1.14)	(7.02)		(0.93)	(5.39)
Tenure	0.008	0.007	0.007	0.008	0.007	0.007
	(26.29)	(4.38)	(4.45)	(27.01)	(7.43)	(7.49)
Tenure^2	-0.0001	-0.0001	-0.0001	-0.0002	-0.0002	-0.0002
	(14.22)	(3.17)	(3.23)	(15.60)	(5.39)	(5.46)
Exper	0.024	0.024	0.024	0.024	0.024	0.024
	(100.79)	(29.81)	(29.76)	(96.49)	(35.88)	(35.89)
Exper^2	-0.0004	-0.0004	-0.0004	-0.0003	-0.0004	-0.0004
	(83.23)	(28.89)	(28.83)	(75.92)	(34.47)	(34.55)
Education Interactions						
Size			0.003			0.013
			(0.47)			(1.39)
Kapital/Labor			-0.006			-0.0003
			(1.19)			(0.071)
Market Share			0.014			0.007
			(2.19)			(1.19)
Comp.			0.0001			-0.0002
			(0.044)			(0.063)
Union			-0.015			-0.009
			(7.41)			(4.33)
Adj R^2	0.33	0.33	0.33	0.31	0.32	0.35
Root MSE	0.271	0.270	0.270	0.280	0.279	0.279
No of Observations	144,740			155,360		

Note: All the plant specific variables are dichotomised into «low» and «high». The cutoff point is the the median of each variable. The reported coefficient is for the high category against the reference category of the small one.

Table 3: Wage Regression by year with skill categories.

	1991		1995	
Female	-0.22 (117.89)	-0.22 (41.12)	-0.22 (119.32)	-0.22 (42.29)
Size		0.028 (1.93)		0.027 (1.92)
Capital/Labor		0.021 (1.66)		0.016 (1.28)
Market share		0.034 (2.29)		0.023 (1.59)
Comp.		0.061 (5.05)		0.046 (3.93)
Union		0.004 (0.38)		0.016 (1.67)
Skill 2	0.186 (117.49)	0.189 (32.13)	.180 (112.30)	.120 (6.90)
Education interactions				
Size		-0.016 (0.65)		0.027 (1.24)
Kapital/Labor		-0.02 (0.96)		0.026 (1.34)
Market share		0.061 (2.28)		0.018 (0.29)
Comp.		-0.018 (1.82)		-0.016 (1.47)
Union		-0.050 (5.59)		-0.018 (2.05)
Skill 3	0.545 (142.01)	0.422 (5.87)	0.555 (161.08)	0.38 (7.80)
Education interactions				
Size		0.069 (0.093)		-.042 (0.660)
Capital/Labor		-0.107 (1.61)		0.012 (0.261)
Market share		0.168 (2.04)		0.212 (3.09)
Comp.		0.070 (3.53)		0.053 (3.57)
Union		-.066 (3.81)		-0.041 (2.75)
Adj R^2	0.32	0.31	0.29	0.29

Root MSE	0.271	0.274	0.284	0.283
N. Observations	144,740		155,360	

Note: All the plant specific variables are dichotomised into «low» and «high». The cutoff point is the the median of each variable. The reported coefficient is for the high category against the reference category of the small one.

Table 4. Earnings Premia for different types of firms.

	1991	1995	1991	1995	1991	1995
	Skill Level 1		Skill Level 2		Skill Level 3	
Baseline	0.000	0.000	0.189	0.120	0.422	0.380
Union	0.004	0.016	0.139	0.102	0.356	0.339
Market Share	0.034	0.023	0.250	0.138	0.590	0.592
Market Share+Union	0.038	0.039	0.200	0.120	0.524	0.551
Market Share+Union+Comp.	0.100	0.116	0.182	0.104	0.594	0.604
Size	0.028	0.027	0.173	0.147	0.491	0.338
Size+Union	0.032	0.043	0.123	0.129	0.425	0.297
Size+Union+Comp.	0.094	0.089	0.105	0.113	0.495	0.350
Size+Market Share	0.062	0.050	0.234	0.165	0.659	0.550
Size+Market Share+Union	0.066	0.066	0.184	0.147	0.593	0.509
Size+Market Share+Union+Comp.	0.128	0.112	0.166	0.131	0.663	0.562
KL	0.021	0.016	0.169	0.146	0.315	0.392
KL+Comp.	0.083	0.062	0.151	0.130	0.385	0.445
KL+Union	0.025	0.032	0.119	0.128	0.249	0.351
KL+Union+Comp.	0.087	0.078	0.101	0.112	0.319	0.404
KL+Market Share	0.055	0.039	0.230	0.164	0.483	0.604
KL+Market Share+Comp.	0.117	0.085	0.212	0.148	0.553	0.657
KL+Market Share+Union	0.059	0.055	0.180	0.146	0.417	0.563
KL+Market Share+Union+Comp.	0.121	0.101	0.162	0.130	0.487	0.616
KL+ Size	0.049	0.043	0.153	0.173	0.384	0.350
KL+ Size+Comp.	0.111	0.089	0.135	0.157	0.454	0.403
KL+ Size+Union	0.053	0.059	0.103	0.155	0.318	0.309
KL+ Size+Union+Comp.	0.115	0.105	0.085	0.139	0.388	0.362
KL+ Size+Market Share	0.083	0.066	0.214	0.191	0.552	0.562
KL+ Size+Market Share+Comp.	0.145	0.112	0.196	0.175	0.622	0.615
KL+ Size+Market Share+Union	0.087	0.082	0.164	0.173	0.486	0.521
KL+ Size+MarketShare+Union+Comp.	0.149	0.128	0.146	0.157	0.556	0.574
Comp.	0.061	0.046	0.189	0.104	0.492	0.433
Comp.+Size	0.089	0.073	0.173	0.131	0.561	0.391
Comp.+Market Share	0.095	0.069	0.250	0.122	0.660	0.645
Comp.+Market Share+Size	0.123	0.096	0.216	0.149	0.729	0.603

Table 5: Contribution of Plant Characteristics to Earnings Dispersion.

	1991			1995		
Standard Deviation of fitted wage using:	Low Skill	Medium Skill	High Skill	Low Skill	Medium Skill	High Skill
Just worker characteristics	0.1253	0.1308	0.1334	0.1245	0.1476	0.1649
Just plant characteristics (1991 employment shares)	0.0332	0.0283	0.0721	0.0283	0.0141	0.0728
Just plant characteristics (1995 employment shares)	0.0374	0.0361	0.0819	0.0316	0.0200	0.0742

Table 6: Earnings Dispersion and the Sorting of Workers.

	1991		1995	
	Positive Sort	Negative Sort	Positive Sort	Negative Sort
St. dev. Of logs	0.287	0.182	0.272	0.179
Coefficient of Variation	0.366	0.187	0.337	0.185
Gini	0.165	0.102	0.155	0.101

Note:Positive sort means that all the low skill workers were assigned to the lowest markup firm type for such workers, high skill workers were assigned to the highest markup firm type for such workers and medium skill workers were assigned to the median markup firm type. Negative sort means the reverse.

Figure 1. Association of Mean Human Capital and Mean Plant Markup over Plant Types, 1991

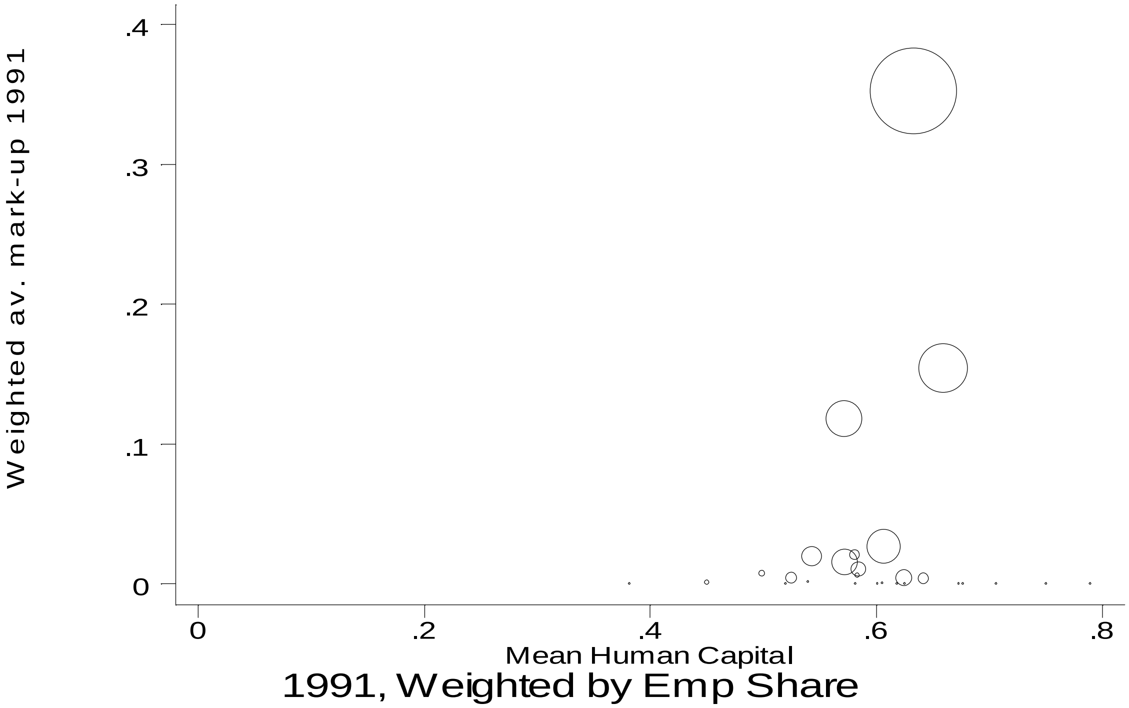


Figure 2. Association of Mean Human Capital and Mean Plant Markup over Plant Types, 1995

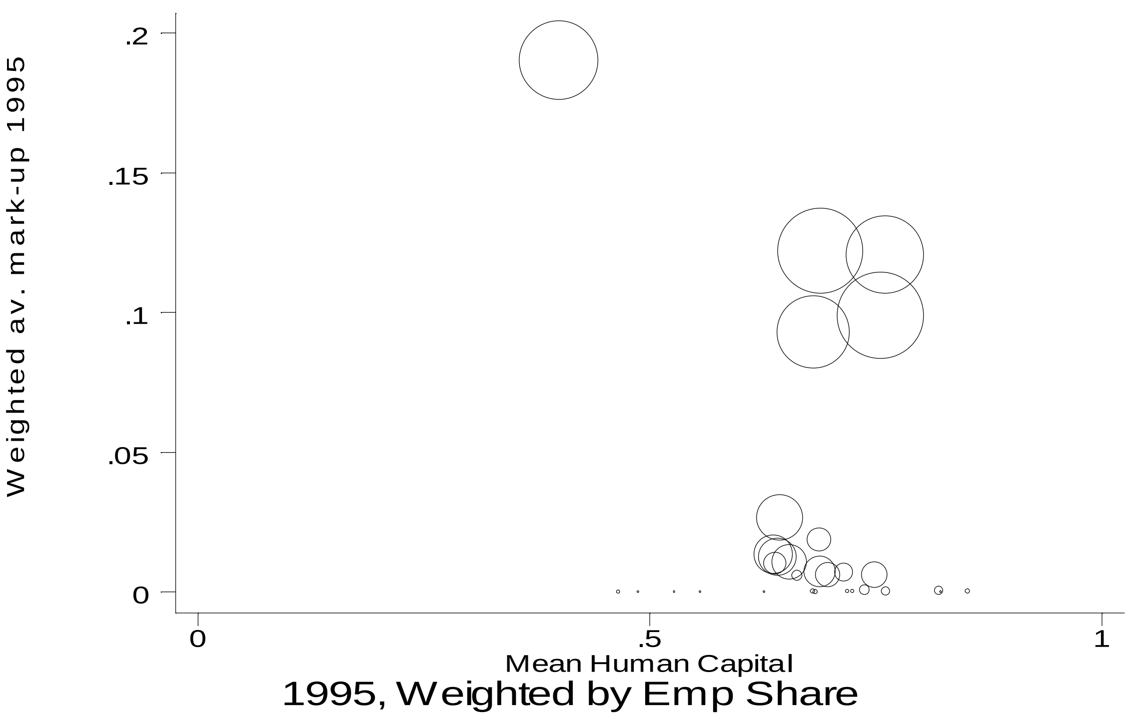
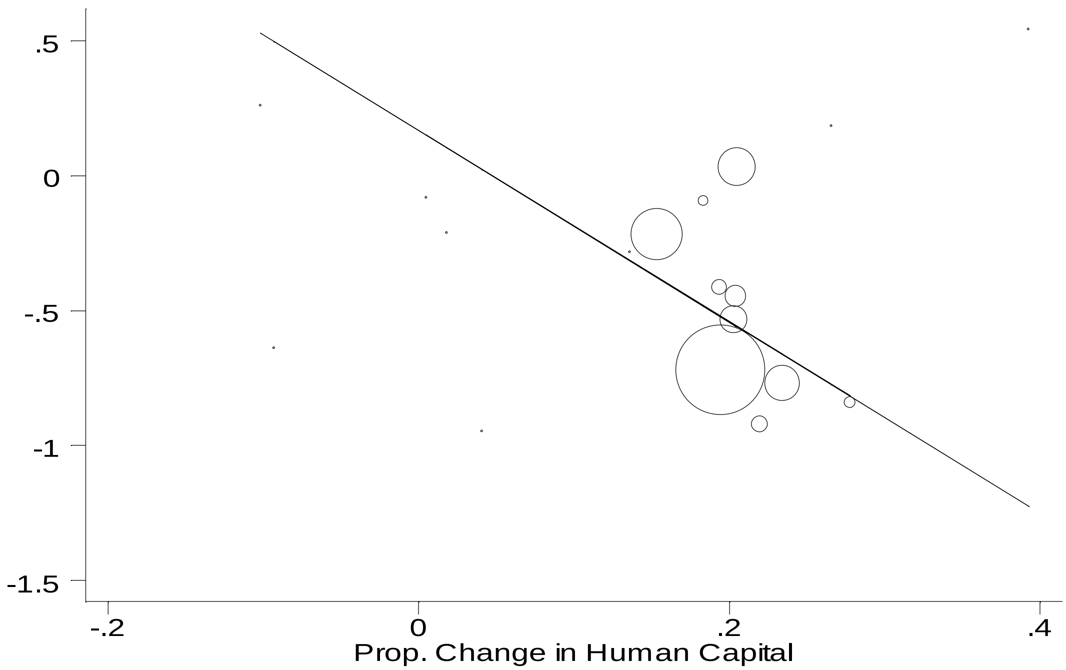


Figure 3. Change in Plant Markup and in Mean Human Capital, by Plant Type



APPENDIX A

The Appendix provides precise variable definitions and descriptive statistics before and after exclusion and merging between the industrial statistics and register data.

Wage variable.

The real (1990) wage (*variable name = wage*) was derived using the annual plant wage payment to the worker (including salaries and wages in cash and kind). The consumer price index was used to derive the wage variable in 1990-values. As an exclusion criterion we used an hourly wage rate, and excluded an hourly wage rate below 30 kroner per hour and above 500 kroner per hour since these are obviously either below or above possible wage rates. We also tested our results using an alternative annual income source, based on the tax register, including interest payments and income for all jobs held by the workers. Using the same selection criteria as above, basically the same results were obtained.

Human capital variables

Experience (*exper*), strictly potential experience, is defined as age minus years of education minus seven. Tenure (*tenure*) is defined as the number of years worked for each employer. Education (*education*) is measured as years of completed education. Education level is based on the normal duration of the education and includes only completed (and highest attained) education, where all formal education courses exceeding 300 hours are registered. We also use a three category discrete measure of skill, based on the level of education. These levels of education are calculated according to the «Nordic Key for Classification of Education» comparable to the «International

Standard of Classification of Education» (ISCED). The groupings of individual educational courses by educational level is based on observation of the normal duration of the educational activities. The standard is organised with 9 educational levels. Following this standard we have defined «low skill» as up to the third level which is equivalent to 10 years of education. «Medium skill» is defined as education from third up to the fifth level which is equivalent to an normal education duration of 14 year and not leading to an academic degree. «High skill» is three years of college/university and leading to an academic degree. Low skill includes primary education plus one year of secondary education (or in the old education system primary education which was changed in 1970; seven years plus three years («realskole»), medium skill includes high school, both vocational and general high school preparing for college/university, plus two years college/university. A gender dummy is included (*female*), equal to 1 if the worker is a woman.

Plant characteristics.

Plantsize (*size*) is defined as the total number of workers at the plant level including also part time workers. The market share (*market share*) of the plant is defined as the gross share per year production in total sector gross production at the 5 digit ISIC level of the firm the plant belongs to. Note that this therefore measures shares of *production* not *sales*. So for example, in a very open sector, a plant producing a high share of domestic production may still only have a low share of domestic or international sales. The plants are also categorized according to the degree of competition (*comp.*) from abroad by using information on whether the plant is a part of a sector (at the 3 digit ISIC level) which is primarily export oriented or open to import competition, or a protected sector, which is the base category). The share of union members at the plant level (*union*) is calculated as the number of union members to the number of workers. The capital labour ratio (*Kapital/labor*) is calculated as the value of capital relative to the number of workers. Labor input is calculated as the expenditures of workers both employed by the plant and expenditures on workers hired from other firms. The capital value is based on the fire insurance value of the buildings and machinery. The Following Griliches and Ringstad (1971) and Klette (1998) we estimate the capital services as follows:

$$K_{i,t} = R_{i,t} + (r + d^{m})\overline{V}_{i,t-1}^{m} + (r + d^{b})\overline{V}_{i,t-1}^{b}$$

where *Ri,t* is rental costs of machinery and buildings for equipment rented by the plant. r is the real return to capital where we used the standard returns used in public investment projects which is 7 % . d^{m} and d^{b} are depreciation rates for machinery (0.06) and buildings (0.02) taken from the Norwegian National Accounts. $\overline{V}_{i,t-1}^{m}$ and $\overline{V}_{i,t-1}^{b}$ are the values of the plants' machinery and buildings based on insurance values, and calculated as the avarage for the present year, and the year before and after using the »perpetual inventory» method. Investments are assumed to take place at the end of each. As noted by Klette (1998) one problem with the fire insurance values reported separately for buildings and machinery by the plants is that there are missing variables. The procedure of taken the average over three years is a avoid to reduce this problem.

Table 1A provides the summary statistics for the variables used for the total sample and for the sample used for estimation, and Table 2A the correlation between the variables for the estiamtion sample.

Table 1A. Summary statistics for variables used (all values in 1990 NOK).

	1991				1995			
	Before exclusion		Estimation sample		Before exclusion		Estimation sample	
Variables	mean	St.d.	mean	St.dev.	mean	St.d.	mean	St.d.
Wage	144947	106987	207640	72176	174898	105199	216589	77280
Tenure (years)	6.93	5.61	7.78	5.60	7.71	6.40	8.81	6.37
Exper (years)	22.57	13.53	23.25	12.64	22.18	12.97	23.30	12.19
Age (years)	39.71	12.89	40.74	11.88	39.72	12.31	41.12	11.42
Educat.(years)	10.39	2.15	10.48	2.19	10.77	2.14	10.82	2.17
Skill1 (share)	0.5597	0.4964	0.5519	0.4973	0.4775	0.4995	0.4825	0.4997
Skill2 (share)	0.3697	0.4827	0.4089	0.4916	0.4397	0.4964	0.4661	0.4989
skill3 (share)	0.0706	0.2561	0.0391	0.1940	0.0828	0.2757	0.0514	0.2207
Female	0.2786	0.2240	0.1856	0.3888	0.2652	0.2254	0.1932	0.3948
Size (workers)	44.89	116.76	48.96	138.29	43.51	107.08	44.29	106.75
Union	0.6396	0.2926	0.6675	0.2873	0.6415	0.2925	0.6600	0.2902
Market share	0.0371	0.1026	0.0423	0.1125	0.0340	0.0949	0.0353	0.0971
Kapital/Labor	65.3	63.9	66.13	62.14	60.1	64.9	61.01	62.31
Comp.	0.8490	0.3580	0.8197	0.3844	0.85300	0.3541	0.8317	0.3741
N plants	5466		3040		5327		3383	
N workers	246,176		144,740		232,575		155,360	

Note: All means of plant specific variables are calculated of plants (market share over firm), and human capital variables over workers

Table 2A. Correlation coefficients between variables.

	s1	s2	s3	Age	Edu.	Exper	Ten.	Female	Size	Union	K/L	Comp.
s1	1.0000											
s2	-0.9123	1.0000										
s3	-0.2258	-0.1931	1.0000									
Age	0.2265	-0.2163	-0.0281	1.0000								
Educat.	-0.7867	0.5518	0.5721	-0.2682	1.0000							
Exper.	0.3510	-0.3001	-0.1270	0.9855	-0.4276	1.0000						
Tenure	0.1175	-0.0876	-0.0730	0.4251	-0.1481	0.4250	1.0000					
Female	0.1206	-0.1151	-0.0152	-0.0210	-0.0675	-0.0079	-0.0699	1.0000				
Size	-0.0863	0.0625	0.0583	0.0171	0.0960	-0.0009	0.0685	-0.0331	1.0000			
Union	0.0102	0.0012	-0.0275	0.0638	-0.0431	0.0675	0.1213	-0.0643	0.2612	1.0000		
K/L	-0.0333	0.0251	0.0201	0.0509	0.0239	0.0436	0.1745	-0.0745	0.3367	0.2318	1.0000	
Comp.	-0.0310	0.0108	0.0485	0.0458	0.0370	0.0365	0.1427	-0.0247	0.4788	0.3278	0.5150	1.0000

Appendix B.

Table 1b. Wage regression with logsize of plants for 1991-95.

1991 and 1995		
logsize	0.0531 (14.76)	0.0386 (12.34)
Education		0.0657
		(72.89)
Female		-0.224
		(56.67)
Tenure		0.006
		(7.01)
Tenure^2		-0.0001
		(5.42)
Exper		0.023
		(46.65)
Exper^2		-0.0004
		(43.14)
const	11.95	11.03
	(842)	632
R^2	0.069	0.346
Root MSE	0.322	0.270
No of Observations	300,100	

Table 1B. Earnings regression by year, continuous firm variables.

	1991			1995		
	(1)	(2)	(3)	(1)	(2)	(3)
Female	-0.228	-0.228	-0.228	-0.225	-0.227	-0.227
	(123.65)	(46.06)	(46.28)	(124.62)	(52.80)	(52.86)
Education	0.067	0.063	0.079	0.070	0.066	0.073
	(183.45)	(55.92)	(28.97)	(191.42)	(63.22)	(37.57)
Size		0.0002	0.0002		0.0002	0.0002
		(5.90)	(5.34)		(4.87)	(4.39)
$Size^2$x1000		-0.00002	-0.00002		-0.00005	-0.00005
		(2.78)	(2.65)		(2.06)	(1.96)
Kapital/ Labor		-0.0002	-0.0001		-0.0001	-0.0001
		(1.58)	(0.80)		(1.26)	(0.90)
$[Kapital/ Labor]^2$x1000		0.0003	0.0003		0.0002	0.0002
		(2.23)	(2.14)		(0.85)	(0.86)
Market Share		0.028	0.008		0.028	0.051
		(1.37)	(0.16)		(0.93)	(0.92)
Comp.		0.025	0.002		0.017	0.040
		(1.87)	(0.074)		(1.21)	(1.53)
Union		0.172	0.405		0.171	0.268
		(3.68)	(7.09)		(3.87)	(5.18)
$Union^2$		-0.228	-0.230		-0.204	-0.199
		(4.34)	(4.36)		(4.09)	(4.00)
Tenure	0.008	0.007	0.007	0.008	0.006	0.006
	(26.29)	(6.32)	(6.30)	(27.01)	(7.39)	(7.44)
$Tenure^2$	-0.0001	-0.0001	-0.0001	-0.0002	-0.0001	-0.0001
	(14.22)	(3.99)	(4.02)	(15.60)	(5.85)	(5.92)
Exper	0.024	0.023	0.023	0.024	0.024	0.024
	(100.79)	(43.14)	(43.61)	(96.49)	(47.24)	(48.02)
$Exper^2$	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004)
	(83.23)	(38.44)	(39.21)	(75,92)	(42.40)	(43.60)
Education Interactions						
Sizex1000			-0.005			-0.0009
			(1.83)			(0.20)
[Kapital/ Labor] x1000			-0.006			-0.002
			(0.60)			(0.21)
Market Share			0.002			-0.002
			(0.42)			(0.46)
Comp.			0.002			-0.002
			(0.80)			(0.86)
Union			-0.022			-0.009
			(5.64)			(3.06)
R^2	0.321	0.356	0.359	0.310	0.338	0.338
No of Observations		144,740			155,360	