Matti Virén

Why do capital intensive companies pay higher wages?

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The views expressed are those of the author and do not necessarily reflect the views of the Bank of Finland.

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Abstract

An obvious answer to this question is the capital-skill complementarity hypothesis originally proposed by Zwi Griliches (1969). But the relatively poor performance of this hypothesis suggests that other explanations are needed. Here we consider the labour union behaviour in the wage bargaining process as such an alternative. The explanation is based on the observation that capital intensive companies are more vulnerable to strike threats and may thus more easily give in for union wage demand. Thus, the bargaining power of unions is related to the capital-labour ratio. This paper provides some tests for these hypotheses with panel data for Finnish companies. The results give support to the wage bargaining hypothesis.

Key words: wages, bargaining, wage distribution, panel data

JEL classification numbers: J31, J51

Miksi pääomaintensiiviset yritykset maksavat suurempia palkkoja?

Suomen Pankin tutkimus
Keskustelualoitteita 5/2005

Matti Virén
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Tässä tutkimuksessa etsitään selitystä kysymykseen, miksi pääomaintensiivisissä yrityksessä maksetaan parempia palkkoja kuin muissa yrityksissä. Ilmeinen vastaus on pääoman ja tietotaidon välinen komplementaarisuus Zwi Grilichesin (1969) esittämän hypoteesin mukaisesti. Tämän hypoteesin suhteellisen heikko selityskyky viittaa kuitenkin siihen, että tarvitaan muitakin selityksiä. Tässä tutkimuksessa esitellään vaihtoehtoisena selityksenä ammattiliittojen käyttäytyminen palkkaneuvotteluissa. Selitys perustuu siihen havaintoon, että pääomaintensiiviset yritykset ovat muita yrityksiä alttiimpia lakonuhkalle ja suostuvat siksi helpommin liittojen palkkavaatimuksiin. Siten ammattiliittojen neuvotteluvoima riippuu pääoman ja työvoiman välisestä suhteesta. Tutkimuksen empiirisessä osassa raportoidaan tämän hypoteesin testituloksia, jotka perustuvat suomalaisia yrityksiä koskevaan paneeliaineistoon. Tulokset ovat sopusoinnussa yllä mainituin neuvotteluvoimahypoteesin kanssa.

Avainsanat: palkat, palkkaneuvottelut, palkkajakaumat, paneeliaineistot

JEL-luokittelu: J31, J51

Contents

1 Introduction

Why are similar workers paid differently, is a question which cannot be easily answered. We know that there is a lot of wage dispersion and that standard wage equations can explain only small fraction of the variation. Take for instance the human capital variables: although they clearly significant they can explain only little of the variance of cross-section wages. It is often argued that 70 per cent of the (log) wage variation is not explained by observed ability differences. Obviously this means that some form of imperfect competition is necessary to explain the empirical findings.[1] As for the characteristics of the wage dispersion there are some regularities in between wages across firms. We know for instance that large companies pay higher wages than small companies. But we do not exactly know why this is the case; do the differences for instance just reflect unobservable worker ability or job attributed differences. Another feature of wage differences is the positive association of wages and capital intensity which at least in the Finnish data shows up quite clearly as the following graph (Figure 1) illustrates.[2]

Now if we take the positive correlation as an established fact, we should of course provide an explanation for it.[3] An obvious starting point is the capital-skill complementarity hypothesis originally proposed by Zwi Griliches (1969). According to this hypothesis capital intensive production requires more human capital (skill) and assuming that a proper rent is paid to human capital we would expect capital intensive firms to use disproportionally more skilled labour and thus there would a positive correlation between capital intensity and wages.

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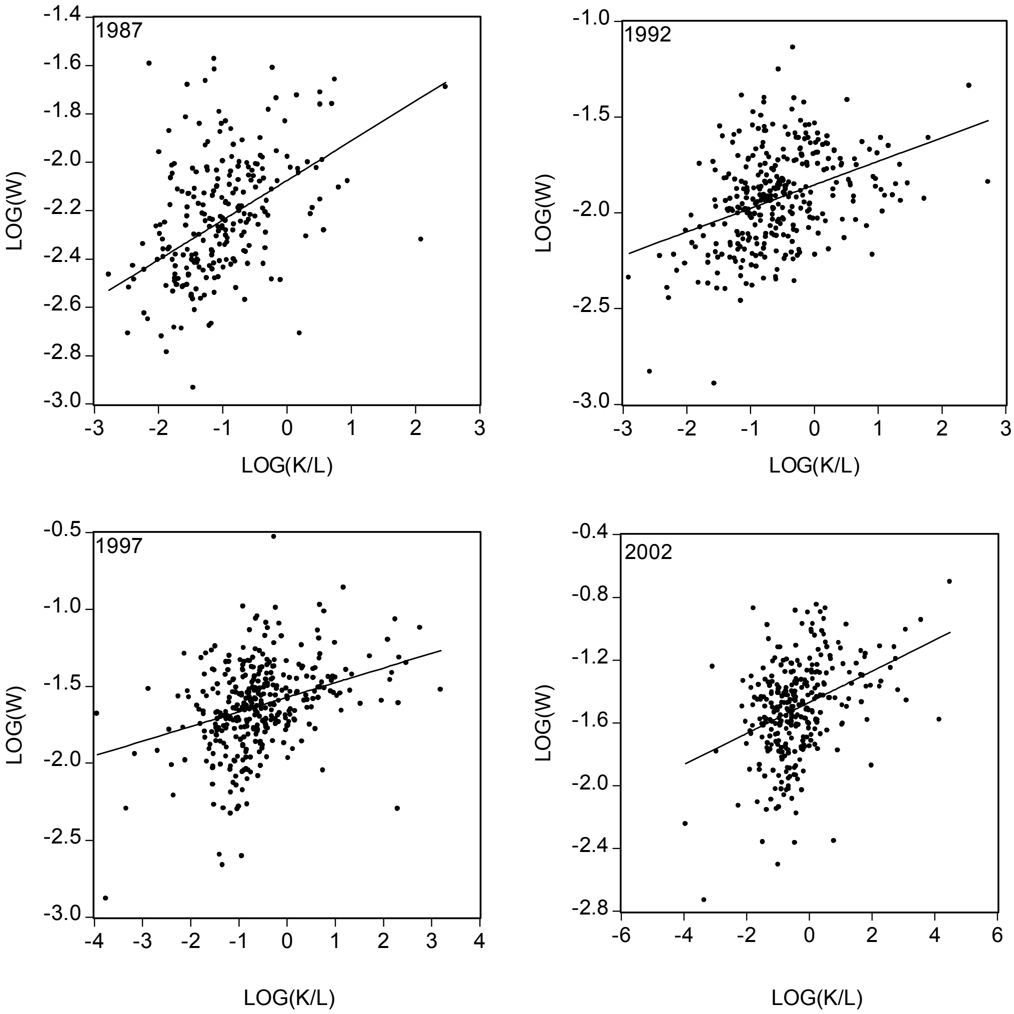
[1] This point is forcefully advanced by Mortesen (2003). Mortensen's explanation for wage differences is based a search-theoretic model which allows all firms to have some sort of monopsony power. In this set-up the search friction and cross-firm differences in labour productivity are key ingredients in the creation of wage differentials.

[2] The regression line in the figures is computed using a robust regression.

[3] Obviously, the explanation can be related to a hypothesis where causality runs from higher wages to higher capital intensity or from higher capital intensity to higher wages. In the fist alternative, which might well be true, we have the problem that we have no obvious explanation for the high wages. Similarly, in the second alternative, capital intensity is just a given fact but that might not be so bad assumption because to some extent technological differences can be taken as exogenous. The positive association between wages and capital intensity has been established also in Juselius (2004) using aggregate Finnish time-series data.

Figure 1. **Wages and the capital/labour ratio for in the Finnish Industry**



The hypothesis has been subject for quite intensive empirical research but while the empirical evidence has generally given some support to the hypothesis (see eg Krusell et al 2000[4]) it has been somewhat moot (see eg Duffy, Papageorgiou and Perez-Sebastian (2003)). Partly this reflects the fact that testing requires quite sophisticated data and such data are usually available only in aggregated from (like in country averages).

In this light it may be well-founded to look for competing explanations. Given the case of Finland where trade unions seem play an important role in wage determination process and where average unionization is above 80 per cent it is not difficult to argue that some specific features of wage bargaining may affect

[4] In the Krusell et al (2000) analysis the idea is that the decrease in the relative price of investment goods has increased investment and – because of the skill-capital complemetarity – and demand for skilled labour. That, in turn, has pushed up the skill premium in wages.

the wage structure. In particular, one could argue that unions make use of the capital intensive companies' 'bad' outside options. That is, if there is a strike the company will end up with negative profits due to fixed costs. The higher are the fixed costs, the more vulnerable are the companies and the more easily they give in to unions' wage demands.

Although union bargaining model provides an obvious explanation for the positive relationship between wages and capital intensity it is not the only explanation. One alternative is the efficiency wage hypothesis which is particularly relevant in the case of non-unionized industries. According this hypothesis wages also increase productivity which obviously creates a positive relationship between wages and productivity. The role of capital comes evident if one takes into account the fact that better effort also allows for more efficient use of capital. In the same way, one may think that 'the capacity utilization rate' is determined by the (relative) wage rate. High wages facilitate the more efficient production, ie higher return to capital which in turn translates to higher capital intensity.[5]

After going through all this, it is perhaps fair to state that also the search theoretic approach (Mortensen 2003) can as well rationalize the positive association between wages and capital intensity (productivity).[6]

From the point of empirical testing that is, of course, bad news because our ability to discriminate between different theories is quite limited. Had we individual (worker) data with also detailed data of the employer characteristics in the way of eg Abowd et al (1999), discriminating different hypothesis might be possible. But anyway it might be useful to be able to establish the exact role of capital intensity in wage determination.

That is why we formulate a wage equation in which we have the capital intensity as the main forcing variable. We have also several proxies reflecting union militancy to control the bargaining power parameter. In order to control the productivity effect we also introduce the labour quality (schooling) variable. The performance of this variable may also shed light on the role of the capital-skill complementarity hypothesis.

In what follows next, is the derivation of he wage equation, then an empirical analysis with panel data of Finnish companies and, finally, some concluding remarks.

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[5] See eg Lerner (1999) who analyzes the determination wages, effort and capital intensity in a simple two sector model. He also presents some evidence on wage/capital intensity association. See also Konings and Walsh (1994) who try compare the different wage determination models with the UK data.

[6] In a addition to Mortensen (2003) and Burdett and Mortensen (1998) one ought to mention Pissarides (2000) in which wages are determined as the outcome of bilateral bargaining between the employee and the employer (in a world where there is incomplete information of wages in different firms).

2 Wage bargaining

Assume efficient bargaining with the following basic assumptions: Workers have utility U in terms of the wage w and the alternative income b (which is finances by lump-sum taxes from workers) while firms have the conventional profit representation in terms of revenues and costs. Assume that (in the short run) capital is fixed and its value is taken as given in the bargaining process.[7]

Thus, we have the following Nash product which ought to be maximized with respect to the wage rate and employment

$$U^{\beta}\Pi^{1-\beta} = [(w - b)L]^{\beta}[pAF(L,K) - wL - cK + cK]^{1-\beta} \tag{2.1}$$

where A is the productivity factor, L employment and cK the fixed (capital) cost (notice that the outside option for the firm is -cK). β indicates the bargaining power of the union.

Given the utility fuction, employment is determined according to the first order condition $pAf_L = b$ which implies a constant employment level L* (independently of the bargaining power of the parties) equal to $f_L^{-1}(b/Ap)$. See eg Muthoo (1999) for details. That in turn implies the following solution to the wage rate

$$w = (1 - \beta)b + \beta\{pAF(L,K)/L\} \tag{2.2}$$

The solution implies that the wage is a convex combination of the alternative income and average gross return (see eg MacDonald and Solow (1981) for details). In other words, we could write the result as $w = (1 - \beta)b + \beta\{pf(L)/L\} - cK\} + \beta cK/L$ where the second term on the RHS is the conventional average return (net of capital costs) while the third term the (fixed) capital costs. Because in the short run the capital costs are sunk costs they simply cancel out. Thus, if $\beta = 1$ (unions completely dominate the wage setting process) wages would exhaust all income, also capital income. Obviously, this could not be a feasible long-run solution because the company would simply go to bankrupt.

This bankruptcy risk suggests that the bargaining power of unions is positively related firms' capital intensity. One way to put it is to say that the

[7] Quite different situation emerges in a dynamic set-up where the outcome of bargaining affects investment and growth, see eg Devereux and Lockwood (1991). In the dynamic set-up the relative bargaining situation of a firm and the union may turn completely upside down: the firm has a positive outside option in financial markets while the union has just a zero option. See eg Bertocchi (2002). In the dynamic set up, we obviously face the problem of time-consistence and credibility due to the fact that the union's bargaining position is quite different before after investment. See eg Van der Ploeg (1987) for details.

longer is the strike, the bigger is the bankruptcy risk. These considerations may be formalized by 'endogenisizing' the bargaining power parameter β in such a way that $\beta = \beta(k)$. One simple way of doing this, is to assume the following functional form for $\beta = 1 - \exp(-\gamma k)$. If we plugged that into (2.2) it would give us

$$w = b\{\exp(-\gamma k)\} + AR(1 - \exp(-\gamma k)) \quad (2.3)$$

where $AR = pAf(k)$, $f(k)L$ being equal to $F(K,L)$. The partial derivative of wages w.r.t. the capital/labour ratio would now be

$$\partial w/\partial k = -\gamma b\{\exp(-\gamma k)\} + \gamma AR\{\exp(-\gamma k)\} + (1 - \exp(-\gamma k))MR > 0.$$

where $MR = pAf'(k)$. Clearly, the behaviour of $\partial w/\partial k$ as $k \to 0$ or $k \to \infty$ depends on the limiting properties of the AR- and MR-functions.

One might extend this line of argument by suggesting that heavily indebted firms are even more handicapped in this bargaining situation and thus β may not only depend on k but on the whole asset liabilities structure of the firm. Although we also test this hypothesis we have to admit that here our approach is quite speculative because bankruptcy threat is quite delicate for both the union and the firm and in reality the bankruptcy risk may prevent most extreme wage demands from the side of the union.

The fact that capital intensity will increase wages does not only apply to the efficient bargaining model which we use here as a point of reference. If we use the so-called 'right to manage model' (which is quite popular in Europe) we can end up with the following solution

$$w = \{(\varepsilon_D + \theta)/(\varepsilon_D + \rho - 1)\}b \quad (2.4)$$

where ε_D is the labour demand elasticity and $\rho = (1 - \beta)\alpha_L/\beta(1 - \alpha_L)$ where α_L is the labour share of income. In the case of CD production function, this simplifies to

$$w = \{(1 - \beta) + \beta/\alpha\}b \quad (2.4')$$

where α is the factor share of labour which also shows up in the labour demand elasticity $-(1 - \alpha)$. Clearly, if $\alpha = 1$, $w = b$ and if $\alpha = 0$, wages go to infinity. Setting β equal to 1, we obtain the monopoly union model solution which here implies that $w = (1/\alpha)b$. In this model capital intensity shows via the labour demand elasticity: if the labour costs represent just a small piece of total costs, labour demand elasticity is correspondingly higher and that offers an advantage to the union.

The matter would be different if we assumed that the fall-back position of the firm would indeed be larger than -cK (eg because of liquidity and customer relationship problems). If we assumed that the true fall-back position were $-(1 + \theta)cK$ we would end up with the following version of (2.2)

$$w = (1 - \beta)b + \beta\{pAf(k)\} + \beta\theta ck \quad (2.2')$$

Accordingly, in the 'right-to manage model cum the CD production function with $\alpha_K = ck/pAf(k) = 1 - \alpha$, the wage equation takes the following form[8]

$$w = [\{\beta(1 + \theta) + (1 - \beta)\alpha)\}/\{\alpha(1 + \beta\theta)]b \quad (2.4'')$$

Clearly, w increases along with θ. If $\theta \rightarrow \infty$ or $\beta \rightarrow 1$ (2.4'') again approaches $w = (1/\alpha)b$. In other words, firms' vulnerability allows unions bargain higher wages.

Before estimating the model it is worth considering alternative models which may produce a similar wage – capital intensity relationship. As pointed out in section 1, one potentially relevant alternative is the efficiency wage model. In a simple one factor (labour) model, the positive association between w and K/L does not, of course, hold because the wages are determined by the Solow condition in which the elasticity of effort with respect to wages is 1. In a more complex world this result does not necessary hold, however.

Introducing capital does not change the basic result unless we also change the form of the production function. In the general set of capital and labour it is tempting to write the production function in such a way that the 'effort' effect applies not only employment but the whole production. One way of interpreting this effect is to consider 'effort' as some sort of capital utilization effect. Having 'better' worker "qality" facilitates non-disturbed and efficient production. This would simply mean that the production function would take the following form

$$Q = uAF(K,L) = uAf(k)L$$

In this case, the Solow condition does not simply hold but wages depend on capital intensity. Take for instance a simple employer – employee relationship with the profit maximization condition

$$pAu(w)f(k) - w - ck \quad (2.5)$$

[8] Notice that in the 'Right-to-manage' model marginal product = wage equality still holds opposite the Efficient bargaining model (see Bentolila & Saint-Paul (2003) for details).

where u(.) can be interpreted as the capacity utilization rate. One might think that it varies between 0 and 1 with for instance the following mapping to the wage rate: $u = (1 - \exp(-\varphi w))$. Now, if k is given, it is almost trivial to show that k has a positive effect on w ($w = u'^{-1}(1/pAf(k))$). If k and w are jointly determined, demand (p) productivity (A) and cost (c) shocks will move k and w to the same direction generating a positive association between these variables (see Appendix 1 for details).

The problem is, that this kind effect cannot really be distinguished from the union power and wage bargaining effect. If we had data on turnover and some other characteristics of firms' employment we might be able to do that but right now we have to leave that kind of analysis to future research (see Gera and Grenier 1994 for an attempt of distinguishing these and other wage effects).

3 Empirical analysis

Now, turn to empirical testing of the hypothesis that higher capital intensity leads to higher wages in a wage bargaining model. Technically, the simplest way is to estimate the nonlinear specification (2.3) directly. Put simply, the model says that capital intensity will increase the share of total return which goes to labour. In other words, at the firm level the relationship between wages and productivity becomes stronger along with capital intensity.

$$w_t = a_1\{\exp(-a_2k_t)\} + q(1-\exp(-a_2k_t)) + a_3w_{t-1} + \mu_t, \qquad (3.1)$$

where w is the real wage, q the output labour ratio (labour productivity) and μ the error term. The lagged dependent variable is introduced to take into account the fact that wage agreements cover more than one period and that firm-specific features in wages and productivity may prevail longer time.

Alternatively, we could just use a linearized form of equation (2.2) or, in fact (2.2') and test whether capital intensity as an additional independent explanatory variable has a positive effect on wages given labour productivity and other control variables of w. Then the estimating equation would simply take the following linear form:

$$w_t = b_0 + b_1w_{t-1} + b_2b_t + b_3q_t + b_4E_t + b_5k_t + b_6s + \mu_t \qquad (3.2)$$

where b denotes the alternative income, E the educational (human capital) level of employees, k the capital-labour ratio, K/L, and s the proxy for union militancy, which is measured with two alternative strike frequency variables. Equation (3.2) is also estimated in logs even if the corresponding form cannot directly be derived from (2.2').

Finally, we could transform equation (2.2) into a wage-share form

$$(wL/Y) = (1\text{-}\beta)bL/Y + \beta \qquad (2,2'')$$

which together with the control variables could be written in the following estimating from:

$$ws_t = c_0 + c_1 ws_{t-1} + c_2 bs_t + c_3 E_t + c_4 ks_t + c_5 s_t + \mu_t \qquad (3.3)$$

where ws stands for wL/Y, bs for bL/Y and ks for K/Q, Y being nominal output and Q real output.[9]

The problem is that we have no data for the alternative income. The Finnish unemployment compensation system is a bit complicated and there is no (single) minimum wage. The best we can do is to assume that b is constant but it is related to the price level due to some form of indexation.

The above-mentioned equations are estimated from an unbalanced panel data of Finnish firms (limited liability companies) so that the sample period is 1986–2002 and the number of firms is 518. Total number of observations is 5089. The data do no contain any information on the characteristics of individual employees in the way of Abowd et al (1999) for instance. Thus we are not able to make a fair comparison between firm specific effects and employee specific effects. The estimating equations also include annual dummies to take into account common aggregate time-specific effects. They may, of course, also capture changes in the alternative income b which are not captured by the price level. Definition of variables is explained in Appendix 2.

The equations are estimated in various alternative forms: in nominal and real form, in level and log level form, and, finally, in the log difference form. In the panel data, we do not have firm-specific data for E and S so we have been obliged to use (two-digest number) industry level data for these variables[10]. More precisely, E is the industry average of educational attainment (measured in school years) while S is proxied by two alternative variables: the number of persons participating in strikes (in relation to employment) and the number of working days lost in strikes (again, in relation to employment.). We denote these proxies as SN and SD. As for the output variable, we have the turnover data for all firms but the value added data only for a part of companies. To overcome this problem we have constructed a value-added measure by subtracting the purchase of intermediate goods and raw materials from total sales. The results with this constructed measure come quite close to the results with the original variable in the case both series are available. Notice that the wage rate is here simply the

[9] In the case of (2.2'), (2.2'') would include a capital income-share term $+\beta\theta(c\cdot K/Y)$.

[10] This obviously invalidates the conventional t-test statistics as pointed out by Moulton (1990)

gross wage sum divided by the number of employees. Quite obviously, there are measurement errors in the constructed time series. The problem is that the output variable, the value-added, comes quite close to the wage sum and in the cross-section context w and Q/L are highly correlated, partly due to these measurement errors. As a consequence, the coefficients of the other variables may be biased downwards. To overcome this problem we use alternative functional specifications and alternative proxies for output.[11]

Before estimating equations (3.1)–(3.3) we shortly consider the empirical performance of the skill-complementarity hypothesis from the point of view of our data. For that purpose, we introduced a simple test by regressing log(k) on log(E) and a set a of dummies for years 1986–2002. The coefficient of log(E) turned out to be -0.64 with the t-ratio being 3.4 and R^2 0.018. This suggests that the relationship between capital intensity and educational attainment is quite weak indeed (and even negative) and may not provide undisputable explanation to wage differences between Finnish firms.

Now, turn to presentation of the estimation results. The estimates are reported in Tables 1–3 below. All estimates are OLS estimates. No fixed cross-section effects are introduced because we also want to make use of the cross-section variability of wages.

The estimates in Table 1 with the non-linear model (3.1) clearly show that higher capital intensity (higher K/L ratio) increases the weight of average returns in wage determination. Thus, if capital intensity becomes very large, all income goes to labour.

Basically the same story applies to estimates of the linear approximations (3.2) and (3.3) which do now, however, allow for identification of the interaction between capital intensity and wage productivity relationship. We may, however, add a multiplicative term of s*k to control the joint effect of capital intensity and union militancy. We also included dividend and indebtedness variables in estimating equation capture the effects of profit sharing and vulnerability of the firm's financial situation in the bargaining situation. These variables turned out to be of marginal importance only and therefore the corresponding specification/ estimates are not reported. We also introduced the company size variable into the analysis but also its role turned out to be marginal which may be explained by the fact that the sample just includes big companies (big in Finnish standards).

When the equation was estimated in the log form, some signs of nonlinearities could be detected. Hence, (3.2) was estimated using a Threshold model specification where the coefficient of the capital/labour ratio was allowed to change according to the value of k. In other words, we introduced an additional

[11] Obviously, the IV (or GMM) estimator would be more appropriate here. Some of the equations were indeed estimated by the IV estimator but because the estimates did not really make much difference only the OLS estimates are reported here.

log(k | k > k_c) variable into the estimating equation (see equations (6)–(8) in Table 2). A grid search suggested that error variance minimizing value of the threshold parameter k_c is 1.8 which in fact is quite close to the sample average of k.

Table 1. **Panel data estimates for equation (3.1)**

Equation	a_1	a_2	a_3	a_e	a_s	R2/SEE	DW
1	.154	.157				0.024	0.51
	(205.26)	(9.74)				0.475	
2	.040	.091	.756			0.577	2.55
	(24.32)	(8.85)	(71.58)			0.313	
3	.030	.094	.722	.426	.026	0.586	2.51
	(10.70)	(9.28)	(65.19)	(4.91)	(1.93)	0.310	

Number inside parentheses are t-ratios. a_e and a_s denote the estimated coefficients of EL and s, respectively. Value-added is used for output in all equations.

Table 2. **Panel data estimates for equation (3.2)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
w_{-1}	.735	.737	.682	.729	.672	.673	.792	.717	.788	.705
	(9.15)	(9.13)	(7.66)	(9.20)	(7.81)	(7.83)	(38.37)	(21.29)	(37.08)	(27.05)
Q/L	.025	.026	.019	.028	.020	.020	.023	.012	.022	.012
	(1.43)	(1.43)	(3.02)	(1.50)	(3.29)	(3.30)	(6.70)	(7.00)	(6.80)	(8.78)
E	.622	.579	.659	.526	.623	.588	.083	.088	.083	.081
	(3.16)	(3.11)	(3.27)	(3.32)	(3.15)	(3.40)	(5.19)	(4.98)	(5.02)	(4.98)
k	.245	.264	.152	.282	.177	.170	.016	.025	.022	.006
	(2.21)	(2.86)	(1.16)	(3.28)	(1.72)	(3.52)	(4.94)	(0.51)	(5.59)	(1.21)
s	.050	.056	.039	.052	.043	.041	.006	.013	.003	.002
	(2.11)	(2.35)	(1.52)	(3.24)	(3.15)	(3.52)	(6.04)	(1.28)	(5.57)	(1.76)
s*k	.015	.365	..018	.025	.027	.112				
	(0.83)	(0.29)	(8.76)	(3.33)	(3.57)	(2.21)				
k>1.80									.868	1.026
									(3.12)	(3.54)
R^2	.787	.787	.794	.710	.720	.719	.790	.810	.791	.813
SEE	.025	.025	.0024	.00022	.00022	.00022	.130	.127	.129	.122
DW	1.53	1.53	1.45	1.54	1.46	1.46	2.04	2.27	2.03	1.86
S	SN	SD	SN	SN	SN	SD	SN	SN	SN	SN
output	T	T	VA	T	VA	VA	T	VA	T	VA
Data	Nom	Nom	Nom	Real	Real	Real	Real	Real	Real	Real
Form	Level	Level	Level	Level	Level	Level	Log	log	Log	Log

Numbers inside parentheses are Newey-West t-ratios Row S indicates the measurement of s and row output the measurement of output. The T indicates turnover and VA the (constructed) value-added.

Table 3. **Panel data estimates for equation (3.3)**

Variables	1	3	3	4	5	6
pL/Y	.071	.065	.078	.105	.031	.083
	(7.93)	(7.23)	(8.17)	(9.20)	(5.27)	(12.17)
K/Q	.019	.170	.013	.017	.031	.047
	(2.09)	(3.95)	(7.66)	(2.99)	(2.89)	(1.66)
ws_{-1}	.987	-.090	.130	-.166	.599	.-.167
	(161.82)	(3.27)	(3.16)	(3.49)	(12.93)	(5.61)
E	.158		.374		.184	
	(1.64)		(3.19)		(4.00)	
s	-.014		.020		.009	
	(0.01)		(2.67)		(2.40)	
R^2	0.964	0.438	0.678	0.836	0.771	0.548
SEE	0.024	0.022	0.144	0.127	0.065	0.054
DW	2.07	2.07	0.875	1.89	1.64	2.22
Form	Level	Dif.	Level	Dif.	Level	Diff.
Data on Q	T	T	VA	VA	VAc	VAc

Numbers inside parentheses are New-West t-ratios. T denotes turnover, VA the original value-added and VAc the constructed value.

As pointed out earlier, the linear model was also estimated in the first difference form. In that case, the capital intensity variable turned out to be highly significant as can be seen from the following concise summary of parameter estimates[12]:

Δk	$\Delta Q/L$	Output variable
.010 (5.09)	.279 (6.92)	turnover
.166 (7.78)	.205 (7.31)	constructed value-added
.134 (6.90)	.226 (7.71)	original value-added

Newey-West t-ratios are inside parentheses

Finally we may refer to Table 3 which contains the estimates of the wage share specification. In this case, persistence varies a lot over different output measures but otherwise the estimates follow the same pattern as in the case of equation (3.2). Thus capital intensity has a positive impact on the wage share. In other words, in capital intensive companies, not only are wages higher but also the wage share is, ceteris paribus, higher.

The results can be summarized quite easily: Wages are persistent but not overly so. Wages are related to average (company) returns which is in accordance with the (efficient) bargaining model, or in general with rent sharing models. The

[12] The model only includes Δw, Δw_{-1}, Δk, $\Delta Q/L$ and time dummies. Thus, the other control variables are not included, partly because they are constant over the sample period. Using the first difference form obviously eliminates the (cross-section) fixed effects.

labour quality (educational attainment) variable appears to systematically significant and correctly sized and signed indicating that some rent is indeed paid to human capital. Recalling that E is measured in terms of school years we may conclude that doubling the number of school years will increase wages about 40 per cent.

Finally, turn to the capital output ratio and union militancy variables. It appears that the variables reflecting striking frequency, are also systematically positive and significant suggesting that union militancy pays off in general.[13] Given the fact that also the capital/labour ratio is significant and correctly sized we may conclude that the bargaining story after all has some relevance in explaining the wage structure – at least in the Finnish industry. Capital intensive industries have to pay a wage premium; the more militant the unions are, the bigger is the premium.

All that has some powerful implications. If indeed there is positive relationship between wages and the capital/labour ratio that may seriously hinder investment activity because (cumulated) investment increases the bargaining power of unions and the total wage bill.[14] But obviously this is not the full story because in a dynamic (general equilibrium) set-up we have to take into account at least the income (distribution) effects which may even reverse the basic results (see Devereux and Lockwood 1991) not to speak about other complications in terms of the bargaining process, time-consistency of future plans and contracts.[15]

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[13] The result may compared with other empirical studies which have tried to isolate the union effect on (relative) wages. All in all, the results have been quite mixed (see eg Miller and Mulvey 1996). Obviously the frequency of strikes does not only reflect union militancy but also behaviour of firms and overall tension in the labour market.

[14] Take a simple specification of w so that that $w = w(K/L)$. Then, in assuming the CD production function with constant returns to scale produces in the cost minimization case the following 'solution' for the capital/labour ratio: $k = (1/\alpha)*(w(1 - \varepsilon)/(c + w'))$ where ε is the elasticity of w w.r.t. k. Although either ε or w' may depend on k we conclude from this condition that the bargaining effect leads to lower capital/labour ratio and consequently to slower output growth. See Grout (1984) for more thorough analysis.

[15] See Malcomson (1997) for implications of capital accumulation on wage contracts in a dynamic set-up.

4 Concluding remarks

Our analysis has shown that there is a positive association between wages and capital intensity at the firm level. This relationship stays even if we control labour productivity, educational attainment and union militancy. Perhaps the most obvious explanation this result is the bargaining power of labour: the power increases along with the level capital intensity. This just reflects the vulnerability of capital intensive firms to all kinds of labour disputes. If this conjecture is true it has powerful implications to investment and growth and therefore it deserves further analysis with data from other sort labour market institutions' countries. It would also be interesting to study to which extent this arguments apply to nontangible capital, or even human capital.

The fact that firm characteristics seem to be crucial in explaining the wage structure suggests that the labour market is not functioning very efficiently. True, we have been able to control the characteristics of employees (and work quality) only marginally but even then the relationship between wages and capital intensity appears to be so strong that it is no point of characterizing the labour market as perfectly competitive. Irrespectively of the exact reasons behind this relationship, it is clear that it leads to lower output (growth) and welfare. Also therefore it deserves more attention and analysis.

Appendix 1

Comparative statistics with the efficiency wage specification

Take equation (2.5)

$$pAu(w)f(k) - w - ck \quad (2.5)$$

Derive the first order conditions and totally differentiate the conditions with respect to k, w and, for instance, p. Then you end up with the following conditions

$$pAuf''dk + pu'f'dw = -Auf'dp$$

$$pAu'f'dk + pAu''fdw = -Au'fdp$$

Using Cramer's rule you can derive the comparative statics results with respect to dk/dp and dw/dp which are

$$dk/dp = (-uu'' + u'^2)/(uu''ff'' - (u'f')^2)$$

$$dw/dp = (-ff'' + f'^2)/(uu''ff'' - (u'f')^2)$$

Using the CD production function and specification for u(w) in text, we derive simple expressions for these values, that is

$$dk/dp = (1 - u)/(\alpha + u - 1) > 0$$

$$dw/dp = 1/(\alpha + u - 1) > 0$$

Obviously these expressions can get perverse values if both α and u are very small but the case can be ruled out by the second order conditions for maximum.

Appendix 2

Data definitions

w	the wage rate (the wage sum divided by employment)
L	employment measured by the number of employees
Q	output which is measured by total turnover, value-added or alternatively by a constructed value-added variable (which is turnover – purchases of intermediate costs and raw materials)
E	average educational attainment of the labour force in industry i measured in average school-years
SD	number of strike days lost in industry i in relation to employment
SN	number of persons participating in strikes in industry in relation to employment
K	capital stock in current prices
P	the consumer price index
IC	interest expenses
D	dividends
Y	p*Q

The price-index P data are common to all firms. Data source: Bank of Finland data base.

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