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Erling Barth
Harald Dale-Olsen

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Forschungsinstitut
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Institute for the Study
of Labor

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Erling Barth
Institute for Social Research, Oslo,
University of Oslo and IZA Bonn

Harald Dale-Olsen
Institute for Social Research, Oslo

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
Email: iza@iza.org

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ABSTRACT

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It turns out that the employer-size effect on individual wages dwindles away once one control for the number of workers of the same skill-group (educational type) as the observed individual within the establishment. The skill-group size effect on wages is substantial. The main results, a dwindling employer size effect and a significant group size effect, remain after controlling for both individual and establishment specific heterogeneity. This observation rejects most of the proposed explanations for the employer-size effect, while it lends considerable support for the notion that there are frictions in the labor market and that each establishment faces an upward sloping supply curve for each type of labor.

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Corresponding author:

Erling Barth
Institute for Social Research
P.O.Box 3233 Elisenberg
N-0208 Oslo
Norway
Email: eba@socialresearch.no

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1. Introduction

The firm-size effect on wages is a long recognized fact in labor economics. Oi and Idson (1999) document that US workers in large plants of large firms (1000+ employees) receives a wage premium of 62.6% relative to workers employed in small plants of small firms. Controlling for human capital and other worker characteristics still leaves a considerable wage premium of 27.8%.

This observation runs counter to most standard theories of the labor market. Brown and Medoff (1989) proposed several potential explanations for this observation, and went to considerable effort to sort them out. The firm-size effect, however, survived their careful scrutiny, and remained quite a puzzle. Subsequently, more and more advanced estimation techniques have been used in attempts to control for endogeneity of firm size and individual heterogeneity, see e.g., Oi and Idson (1999). Winter-Ebmer and Zweimüller (1999) use information on job changers to show that firm-size wage differentials cannot be explained by job heterogeneity.

Concurrently, the firm-size effect showed up in a large number of different countries with rather diverse labor market institutions and wage setting regimes. Albæk et al. (1998) establishes a significant and large firm-size effect in the Nordic countries. The firm-size wage effect now appears as an empirical regularity. We know of no study from any part of the world that has been able to eliminate the firm-size effect with appropriate data and methods.

Green et al. (1996) argues in favor of the dynamic monopsony model as the explanation for the firm-size effect. They argue that the firm-size effect on wages is actually the inverse of the wage elasticity of labor supply to any one firm. This idea originates with Burdett and Mortensen (1998), who show that with labor market frictions and job-to-job search, a unique equilibrium wage distribution exists among wage posting firms for homogenous workers. The wage distribution has the characteristic feature that wages increase with firm size. Or put differently; in order to obtain a larger share of the labor force, the firm has to climb its own labor supply curve. Green et al. (1996) give evidence that is

consistent with this explanation of the firm-size effect, even if they are not able to rule out other explanations in their analysis.

Our contribution is the following. We identify each individual employee by his or her 2-digit-type of completed education. This gives us 66 different educational types. Examples are education at the second level, stage I within humanities and aesthetics (1-year in excess of 9 years compulsory schooling), education at the third level, stage I within health care (3-years in excess of 9 years compulsory schooling), Phd. in administration and economics, social science and law(8-years in excess of 9 years compulsory schooling).

Then we count the group size of that type within the establishment; i.e., the number of employees of that type in the establishment in which the employee work. Once including the log of the group size in the standard wage regression, the firm-size effect drops considerably or disappears. This result is rather robust to a host of specifications, in particular to the introduction of a full set of establishment and individual controls.

It turns out that the firm-size effect is actually a group-size effect on wages. We argue that this observation is at odds with most proposed explanations for the firm-size effect. This is not surprising, of course, since we effectively eliminate the firm-size effect. In particular, our observation eliminates explanations that are based on product market considerations to the advantage of explanations relating to the labor marked. All in all, the observation that there is a significant and large group size effect, strongly suggests that a turnover model provides the most likely explanation for the previously observed empirical regularity.

2. Theory

The observed firm size effect on wages runs counter to implications from standard production and labor demand theory. Diminishing marginal returns imply more employees with lower wages, not the opposite. Potential explanations are thus hardly to be found from the demand side of the market. As we discuss in section 5 below, the same reasoning applies to the group size effect we observe.

Brown and Medoff (1989) discuss six potential explanations for the firm size effect. One is individual heterogeneity, the second is a compensating wage differential and the third is a union threat argument. They also consider a rent sharing argument, following from a premise that large firms have more market power and thus earn more per worker. Their fifth argument is that worker monitoring is more difficult in larger firms. Finally, they consider the idea that large establishment have to pay more to recruit the higher level of employees. From their empirical analysis, they are able to control for indicators of the first three types of arguments, but they end up concluding with a bottom line that they are left ”uncomfortably unable to explain” the firm-size effect (pp. 1056).

In our view, our results eliminate also the next two arguments as the sole explanations for the size effect. Since it turns out that the effect is actually a group size rather than a firm-size effect, product market explanations are ruled out while labor market explanations are enhanced. Furthermore, it seems unlikely that the monitoring argument is the whole story. Monitoring is difficult in large firms, not particularly for large groups of worker types. Quite on the contrary, large firms with a diverse group mix should be more difficult to monitor than identical firms with a large and homogenous work force. Information and monitoring problems should be an establishment-level problem, not a problem relating to group size.

A turnover based explanation that is developed in the equilibrium wage literature of Burdett and Mortensen (1998) and Manning (2003). The point is that larger firms have to pay a premium in order to recruit and retain a larger pool of employees. Our evidence is highly consistent with this story. We present a simple version of this model below. This line of thought is closely connected to the efficiency wage literature as well. The pivotal assumption is that workers and firms cannot find each other instantaneously. This assumption is not new. Efficiency wage theories based on turnover costs are elaborated in Weiss (1991). Hamermesh and Goldfarb (1970) and Salop (1973) argues that quits is a continuous function of wages, with a finite slope. Even in the human capital literature, the idea that firms may face an upward sloping supply curve for labor, also in a world with many firms, is present. In the analysis of specific human

capital, Becker (1975) argues that firms may reduce their turnover by increasing wages above workers alternative wage.

However, both the efficiency wage models and Becker's argument suffer from the problem that the proposed quit function is ad hoc. The job-to-job search model closes this gap and produces the necessary wage distribution to induce a continuous quit function. With a non-degenerate wage distribution outside the firm, the number of credible outside opportunities, and thus the propensity to quit, is reduced with higher wages. This type of models is consistent with the observation of a group size effect of wages; it is not the firm size per se that matters, but rather how many workers you want to recruit and retain from the pool of a specific type of labor that counts.

Here is a brief exposition of the main points in the job-to-job search model with frictions (see Burdett and Mortensen (1998) and Manning (2003) for thorough analyses, existence proofs etc.) Consider the evolution of employment for a specific type of labor in an establishment: $L_{t+1} = L_t(1-q) + H_t$,where L_t is the stock of labor at time t, q is the quit rate for this type of workers in the establishment and H_t is the number of hires during period t. The quit rate is given by: $q(w)=\delta+ \lambda(1-F(w))$, where δ is an exogenous quit rate, λ is the probability of receiving a wage offer from other establishments when working, and F(w) is the c.d.f of the wage distribution outside the establishment. The number of hires that any one firm may obtain is given by $H(w)=\lambda(U+G(w)E)/M$, where M is the number of firms, E = (N-U) is the number of employees in the economy, U is the number of unemployed and G(w) is the c.d.f. of the wage distribution of the individuals. The rationale is that since any unemployed worker takes any wage offer received and our establishment may pick from individuals working in other establishments that pays below its own wage offer, w, our firm may obtain H(w) when posting an offer.

Note that G(w) and F(w) are not identical since an establishment with, say, 100 employees counts for 100 in the distribution over individuals, while it counts for only one in the distribution over establishments. The condition for an equilibrium flow in and out of unemployment; $\delta E = \lambda U$ as well as the condition

for the wage distributions to be in equilibrium; G(w)= δ F(w)/ (δ+λ(1-F(w)), are sufficient to show that H(w)= δλN/q(w)M in equilibrium. Inserting the quit function as well as the hiring function into (1), gives:

$$L_{t+1} - L_t = -L_t(\delta + \lambda(1-F(w)) + \frac{\delta\lambda}{\delta + \lambda(1-F(w)}\frac{N}{M}$$

In steady state $L_t = L_{t+1} = L$ which gives the steady state labor supply of any given establishment:

$$L(w) = \frac{\delta\lambda}{\left[\delta + \lambda(1-F(w)\right]^2}\frac{N}{M} = \frac{\delta\lambda}{q(w)^2}\frac{N}{M} = \frac{H(w)}{q(w)}$$

The intuition behind this labor supply equation is the following: In order to keep a given stock of labor, the firm has to make replacement hires every period to fill up for the quits that occur to the establishments higher up in the wage distribution. The larger the firm, the number of quits, and thus the more replacement hires are needed. For a larger firm, a higher wage level keeps the quit *rate* lower and also enables the necessary higher number of hires. We have $\frac{\partial L}{\partial w} > 0$ and consequently the elasticity of labor supply with respect to wages is positive. Obviously, this also gives a positive elasticity of wages with respect to the number of employees of the same type in the establishment, once we turn the equation around.

Note that N, the total supply of a given type in the economy is given in this analysis. When we use the expression, dynamic monopsony, we do not mean that the establishment affects the total supply of a given type of labor by its wage policy. In fact, by assumption, the firm is so small that it's actions in the labor market neither affect the wage distribution nor the total labor supply. The reason why we call this a dynamic monopsony model, is that there are frictions in the market, represented by a finite λ in the model, that gives the firm some monopsony power. The firm will not loose all its employees if it reduces wages

infinitesimally, only a small fraction, and furthermore by increasing its wage a bit, it may attract some more workers, but not the entire labor force. All in all this gives the firm an upward sloping supply of workers as it is able to keep a higher *fraction* of the given total labor force, if it increases wages.

Now, high paying firms may keep a higher steady state stock of employees. But it needs not to be more productive than other firms. In the standard formulation of models in this framework, the firms are homogenous with an equal constant marginal productivity, p and an equal profit condition solves for an equilibrium wage distribution. Profit is given by $\pi=(p-w)L(w)$ and we immediately see that high paying firms earns less per employee, but since it is able to keep a higher stock of employees, they earn the same as a small firm that earns more per worker, but is able to maintain only a small stock of workers in steady state.

However, as suggested by Oi and Idson (1999), the production function may be such that larger teams are more productive. Within the framework developed by Kremer (1993) they discuss the possibility that larger teams are more productive. If this is the case, establishments with larger teams may be able to pay more. In this case, the wage distribution across establishments reflects productivity differences. In that case, there must be some element of rent sharing and non-competitive wage differentials[2], which are difficult to reconcile with a notion of perfect mobility of workers across establishments. In an economy with frictions, however, such differentials may prevail. Based on our data, we are not able to sort out if the observed wage distribution is a reflection of productivity differences and an upward sloping labor supply curve facing each establishment, or only a reflection of the elasticity of labor supply.

In both cases, we suggest a labor market explanation for the firm-size effect on wages. It is necessary for the large firm to offer higher wages in order to keep a higher fraction of the labor force attached to own establishment. Or put the

[2] Note, for example that the competitive wage differentials developed in Kremer and Maskin (2000) are based on equal wage for equal skills.

other way, it is possible for small firms to keep a small fraction of the labor force, since there are frictions and the workers cannot immediately obtain another job at the high-paying firm across the street. This theory is also consistent with the notion that larger establishments face a lower turnover rate, as documented by Idson (1996). The labor market explanation of the firm size wage differential would predict that it is the size of employment of the same type of labor that should matter.

3. Data

Our linked employer-employee data is based on information from several administrative registers, supplied by Statistics Norway. We have chosen to take three different samples from our data. The first data set is a representative 1 percent sample of all wage earners between 20 and 60 years of age in Norway in each year from 1991 to 1997. This sample is denoted "the representative cross section" in the following. It is drawn independently in each year, and including year dummies it will be regarded as a "cross section" – data set, even if it constitutes a synthetic panel. For each employee we identify the educational type (66 types), daily wage, working time group (three types), Mincer-experience, seniority within the establishment, gender, and union status, as well as the establishment characteristics, industry, region, number of employees and the number of employees of the same type as the observed worker.

The second data set is a representative 2 percent sample of all wage earners between 20 and 60 years of age in Norway in 1995, which we then follow from 1991 to 1997. Thus all job changes during this period are covered. This sample is denoted "the representative panel". We have the same variables in the representative panel as in the cross section data.

The third data set is a panel of workers and establishments. It contains all employees[3] in the south eastern part of Norway (including, but not restricted to the area of and around the capital) of three very specific types of labor; one is unskilled labor, defined as workers with no more than the mandatory years of formal schooling (basically 7 or 9 years of schooling depending on cohort), the second is persons with an economic, administrative degree above high school level, e.g., a degree from the Norwegian School of Business and Administration in Bergen, and the third is persons with a technical education above high school level, e.g. a degree from the Norwegian University of Technology in Trondheim. We cover the complete labor market for these types of labor in the south eastern part of Norway, from the county of Østfold to Telemark, including Oppland and Hedmark. Then a panel is constructed by including information from all years from 1989 to 1997 of these workers and the establishments in which they work. We use the same variables for "the panel of three types" as for the representative sample.

We use the representative cross section sample to study the effect of including group size effects in the analysis of the whole labor market. Using this sample, we may claim that our results are pervasive and economy wide, applying to all types of labor, at least on average. Using the representative panel, we show that our results survive even control for fixed individual effects.

We use the panel of three types to show that our results survive complete control for group effects as well as of both establishment and individual hetero-geneity. This latter endeavor is rather data demanding, since we have to identify individual and establishment effects from establishment movers only. In order to limit the number of establishment dummies to below 6.000 in the wage equation for each type, we limited ourselves to the south eastern part of Norway (in which

[3] Actually, for identification reasons, the number of employees is limited to that of employees working in establishments with at least 2 movers in the period from 1989 to 1997, where movers are identified as persons coming from or going to another establishment within the period.

1/3 of the population of Norway lives)[4]. We then choose three types of labor that are large, rather homogenous and at the same time work in a large range of establishments and industries. We have done a full count of all employees in this region of these three types employed in establishments employing at least two movers of the same type in the whole period from 1989 to 1997.

From the panel of three types we estimate the coefficients of establishment dummies in a ”within individual” regression including all time-varying covariates (estimated on deviations from individual means on all variables including the establishment dummies) separately for each type of labor. These coefficients are interpreted as the firm-specific wage premia for a given type of labor. These coefficients, which are notably purged of *all fixed individual effects* as well as the time-varying covariates, are used in the subsequent analysis (see chapter 7 below).

4. The Null-Hypothesis and the Main Result.

Since this literature almost exclusively use log-log specifications and thus estimate elasticities, we will do that as well. Our null-hypothesis, then, is that the employer-size effect operates on the number of workers in total, regardless of which type of workers that is at the margin, so to speak. The simplest way to test for this is simply to augment the log wage equation with the log of the group size:

$$\ln w = a + b\ln(N+G) + c\ln(G) + Xd + u \tag{1}$$

where w is wage, X is a vector of covariates, like education, G is the number of workers of the same type as the observed individual and N is the number of workers not of the same type (G+N is thus the number of employees in the establishment). Consider now the derivative of w with respect to G:

[4] Thus if a worker moves outside this area, he or she disappears from the panel as do people who leave the labor force or become unemployed.

$$dw/dG = w\left[\frac{b}{G+N} + \frac{c}{G}\right]$$

while the derivative of w with respect to N is:

$$dw/dN = w\left[\frac{b}{G+N}\right]$$

Now, under the null, the relative effect of increasing the establishment size with one person should be equal regardless of worker type. Our zero hypothesis thus reduces to a test of the null-hypothesis that c=0. We thus use specification (1) as our main model in this paper.

Table 1 gives results from representative samples. Consider first the cross-section evidence. We start by noting that we have an establishment size effect in Norway. With year and human capital controls, we have an establishment size effect of about 3 percent in Norway. This observation is not much different from the size of the effect observed by Brown and Medoff (1989) for the US, and only slightly lower than that observed for Norway by Albæk et al. (1998) from survey data on hourly wages from the late 1980'ies. Controlling for region, detailed industry and sector and even detailed educational type leaves us with an establishment size effect of almost 2 percent, only slightly lower than the similar estimates reported by Brown and Medoff (1989) for the U.S.

[Table 1 around here.]

Column 3 introduces the main result of this paper. Now the wage equation is augmented with the (log of) the number of employees of the exact same educational type as the observed individual (as well as a fixed effect for each of the 66 educational types). The coefficient of the log of the establishment size is now reduced to below 1 percent. The coefficient of the log of the group size is a significant 0.012. This means that increasing firm size by increasing the number

of employees of the same type, increases wages significantly *more* than if the increase is only by employees of different types than the observed individual. We may thus reject the null hypothesis of equal effects on wages of our type of labor and other types of labor. Our type counts more.

To see how much more, consider the following exercise: Augment the standard equation by G/(G+N), in stead of the log of G and denote the coefficient for the input share, G/(G+N), as c'. Since such a model implies that

$$dw/dG = w\left[\frac{b}{G+N} + \frac{c'}{(G+N)}\frac{N}{(G+N)}\right]$$

while the derivative of w with respect to N is:

$$dw/dN = w\left[\frac{b}{G+N} - \frac{c'}{G+N}\frac{G}{G+N}\right]$$

we have:

(2) $$c' = \frac{dw}{dG}\frac{G+N}{w} - \frac{dw}{dN}\frac{G+N}{w} = \varepsilon_G - \varepsilon_N$$

where ε_i is defined by the last equality. c' may thus be given the following approximate interpretation: Multiplied by 100, it measures the difference in the percentage effects on wages of doubling the establishment size, when the establishment increases with the *same type* as the one who's wage we observe, compared to the effect of doubling establishment size by increasing the employment of workers of *other types.* The point estimate c' (see model 2 of table A2 in the appendix) is 0.028, indicating that the employer-size-effect on your wages *is almost 3 percentage points larger if the establishment grows involving only your type*, compared to growth that only involves other types. The establishment size effect along a ray in the input diagram, is 1.9, which is of course the effect of increasing both types of labor proportionally.

The next three models of Table 1 give results from the panel of employees. We have 152 064 observations over 9 years of the sample of 26 219 employees from 1995. This data set enables us to sweep out all individual heterogeneity by controlling for individual fixed effects.

Model I and II both give an employer size effect of 1.5 percent. The (slight) reduction from 0.019 to 0.015 indicates positive sorting among individuals: the more productive workers are in larger establishments. However, this effect is not sufficient to "kill" the employer size effect. Once introducing group size effects, however, more than half of the remaining establishment size effect disappears. This skill-group size effect of 1.2 percent remains constant even after introduction of the full set of individual fixed effects.

5. Demand and Supply

Obviously, we observe here points in the price*X*quantum diagram, and may fall into the classical identification trap. However, as noted by others in the context of the firm- or establishment size effect, the bias introduced from the demand side goes in the opposite direction, adding to the strength of our argument, rather than weakening it. This point is clearly valid also in our setting, with different types of input. In order to see this point clearly, consider the following illustrative analysis involving both a supply and demand curve for each establishment:

Let the firm's revenue be given by the two-factor, CES production function:

$$Y = A[a(\gamma G)^{\rho} + (1-a)(\eta N)^{\rho}]^{\frac{1}{\rho}} \tag{3}$$

where again G is the number of employees in "our" group and N is the number of workers of the other type. a is a technology parameter representing the share of workers of each type, while γ and η represent productivity parameters for each type. $\sigma = 1/(1-\rho)$ is then the constant elasticity of substitution between the productivity units of the two types of labor.

Assume now that each establishment faces an upward sloping supply curve for each type of labor:

$$G(W_G) = S_G W_G^{\frac{1}{\varepsilon}}, \qquad N(W_N) = S_N W_N^{\frac{1}{\varepsilon}}$$

where S_i is a supply parameter for each group (for instance total labor supply divided by the number of firms in the economy, appropriately normalized) and $1/\varepsilon$ is the elasticity of labor supply for each type. ε is a measure of frictions in the labor market. As ε approaches zero, the elasticity of labor supply to any one firm approaches infinity. For simplicity ε is assumed constant across establishments and types of workers in this discussion.

Profits is given by: $Y[G(W_G), N(W_N)] - G(W_G)\, W_G - N(W_N)\, W_N$ and the establishment chooses wages to maximize profits. From the first order conditions we obtain: $Y'_i = W_i (1+\varepsilon)$ for each type of input. This gives the following relationship between relative wages and relative demand in each establishment:

(4) $$\frac{W_G}{W_N} = \frac{a}{1-a}\left(\frac{\gamma}{\eta}\right)^{\rho}\left(\frac{G}{N}\right)^{-\frac{1}{\sigma}}$$

Relative supply facing each firm is:

(5) $$\frac{W_G}{W_N} = \left(\frac{S_N}{S_G}\frac{G}{N}\right)^{\varepsilon}$$

Let ω be log relative wages: $\ln (W_G/W_N)$. Consider now the following stochastic specification of the model:

(6) $$\omega = \ln\left(\frac{a}{1-a}\right) + \rho \ln\left(\frac{\gamma}{\eta}\right) - \frac{1}{\sigma}\ln\left(\frac{G}{N}\right) + u = \alpha - \frac{1}{\sigma}\ln\left(\frac{G}{N}\right) + u$$

and

$$\omega = \varepsilon \ln\left(\frac{S_N}{S_G}\right) + \varepsilon \ln\left(\frac{G}{N}\right) + \nu = b + \varepsilon \ln\left(\frac{G}{N}\right) + \nu \quad (7)$$

where u is an error term in relative demand, while v is an error term in the relative supply equation.

What do we get when we estimate an OLS regression of log wages with respect to log relative factor use? Treating α and *b* as constants (or allowing for differential intercepts between different types of establishments) and assuming that u and v are independent, we obtain the following probability limit of the slope estimator (β) (see e.g., Green 1993):

$$p\lim \beta = \theta\varepsilon - (1-\theta)\frac{1}{\sigma} \quad (8)$$

where $\theta = \frac{\sigma_v}{\sigma_v + \sigma_u}$.

Thus, we find that the estimated coefficient of relative factor utilization is a weighted sum of the friction parameter, ε and minus the inverse of the elasticity of substitution, σ. $1/\sigma$ is a positive number, since the firm demands relatively more of a given type of workers if the relative wage of that type declines. Since $1/\sigma$ enters negatively, it is evident that the bias in the estimate of ε arising from endogeneity of factor utilization, is downward. This means that the estimated elasticity of labor supply is smaller than the true elasticity, and perhaps more important; the test against the benchmark competitive model is unnecessarily strong, since the potential bias from the demand side works against rejection of the null.

So what is our estimate based on the above model? In model 3 and 4 in appendix A2, we report from a model of log wages including the log of total employment as well as the log of relative factor utilization (the number of workers of the same type as the unit of observation divided by the number of workers of other types than that of the unit of observation). Considering for now workers of

other types, N, as one composite labor type, we may derive the following expected log relative wage from this regression model:

$$E\left[\ln\left(\frac{W_G}{W_N}\right)\right] = \Delta A + 2B\ln\left(\frac{G}{N}\right) \quad (9)$$

where B is estimated conditional on total factor use (G+N). Consider now the benchmark case of competitive wages. Each establishment faces an infinitely elastic labor supply and ε=0. In this case, $\Delta A = \ln\left(\frac{a}{1-a}\right) + \rho\ln\left(\frac{\gamma}{\eta}\right)$ and $B = \div 1/2\sigma$.

In model 4 of Table A2, B is estimated to 0.009, which in this case gives an estimated elasticity of substitution of less than ÷55 between the two types of workers. This is an unreasonable result, and in the two input case, not consistent with standard assumptions from production theory. Hamermesh (1993) reports a host of positive estimates of σ. Autor, Katz and Kearney (2005) use US data from 1963 to 2000 to estimate an elasticity of substitution of 1.66 between high-school and college educated workers.

We do not, of course, claim that our estimate here represents an attempt to put a number on the elasticity of substitution, σ. Quite on the contrary, our results shows that there has to be frictions in the market which again gives the firms an incentive to climb along the supply curve. By controlling for industry, sector, time, and educational type, we believe that we have controlled for a large part of the variation in demand, which means σ_u is small relative to σ_v and consequently, that the estimated coefficient should be close to the supply elasticity. Furthermore, by including time and educational type dummies, we have controlled for most changes in the *aggregate* market supply of each type of workers as well, leaving us with an estimate of ε facing each firm.

To sum up, the endogeneity bias potentially arising from optimal factor utilization on part of firms represent a counter-effect to that of the estimated labor

market friction parameter on the supply side, ε. The test against the frictionless labor market is strengthened. By controlling for industry, time, sector and educational type, we believe that we have captured important parts of variation in relative demand.

6. Relative bargaining power?

We may reject the benchmark competitive model of equal wages across establishments as well as the standard firm-size effect on wages. But there may of course be other causes behind our group size effect than the labor supply story. An immediate candidate is one of relative bargaining power within the establishment. As shown by Moene (1988), the outcome of bargaining depends crucially on the loss workers may impose on the employer during a conflict. One could easily argue that a large group may impose a larger loss on the establishment in case of a conflict, which again could be reflected in higher relative wages, even without any labor supply considerations. Since large parts of the wage contracts in Norway are union contracts, we may test for this effect by using information on union membership within each group in the establishment.

Consider the following formal model, where we abstract from labor demand and supply effects by assuming a given number of employees. Assume that the firm bargains with every group of workers separately. Consider the bargain for one group. Let $A=(1-u)\overline{W}$ be the alternative outside option for employees and assume that the union cares about its' rent above alternative wages (W-A). Let R be the firm's revenue net of all other costs than wages to our group. Let *m* be the fraction of employees in our group that are union members[5]. In case of a conflict over the union contract, the loss incurred on the firm is assumed to be given by $\lambda R m^{\gamma}$, which means that operating profits during a conflict with our

[5] Barth, Naylor and Raaum (1999) show that for establishments with local bargaining, union density is what matters for wages. Once controlling for union density of the establishment, the individual union membership effect disappears, indicating that the set up here, where union workers also determine the wages of non-union workers within the same group is appropriate.

group is: $R - \lambda R m^{\gamma} - W_N N$. γ measures the sensitivity of the loss to membership share. The Nash product is given by:

$$\Gamma = \left\{ [U - A]^{\beta} [R - GW - R(1 - \lambda m^{\gamma})]^{1-\beta} \right\} \tag{10}$$

Maximizing Γ with respect to wages give:

$$W = \beta \frac{R}{G} \lambda m^{\gamma} + (1-\beta)A = \frac{\beta\lambda}{1-(1-u)(1-\beta)} m^{\gamma} \frac{R}{G} \tag{11}$$

where the last equality is derived as follows: In equilibrium, $W = \overline{W}$. Inserting this condition into the first equation and solving for W gives the last equation. Taking log gives:

$$w = \ln\left(\frac{\beta\lambda}{1-(1-u)(1-\beta)} \right) + \ln(\frac{R}{G}) + \gamma \ln(M) - \gamma \ln(G) \tag{12}$$

where the first term is a group specific constant term, the next term is declining in G, the next term is the membership effect on wages and the last term is another negative term for G, reflecting lower bargaining strength for our group at a given level of membership.

If the bargaining story is correct, we would expect to observe a positive relationship between the number of union members in our group and their wages. *More importantly, we would expect the sign for ln(G) to become negative or zero once we introduce membership into the equation.* This is what we test in table 2.

[Table 2 around here]

Because our model here concerns bargaining, we limit the sample in this section to workers in establishments where there is a union present for own group. We control both for union membership of own group workers as well as union membership among the other types of workers at the establishment. In column 1 we find no effect of union membership among other groups, and even a negative effect of union membership among own group on wages. The group-size effect is strong and the establishment size effect remains very small. In the next two columns we limit ourselves to the wages of union members. Now we find a positive effect of union membership (1 percent other groups, 1/2 percent own group) as we expected from the bargaining model, but the group size effect remains (1,3 percent) and the firm-size effect even turned negative(!). The third column reports from a model where we pool union membership and consider the elasticity of wages with respect to the total establishment union membership. The elasticity of union membership is .011, (a doubling of membership increase wages by 1 percent, given the number of employees). This model gives almost identical results to the former model; and we particularly note that there is a significant group size effect on wages while the establishment size effect is negative and insignificant. The introduction of different measures of relative bargaining strength does virtually nothing to reduce the observed group size effect, even if the bargaining variables performs reasonable, at least for the sample of union members.

The next three columns report the same specifications from the panel data, including individual fixed effects as well. What changes when we introduced individual fixed effects are the coefficients for union members versus the coefficients for employer size. With control for individual heterogeneity, it turns out that we obtain a large positive effect of the number of union members within the establishment, 4.7 percent in the restricted model (III), while the establishment size effect is drops to a significant and very large negative effect. An inter-pretation of this result is that we have positive sorting into large establishments (conditional on the number of union members), while we have negative sorting into high-union density establishment (conditional on establishment size). Since

we do not control fully for all establishment specific heterogeneity, we are somewhat reluctant to conclude too firmly on the division between the effect of the number of union members versus the number of employees at this stage.

The main result, however, is completely unaltered by the introduction of individual fixed effects; - even with careful control for relative bargaining power and establishment size, the skill-group size of wages remains stable and significant at about 1.2 percent.

7. Individual and establishment specific heterogeneity

In this section we control fully for both individual and establishment specific fixed effects. This is a rather data-demanding exercise, and we have chosen to limit our sample to three types of workers, (unskilled workers, business economists and engineers) and a specific region of Norway (which includes the capital and comprise about 1/3 of the population in Norway). This enables us to use establishment dummies in within-individual regressions. This exercise effectively sweeps out all individual and establishment specific heterogeneity. Regressions are done for each group separately, and *the estimated establishment coefficients are used as our wage measure* in this section. We thus have a measure of the establishment's wage policy towards this type of employees rinsed for all individual effects as well as observed time-varying variables. We call this the wage premium of each establishment.

In table 3 we present the results from several OLS regressions of the establishment's wage premium on different measures of establishment and group size. We have observations from 10 347 establishments from these three groups.

[Table 3 around here]

In model 1 we establish that there is an establishment size effect in our data. We note that it is now considerably smaller, below 1 percent, but still significant. Controlling for sector, industry and region brings the coefficient down to .006. Note that in this data, the correlation between establishment size and group size is

expected to be smaller than in the representative sample, where the correlation between group size and firm size is enhanced by the fact that there will be more people from types within the establishments that comprise a larger part of the establishment. *A drop in this coefficient is thus expected if the real reason behind the establishment size effect is group size effects*.

In model 3 we introduce group size into the equation. The coefficient exactly the same as the one observed in several specifications in the previous sections. Furthermore, the coefficient for log establishment size effectively disappears.

This is also the result in model 4 where we allow for differential group effects between the three groups. This model does not seem to perform better than model 3. In model 5 we report figures where we allow both the establishment size effect and the group effect to vary across groups. Now, the group coefficient for unskilled workers drops to zero and the effect is shifted towards the establishment size effects. Note, however, that the model does not perform particularly better than the restricted model. One reason for this, is that there is a very high correlation between group size and establishment size for unskilled workers (0.73!vs. 0.40 and 0.55) and it is thus very difficult to actually pin down the net of the effect for this group. We thus do not rely that much on this result for this group. The other is that this group is the most diverse among our types, and may actually not represent a common labor market. For both other groups, the results remain the same. All in all, the results are highly supportive of the main conclusions in this paper. Even with control for full individual and establishment fixed effects, the establishment effect disappears and we observe a significant group size effect on wages.

8. Conclusion

The unexplained establishment size effect on wages turns out to be a “skill-group size effect” on wages. The more employees of the same educational type that work in the establishment, the higher is the wage of this particular group of

workers. The group size effect is about 1.2 percent in our data. Given group size, the number of employees of other types has small or negligible effects on the wage.

This observation particularly rules out two types of explanations of the firm- or establishment size effect on wages: Explanations based on product market considerations and explanations based on organizational control. The most relevant remaining explanation is a turnover model, or that an establishment de facto faces an upward sloping supply curve for labor even in large labor markets with many firms. This explanation would imply exactly the observed outcome, namely that the establishment size effect turns out to be a skill-group size effect.

Even if we claim that the "unexplained" establishment size effect arises from a correlation between establishment size and group size, we do not claim that all establishment size effects arise from this source. We have taken care to control for a host of human capital variables as well as other fixed individual productivity effects in addition to type- industry and region specific effects, all of which may be related to establishment size.

We have taken particular care to discuss two potential problems or candidates for other explanations of the group size effect. First we have illustrated that a production function explanation from the demand side rather strengthens our argument that what we observe is a supply side feature. A demand side interpretation of the coefficient would be one of a pervasively negative elasticity of substitution, which is not likely. The second alternative candidate to explain a group size effect on wages is internal bargaining power. We use the size of unions within the firm as a measure of bargaining power. Controlling for the relative strength of the union of own type does not weaken our results with respect to establishment- versus group size effects.

There are some caveats, of course. One is that we have assumed a constant group size effect throughout even if there is no reason to believe that the group size effect on wages should be constant across establishments or different parts of the labor market. In fact, the theory of dynamic monopsony predicts different elasticities of labor supply for different establishments, depending on how dense

the wage offer distribution is in the immediate surroundings of the establishment. We leave this issue for future research. Furthermore, the correlation between establishment size and the group size of the establishment, which give rise to the "spurious" establishment size effect, differs between groups of establishments. All in all, this means that we should expect that the relationship between establishment size and group size to turn out differently in different data sets.

We have found remarkable stable results for Norway from this period. It is our conjecture that one will find the following result also in data from other countries: Increasing establishment size by employing more workers of the same skill-type as the observed individual, have a greater effect on individual wages than increasing establishment size by employing more of other types of workers.

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Appendix

[Table a1 around here]

[Table a2 around here]

Table 1. Establishment-Size- versus Group-Size-Effects on Wages.

Dependent variable: Log daily-earnings.

	Cross section data			Panel data		
	I	II	III	I	II	III
Log Establ. Size	0.029*	0.019*	0.008*	0.015*	0.015*	0.006*
	(0.0007)	(0.0007)	(0.0012)	(0.0009)	(0.0010)	(0.0015)
Log Group Size			0.012*			0.012*
			(0.0012)			(0.0014)
Region, sector and industry dummies (77)		Yes	Yes		Yes	Yes
Educational type (66)			Yes			
Individual fixed effects (26 219)				Yes	Yes	Yes
R-square	0.531	0.572	0.583	0.845	0.846	0.847
N	92 948	92 948	92 898	152 064	152 064	152 064

Note: All models include 6 year dummies, (years of education, years of experience and its square, years of seniority, short- and long-part-time dummies) *X* Gender.

Table 2. Controlling for bargaining power.

Employees in establishments with union presence for own group.

Dependent variable: Log daily-earnings.

	Cross-Section Data			Panel Data		
	Union present	Union Members		Union present	Union Members	
Log Group Size	0.022*	0.013*	0.013*	0.008*	0.012*	0.012*
	(0.0035)	(0.0052)	(0.0052)	(0.0032)	(0.0044)	(0.0018)
Log Union members. All employees			0.011*			0.047*
			(0.0043)			(0.0043)
Log Union members. Other types	-0.000	0.010*		0.016*	0.030*	
	(0.0037)	(0.0034)		(0.0025)	(0.0034)	
Log Union members. Same group	-0.008*	0.005		0.005z	0.006	
	(0.0030)	(0.0047)		(0.0027)	(0.0041)	
Log Establ. Size	0.006z	-0.007	-0.006	-0.014*	-0.032*	-0.043*
	(0.0036)	(0.0044)	(0.0046)	(0.0035)	(0.0045)	(0.0047)
Individual fixed effects				22 384	18 538	18 538
R-square	0.590	0.579	0.579	0.852	0.848	0.848
N	75 485	60 063	60 063	122 938	101 172	101 172

Note: All models include 6 year dummies plus (years of education, years of experience and its square, years of seniority, short- and long-parttime dummies) *X* Gender in addition to region, industry and educational type dummies (14x dummies).

Table 3. Establishment- and Group-Size Effects on Wages.

Panel of three types.

Dependent variable: Type- Specific Establishment Wage Premium (logs).

	Model 1	Model 2	Model 3	Model 4	Model 5
Log (Est. Size)	0.008*	0.006*	-0.000	-0.000	
All Employees	(0.002)	(0.002)	(0.003)	(0.003)	
Log (Est. Size)					0.017*
X unskilled					(0.005)
Log (Est. Size)					-0.008*
X economists					(0.004)
Log (Est. Size)					-0.010z
X engineers					(0.005)
Log (Group Size)			**0.012***		
			(0.003)		
Log (Group Size)				0.014*	-0.001
Unskilled				(0.004)	(0.005)
Log (Group Size)				0.008z	0.014*
Economists				(0.004)	(0.005)
Log (Group Size)				0.017*	0.022*
Engineers				(0.006)	(0.007)
Sector/Industry/Region		65	65	65	65
Dummies					
Adj. R sq (**)	0.500	0.559	0.560	0.560	0.561
N (Establishments)	10347	10347	10347	10347	10347

Note: Establishment Wage Premium are the coefficients from the establishment dummies in individual regressions conducted for each type separately, including human capital and individual fixed effects in a panel of all employees of this type in 1995 observed from 1989 to 1997. The regressions include dummies for type and year. (**) The level of Rsq is exaggerated because the type dummies take out differences in reference type as well (normalization).

Table A1. Descriptive statistics

	Cross-Section Data		Panel Data	
	Mean	Std. dev.	Mean	Std. dev.
Log daily wage	6.3200	0.4502	6.3515	0.4367
Log Union members. All employees	4.4053	1.6773	4.4105	1.6777
Log Union members. Other types	4.1227	1.8082	4.1244	1.8064
Log Union members. Same group	2.3695	1.6480	2.3854	1.6580
Short part-time	0.1104	0.3134	0.0994	0.2992
Long part-time	0.1093	0.3112	0.1061	0.3080
Woman	0.4845	0.4998	0.4728	0.4993
Experience	29.7743	12.1092	28.4544	10.4053
Experience^2	1033.1400	769.7827	917.9232	610.8630
Seniority	6.2357	5.9411	6.2618	5.7995
Woman X seniority	2.7505	4.6625	2.7005	4.5948
Woman X short part-time	0.0930	0.2905	0.0845	0.2782
Woman X long part-time	0.0978	0.2970	0.0950	0.2932
Woman X experience	14.6189	17.2998	13.6680	16.1317
Log Establishment Size	4.7260	1.5852	4.7257	1.5877
Log Group Size	2.6582	1.5799	2.6667	1.5946
Group Size/Establishment Size	0.1952	0.1701	0.1973	0.1717
Log (Group Size/Others size)	-1.8198	1.2670	-1.8075	1.2729

	Panel of three types	
	Mean	Std. dev.
Establishment's wage premium	-0.0845	0.3075
Economist establishment	0.4124	0.4923
Engineer establishment	0.1370	0.3438
Log Establ. Size – all employees	3.8017	1.0715
Log (Est. Size) X unskilled	1.0064	1.2683
Log (Est. Size) X economists	0.6343	0.9410
Log (Est. Size) X engineers	0.1673	0.5373
Log (Group Size)	1.8079	0.9783
Log (Group Size) - Unskilled	1.6803	1.9754
Log (Group Size) - Economists	1.5497	1.9726
Log (Group Size) - Engineers	0.5718	1.5025

Table A2. Establishment- and Group-Size Effects on Wages.

	Cross section data			
	I	II	III	IV
Log Establ. Size	0.021*	0.019*	0.022*	0.019
	(0.0007)	(0.0007)	(0.0008)	(0.0007)
Group Size/ Establ. Size		**0.028***		
		(0.0076)		
Log Group Size/ Others Size			0.0059*	**0.009***
			(0.0009)	**(0.0010)**
Region, sector, industry dum. (77)	Yes	Yes	Yes	Yes
Educational type (66)				Yes
R-square	0.576	0.586	0.576	0.583
N	92 948	92 948	92 898	92 898