WAGE EFFECTS OF FIRM SIZE: EVIDENCE FROM LINKED EMPLOYER-EMPLOYEE PANEL

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Abstract

This study explores the relationship between wages and firm size using large registered data and different identification strategies. We find that the effect of firm size on wages is negligible when worker and firm characteristics are accounted for. The findings are robust across identification strategies and numerous covariates. The findings are also consistent with the view that coordinated wage-setting systems narrow wage distributions.

JEL classification: J31

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1. Introduction

Empirical and theoretical research on the relationship between wages and firm size has provided two main conclusions. First, wage differentials between small and large firms are substantial and pervasive, and, second, the firm-size wage premium arises from the labour market, the product market, or both. Typically, doubling the firm size increases wages by 4–6 per cent. Controls for certain worker characteristics (such as human capital) and firm characteristics (such as rent sharing) tend to halve the effect to 2–3 per cent.[1]

This study contributes to the literature in two novel ways. First, large and representative data allow us to identify the firm-size wage effect from different samples with varying identification assumptions: job stayers with a changing firm size, workers moving between firms of different sizes, and the job moves of displaced workers. Second, matched register data provide a rich set of observable covariates on workers and firms, of which some have not been controlled for in previous studies. In addition to conventional controls for human capital and firm characteristics, we control for the existence of profit-sharing schemes, capital intensity, skill group size, compensation for working conditions, effort-related differences in pay, and tightness in the local labour market.

2. Matched data and model

We exploit a 20% sample of private sector wage earners in Finland.[2] The panel data span the 2003–2010 period and include information on 283,757 individuals working in 18,570 firms. The number of unique combinations of workers and firms (job spells) is 384,041, and the total number of observations is 1,162,325. We also employ two subsamples: the first consists of workers changing firms over the investigation period. This sample includes 79,984 different individuals working in 13,832 different firms, with a total of 419,770 wage observations. The second subsample consists of job moves due to firm closures. In this sample, the total number of observations is 11,138, from 2,211 individuals in 1,612 different firms. In these subsamples, the number of unique worker-firm combinations varies from 5,338 to 178,408.

The overall quality of the data is worth noting: firm size is measured as a continuous variable; worker wages are measured on an hourly basis; and the often poorly measured firm heterogeneity can be controlled for by using a number of firm characteristics. Figures 1 and 2 provide two snapshots of the relationship between firm size and wages. Figure 1 describes the average development in wages over the estimation period by four size categories (micro, small, medium and large firms). The mean wage differential between the categories reveals a stable pattern. Figure 2, in turn, describes the variation in hourly wages in firms of different sizes. Fitted values show a very small but positive relation. To prevent identification, we have excluded all firms with more than 10,000 workers. In our estimations, we use a continuous measure (log number of workers in a firm) as the main explanatory variable. The dependent variable is the worker's (log) hourly wage.

We use the linear three-way error-component model (see, e.g., Andrews, Schank, and Upward 2006) and write the standard Mincerian wage equation as follows:

$$(1)\ w_{it} = \boldsymbol{x}_{it}\boldsymbol{\beta} + \boldsymbol{w}_{j(i,t)t}\boldsymbol{\gamma} + \theta_i + \psi_{j(i,t)} + \epsilon_{it}$$

where workers (i = 1, . . ., N) are observed once per period (t = 1, . . ., T) in a firm (j = 1, . . ., J). Because workers can move from one firm to another over time, the function j(i, t) maps worker i to firm j at time t. w_{it} denotes the dependent variable (log wages), and ϵ_{it} denotes a stochastic error term. $\mathbf{x}_{it}$ and $\mathbf{w}_{j(i,t)t}$ are vectors of time-variant observables for workers and firms, whereas θ_i and ψ_j capture corresponding time-invariant unobservables.

1 See, e.g., Brown and Medoff (1989), Groshen (1991), Kruse (1992), Albaek et al. (1998), Idson and Oi (1999), Troske (1999), Arai (2003), Green et. al. (2006), Lallemand et al. (2007), Ferrer and Luis (2008), and Barth and Dale-Olsen (2011).

2 See Appendices 1 and 2 for data and definitions.

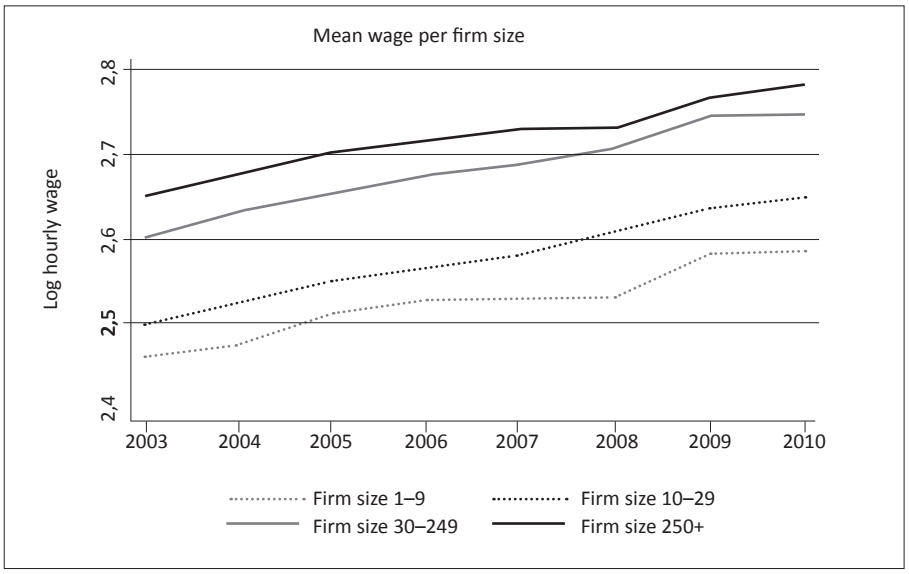

Figure 1. The development of mean hourly wages from 2003–2010 in four firm size categories.

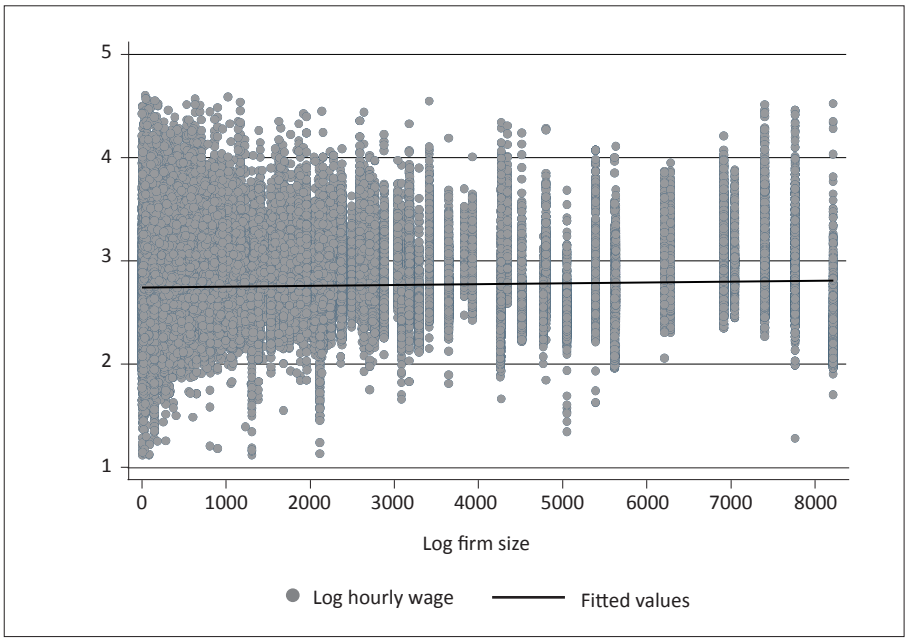

Figure 2. Log hourly wages by firm size in 2010.

3. Results

3.1. Benchmark estimates

The estimates in table 1 provide our benchmark. The OLS estimate without observable controls (column 1) indicates that the firm-size wage premium is rather small in quantitative terms but statistically significant: doubling the firm size relates to a wage increase of 1.9 per cent. Controlling for worker characteristics (column 2) reduces the estimate to 1.4 per cent. The inclusion of observable firm characteristics (column 3) reduces the effect to 0.7 per cent. The premium further decreases to 0.3 per cent when we add individual fixed effects (column 4). This finding implies that unobserved worker heterogeneity (quality, effort) and firm size

are positively correlated. The premium similarly decreases to 0.5 per cent (and loses significance) when we add firm fixed effects (column 5). This finding indicates that unobserved firm heterogeneity (productivity) and firm size are positively correlated. The use of the spell specification (column 6), which combines both effects, increases the estimate to 0.8 per cent. The comparison of the point estimate to those in columns (4) and (5) is not straightforward because, in the spell and firm fixed effects specification, the firm-size effect is identified only by changes in firm size; that is, it does not utilize variation that arises from workers switching firms.

The results in table 1 offer two robust conclusions. First, the firm-size wage premium is statistically significant but modest, as the pure firm-size effect is small when compared with earlier estimates from other European countries; see, e.g., Lallemand et al. (2007) for evidence from five European countries**.** As such, the finding is consistent with the view that coordinated wage-setting systems, such as those in Finland, tend to narrow wage distributions; see, e.g., Wallerstein (1999).[3]

Second, the results imply that the relative importance of observed firm and worker heterogeneity for the firm-size wage effect is substantial. Individual heterogeneity accounts for approximately 40 per cent, and firm heterogeneity accounts for 60 per cent of the estimated decline in the firm-size wage premium.[4] Unobserved worker heterogeneity captured via fixed effects plays a significant role, decreasing the estimate from 0.7 to 0.3 per cent. The findings can be compared with, for example, those of Brown and Medoff (1989) and Scoppa (2014), who show that the firm-size wage differential is reduced by up to 45–50 per cent when worker fixed effects are used, or those of Brunello and Colussi (1998), who report that the firm-size wage premium completely disappears after controlling for observed worker characteristics and selection. Winter-Ebmer and Zweimuller (1999), in turn, conclude that approximately 50 per cent of the firm-size wage premium is due to worker heterogeneity but that it cannot be explained by firm heterogeneity. Similarly, Abowd et al. (1999) find that individual heterogeneity explains approximately 75 per cent of the firm-size wage effect but that the role firm heterogeneity is negligible.

3.2 Firm-size premium and exogenous job moves

The firm size is not exogenously given because a firm's growth may well depend on the quality of its labour; see, e.g., Foster et al. (2008). Thus, it is important to explore the firm-size effect using a model in which the identification is based on workers moving between firms of different sizes. The approach has its drawbacks. First, if job moves are not exogenous, there might be self-selection among workers. For example, low-quality and low-paid workers move to small firms with low profits, and high-quality and high-paid workers move to large firms with high profits (Abowd 1999). This suggests an upward bias of the estimate. Second, the identification of exogenous job moves is difficult. For example, the use of firm closures as an indicator is problematic because the firm identifier bears the potential of measurement error if, for example, a change in firm identifiers may also result from ownership changes. Third, the joint estimation of fixed worker and firm effects becomes cumbersome (Abowd et al. 1999; Barth and Dale-Olsen 2011).

The results from the models using observations of all workers that switch jobs (table 2) and displaced (exogenous) job movers (table 3) provide similar results. The identification of the firm-size effect is based on changes between post-move (t) and pre-move wages (t-1) in firms of different sizes. Uncontrolled OLS estimates indicate a premium that varies from 1.1 per

3 We estimated the model (specification 6) using dummies for four firm size categories, i.e., micro (1-9 employees), small (10-29 employees), medium (30-249 employees), and large (over 250 employees). The results were consistent with the continuous measure as medium and large firms obtained a modest but statistically significant premium over micro and small firms. For medium firms the premium was one percentage points and for large firms two percentage points.

4 The effect of firm heterogeneity is even stronger if we first control for firm observables only. In fact it directly reduces the estimate to 0.003 (0.0002).

Table 1. Estimates of the Firm-Size Wage Effect. The Dependent Variable is Log Hourly Wages. Full Panel (1,162,325 observations).

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Log (firm size)	0.019** (0.0003)	0.014** (0.0002)	0.007** (0.0002)	0.003** (0.0003)	0.005** (0.004)	0.008** (0.0025)
Controls						
*Worker characteristics	-	yes	yes	yes	yes	yes
*Firm characteristics	-	-	yes	yes	yes	yes
*Worker fixed effects	-	-	-	yes	-	yes
*Firm fixed effects	-	-	-	-	yes	yes
R^2_Adj.	0.01	0.57	0.60	0.91	0.70	0.93

*Notes: All specifications include time dummies. Worker controls include age, age squared, gender, occupation, tenure, tenure squared, level and field of education, and form of employment. Firm controls include industry, region, and export status. ** (*) denotes statistical significance at the 0.01 (0.05) level. Standard errors are clustered for workers in columns 1–4, and for firms in columns 5 and 6.*

Table 2. Estimates of the Firm-Size Wage Effect. The Dependent Variable is Log Hourly Wages. All Movers (193,645 observations)*.

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Log (firm size)	0.011** (0.0005)	0.010** (0.0003)	0.002** (0.0003)	0.001** (0.0004)	-0.002 (0.0001)
Controls					
*Worker characteristic	-	yes	yes	yes	yes
*Firm characteristics	-	-	yes	yes	yes
*Worker fixed effects	-	-	-	yes	-
*Firm fixed effects	-	-	-	-	yes
R^2_Adj.	0.01	0.59	0.62	0.85	0.71

*Notes: See Table 1. *Sample consists of observations prior to (t-1) and after (t) job move. In specification 5, where the firm effect is captured by a firm dummy at time t, the number of observations is 249,453.*

cent (table 2, column 1) to 1.5 per cent (table 3, column 1). The inclusion of observable worker characteristics decreases the estimates to 1.0 and 1.2 per cent, respectively. As in the case of the full panel, observable firm controls lower the estimates further to 0.2 (table 2) and 0.6 per cent (table 3). The FE models by workers (column 4) or by firms (column 5) yield similar estimates. In table 2, the premium estimates are close to zero (0.1–0.2 per cent) and are statistically significant (column 4) or insignificant (column 5). The difference in point estimates between table 1 and 2 stems from the fact that voluntary movers tend to make wage gains regardless from the size of the firm to which they move. In table 3, the FE estimates show more variation, from 0.5 per cent (column 4) to 1.1 per cent (column 5). The standard errors are also larger, especially for the firm fixed[5] effects.

The difference in point estimates between table 2 and 3 can be motivated as follows. Sorting of workers (endogeneity bias) would suggest a stronger upward bias in case of voluntary moves which should lead to higher estimates in table 2 compared to table 3. However, many other factors beyond wages (or specifically the firm size-wage premium) can induce a voluntary move. Therefore self-selection is much more prominent for a voluntary compared to an involuntary move (Solon 1988). Displaced workers are under pressure to accept the next job offer. This reduces the possibility to self-select into a firm with specific characteristics (not captured by the observable firm controls).[6]

5 "Note that, in case of firm fixed effects, identification stems only from changes in firm size of those companies from (and to) which workers moved."

6 "We also estimated worker fixed effects, separately for workers who switch from a micro/small to a medium/large firm and vice versa. The estimate is positive (2 respectively 8 per cent) yet not significant.

Table 3. Estimates of the Firm-Size Wage Effect. The Dependent Variable is Log Hourly Wages. Displaced Movers (5,674 observations)*.

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Log (firm size)	0.015**	0.012**	0.006**	0.005*	-0.011
	(0.002)	(0.002)	(0.002)	(0.003)	(0.014)
Controls					
*Worker characteristics	-	yes	yes	yes	yes
*Firm characteristics	-	-	yes	yes	yes
*Worker fixed effects	-	-	-	yes	-
*Firm fixed effects	-	-	-	-	yes
R^2_Adj.	0.01	0.50	0.53	0.75	0.73

*Notes: See table 1. *In specification 5, where the firm effect is captured by a firm dummy at time t, the number of observations is 6,102.*

In sum, the results confirm the findings of the full panel: observed worker and firm characteristics are important in explaining the firm-size wage premium. Furthermore, the possible biases arising from endogenous job moves appear to be modest.

3.3. Robustness

We explore the robustness of the results further by augmenting the model (full panel with worker fixed effects) with additional covariates; see table 4 for the results and the data appendix for definitions. First, we exploit variations in the data, i.e., whether wage bargaining is centralized (coordinated at the national level) or decentralized (conducted at the industry level) and whether a firm has a profit-sharing scheme (Wallerstein 1999; Long and Fang 2012). Thus far, institutionalized profit sharing has not been controlled for by previous studies using linked data. These extensions (dummies and interactions) allow us to evaluate the effects of profit sharing on wages and the firm-size wage premium through the effect of the bargaining mode. Typically, centrally coordinated agreements provide less room for local negotiations regarding firm- or industry-specific benefits or pay increases (Asplund 2007). Second, following Barth and Dale-Olsen (2011), we add skill group size as a covariate. This addition is in line with the dynamic monopsony approach (Manning 2003), which postulates that increased demand for one particular worker category implies higher wages for that group but does not increase wages for other worker categories in the firm. Third, to control for labour market frictions and difficulties in the job-to-job search process (Manning 2011), we augment the model with a well-measured proxy of local labour market tightness, namely, local unemployment measured by the travel to work area and weighted by municipality-level unemployment rates. Fourth, following Arai (2003), we control for the capital intensity of firms. The variable is important, as capital intensity may signal higher product market rents stemming from high barriers to entry due to high fixed costs and, in the presence of unions, may indicate rent extraction and thus higher wages. Fifth, we add dummies that identify compensating differentials that arise from differences in irregular working hours, compensation for on-call and urgent work, or increased compensation based on location and workplace conditions (Lallemand et al. 2007). Finally, we account for effort-related differences in pay across workers, i.e., if a worker's wage contains a performance-based component (Oi and Idson 1999).

The covariates increase the precision of the analysis, and they are in line with previous empirical studies. First, profit sharing at the company level increases wages and, as expected, decreases the firm-size wage premium even further. Second, the effect of the skill group

Table 4. Robustness. The Dependent Variable is Log Hourly Wages.
Full Panel (1,162,325 observations).

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Log (firm size)	0.001**	0.003**	0.002**	0.001**	0.001**
	(0.0003)	(0.0006)	(0.0006)	(0.0003)	(0.0003)
Controls					
*Profit sharing	yes	yes	yes	yes	yes
*Bargaining mode	yes	yes	yes	yes	yes
*Skill group size	yes	yes	yes	yes	yes
*Local tightness	yes	-	-	-	yes
*Capital intensity	-	yes	-	-	yes
*Wage provisions	-	-	yes	-	yes
*Effort pay	-	-	-	yes	yes
Worker fixed effects	yes	yes	yes	yes	yes
R^2_Adj.	0.91	0.91	0.91	0.91	0.91

Notes: See table 1 and Appendix 2 for definitions.

size on wages is positive, though only when bargaining over wages is centralized. Third, tightness in the local labour market affects wages, and wages are more responsive to labour market conditions under decentralized wage bargaining. Fourth, higher capital intensity implies a modest increase in wages, and the effect is stronger when bargaining over wages is centralized.[7] Most importantly, the inclusion of additional measures to capture heterogeneity across workers and firms corroborates the main conclusions: the firm-size effect on wages remains modest, even negligible.

4. Conclusions

Our analysis provides two main conclusions. First, the firm-size wage effect is statistically significant but modest when we account for worker and firm characteristics. Individual heterogeneity accounts for approximately 40 per cent, and firm heterogeneity accounts for 60 per cent of the estimated decline in the firm-size wage premium. This finding is robust across alternative identification strategies and for a large number of controls. The inclusion of covariates that describe profit sharing, bargaining modes, labour market tightness and working conditions further decreases the firm-size effect on wages. Thus, our study is among the few that can explain the commonly detected firm-size wage premium. Second, our empirical findings are consistent with the view that countries with coordinated wage setting tend to have narrower wage distributions.

7 See Pehkonen et al. (2017) for more detailed results.

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Appendix

Appendix 1. Matched Employer-Employee Data for Finland, 2003–2010.

Sample	*Workers N*	*Firms J*	*Spells J*	*Rows N**
Full panel	283,757	18,570	384,041	1,162,325
All movers	79,984	13,832	178,408	419,770
Displaced movers	2,211	1,612	5,338	11,138

Appendix 2. Variable definitions

Wages: Total monthly earnings include supplements based on location and workplace conditions; performance-based pay components for salaried employees; wage earner performance-based earnings; taxation values for fringe benefits; earnings for extra and overtime work; eventual compensation for on-call or urgent work; other irregularly paid supplements; and pay for working hours not worked.
Firm size: the number of employees.

Worker characteristics:
Age and age squared (Age, Age^2): age.
Tenure and tenure squared: years of employment in the firm.
Occupation: 25 categories, ISCO 2-digit classification.
Education: 9 categories, ISCED 1997 classification.
Field of Education: 9 categories (General Education; Teacher Education and Educational Science; Humanities and Arts; Social Sciences and Business; Natural Sciences; Technology; Agriculture and Forestry; Health and Welfare; Services; Other).
Form of employment: dummy (full time = 1, part time = 0).

Firm characteristics:
Regions: 18 regions, NUTS2 classification.
Industry: 12 categories, NACE 1-digit classification.
Firm's export status: dummy (exports = 1).
Firm's legal status: dummy (limited company = 1).
Firm's ownership: dummy (public majority = 1).

Additional controls:
Profit-sharing scheme: dummy (yes = 1).
Skill group size in firm: 81 groups (9 education levels and 9 education fields).
Local tightness: unemployment rate measured by the travel to work area (82 areas) and weighted by municipality-level unemployment rates (445 municipalities).
Capital intensity: physical capital (in euros) per worker (number of employees) in a firm.
Wage provisions: dummy (worker has received overtime pay; additional compensation based on location and workplace conditions; on-call compensation = 1, otherwise 0).
Effort-based pay: dummy (worker has received performance-based pay component = 1, otherwise 0).
Degree of centralization in bargaining: dummy (centralized =1, otherwise 0).