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Decomposing the Large Firm Wage Premium in Germany

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Contents

List of Figures

List of Tables

Abstract

We use an extensive, matched employer-employee dataset to analyze the employer-size wage relation and its contribution to wage inequality in Germany. Applying models with additive fixed effects for workers and establishments, we document that the large firm wage premium, which has risen over 25 years, has only recently started to decrease. Our estimates show that the recent decline is due to a decrease in the variation of establishment-specific wage premiums both across establishment size groups and within. This decline together with decreasing worker segregation at small firms account for an overall reversal in the trend of increasing wage dispersion.

Zusammenfassung

Wir nutzen einen umfangreichen Datensatz, der Informationen zu Arbeitsverhältnissen zwischen Arbeitnehmern und Arbeitgebern enthält, um den Zusammenhang von Firmengröße und Löhnen und dessen Einfluss auf die Lohndispersion zu untersuchen. Wir verwenden dazu Modelle, die für unbeobachtbare Charakteristika beider Marktseiten kontrollieren. Wir dokumentieren, dass das Lohnpremium, das Arbeitnehmer bei großen Firmen erhalten, über 25 Jahre anstieg. In den letzten Jahren ist jedoch ein Rückgang zu beoabachten. Unsere Schätzergebnisse zeigen, dass für diesen Rückgang hauptsächlich rückläufige, betriebsspezifische Lohnunterschiede sowohl zwischen als auch innerhalb bestimmter Größenklassen ursächlich sind. Außerdem ist zu beobachten, dass sich kleine Betriebe in ihrer durchschnittlichen Arbeitnehmerzusammensetzung angleichen. Diese Entwicklungen tragen dazu bei, dass die Lohndispersion in Deutschland in den letzten Jahren leicht rückläufig ist.

JEL

J00, J21, J31, J40

Keywords

firm size, wage inequality, wage premiums, fixed-effect wage models, firm and worker heterogeneity

Acknowledgement

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1. Introduction

The large firm wage premium (henceforth LFWP) has long been recognized as one of the major differentials in the labor market and has been documented for many countries (Brown/Medoff, 1988; Colonnelli et al., 2018). Bloom et al. (2018) show that in the US, the LFWP has substantially declined over the last 30 years. A closely related literature emphasizes the role of firms in wage inequality, in particular large firms (Song et al., 2019).

Our paper analyzes the employer-size wage relation and its role for wage dispersion in Germany over the last 30 years. We use extensive linked employer-employee data and apply wage regressions in the spirit of Abowd/Kramarz/Margolis (1999) (henceforth AKM) to decompose the LFWP into observable and unobservable wage components. Our goal is to isolate the key drivers of wage inequality both between and within firm size groups.

The novel findings are at least threefold: First and in contrast to the US, the LFWP in Germany has increased from the mid 80s to 2010. Since 2010, however, the LFWP did not further increase and even declined slightly.[1] Our decomposition reveals that this recent decline is mostly due to a weaker link of establishment-specific wage premiums and size which we observe across all size groups and industries.

Second, the recent decline in the LFWP goes along with a reversal of the trend of increasing wage variation. When we partition establishments in size deciles, we find that this decrease happens mostly within size groups, also almost only driven by less dispersed establishment-specific wage premiums.

Third, when we zoom in size deciles and look at the most recent changes, we find that the decline in overall wage variance is predominately driven by the lowest size decile. Within the group of very small establishments, we observe decreasing worker segregation, less dispersed establishment wage premiums, and increasing sorting. For the highest size decile, we observe increasing worker segregation, less pronounced dispersion in establishment wage premiums, and increasing sorting, leading to higher overall wage dispersion.

2. Methodology

We estimate two-way fixed effect wage regressions in the spirit of AKM for five overlapping time intervals reaching from 1985 to 2017. By assumption, the individual's log real daily wage y_{it} is an additive separable function of the time-invariant worker fixed effect α_i, the establishment fixed effect $\psi_{J(i,j)}$, an index of time-varying observable characteristics $x'_{it}\beta$, and an error component r_{it}:[2]

$$y_{it} = \alpha_i + \psi_{J(i,j)} + x'_{it}\beta + r_{it}. \tag{1}$$

[1] In a descriptive manner, the difference in (employment-weighted) mean wages between the largest and the smallest establishments increased from 60 to 83 percent (see Figure C.2 in the Appendix).

[2] As in CHK, we include an unrestricted set of year dummies as well as quadratic and cubic terms in age fully interacted with educational attainment in x_{it}. We normalize the age variable around 40 years. See Card et al. (2018) and Song et al. (2019) for a discussion.

We estimate equation 1 on the largest connected set of establishments, that is, all establishments that are linked through worker transitions. Establishment fixed effects are hence estimated relative to a reference establishment in each time interval.
To evaluate the relationship between establishment size and wages, we then regress log real daily wages on establishment size:

$$y_{it} = \gamma size_{J(i,j)} + \eta_{it}, \tag{2}$$

where $size$ is the log of the number of all full-time workers in the year the worker i is employed in establishment j, and η_{it} is an error term. We further decompose γ by separately estimating all additive separable AKM components on the establishment size, as in Bloom et al. (2018). Furthermore, we follow Card/Heining/Kline (2013) (henceforth CHK) and decompose the variation in wages across and within establishment size deciles:

$$\begin{aligned} Var(y_{it}) = Var(\alpha_i) + Var(\psi_{J(i,j)}) + Var(x'_{it}\beta) \\ +2Cov(\alpha_i, \psi_{J(i,j)}) + 2Cov(\psi_{J(i,j)}, x'_{it}\beta) \\ +2Cov(\alpha_i, x'_{it}\beta) + Var(r_{it}) \end{aligned} \tag{3}$$

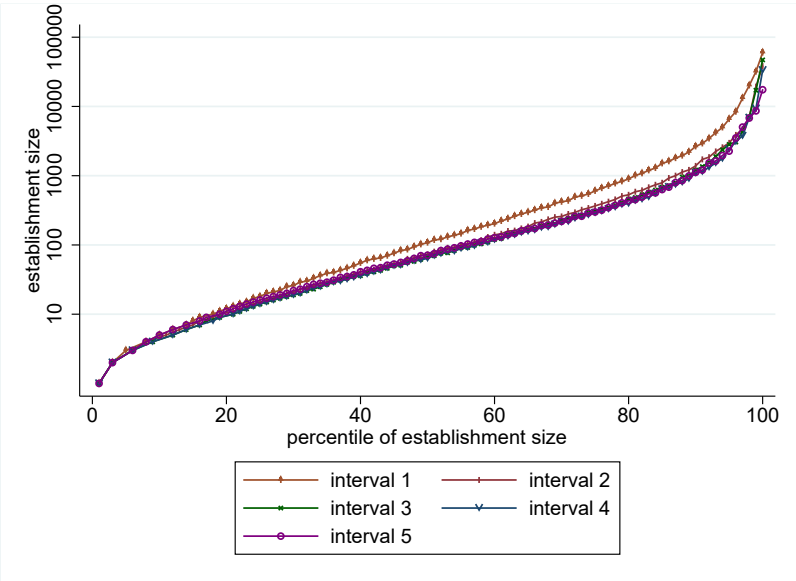
3. Data

We use the IAB employee history file (BeH) for Germany from 1985 to 2017. The administrative data contain information on employment, total earnings, education, job and industry, among other things. They cover the majority of the German workforce, only excluding civil servants and the self-employed. Each worker and each establishment has a unique identification number, which allows us to follow workers over time and from one establishment to another. For our data preparation, we largely follow CHK: We start with the universe of employment histories and then restrict the sample to full-time employees to account for the fact that we do not observe working hours. We restrict the sample to workers aged 20 to 60. For each worker, we identify the main job in a given year, that is the job with the highest total wage sum (including bonus payments). Wages above the social security contribution threshold are imputed.[3] We estimate the AKM model in five overlapping time intervals for both females and males: 1985-1992, 1993-1999, 1998-2004, 2003-2010 and 2010-2017. The first interval covers only former West Germany, the subsequent intervals include both Eastern and Western Germany.
Figure 1 shows the employment-weighted establishment size distribution across the time intervals. Our measure of establishment size refers to our sample restrictions, that is full-time workers aged 20 to 60. 50 percent of all workers are at establishments which employ less

[3] We follow the procedure suggested by Dustmann/Ludsteck/Schönberg (2009) and CHK and impute the upper tail of the wage distribution by running a series of Tobit regressions, allowing for a maximum degree of heterogeneity by fitting the model separately for gender, time, education levels, and eight five-year age groups. We impute missing and inconsistent information in the education variable using the methodology proposed in Fitzenberger/Osikominu/Völter (2006).

than 100 workers. After the reunification (interval 2), the establishment size distribution is rather stable. Table A.1 in the Appendix shows detailed statistics on the establishment size distribution across time.

Figure 1: Cumulative establishment size distribution (employment-weighted)



Note: Establishment size is measured as the number of full-time workers aged 20 to 60. Source: BeH.

4. Results

4.1. AKM estimation

Table 1 highlights four important results from the estimation of the AKM model. First, for intervals 1 to 4, our results are qualitatively similar to CHK: the dispersion of wages increased from a combination of rising heterogeneity between workers, rising dispersion in the establishment wage premiums, and more sorting of high wage workers to high wage establishments. Second, in the most recent years this trend has stopped and wage dispersion declined. Third, while the variability of both unobservable and observable worker components further increased, we observe that the increase in the dispersion of establishment effects has stopped and declined. Fourth, the positive correlation between the person and establishment effects increases substantially, from 0.15 in interval 1 to 0.33 in interval 5.

4.2. LFWP

Table 2 shows the estimated LFWP (recall equation 2). The estimation reveals that from interval 1 to 4 the coefficient of log wage increased, indicating that an increase in establishment size by 1 percent goes along with an increase in wages by 0.07 to 0.109 percent. In interval 5 however, we find a decline in the LFWP as the coefficient falls from 0.109 to 0.104. The decomposition of the LFWP into the AKM components shows that the main driver of this decline is a fall in the coefficient of the establishment fixed effect. From interval 1 to 4, the main ingredient of the LFWP was the establishment effect. In interval 5 however, the establishment

Table 1: Summary statistics and AKM parameter estimates

	Interval 1 1985 - 1992	Interval 2 1993 - 1999	Interval 3 1998-2004	Interval 4 2003-2010	Interval 5 2010-2017
Number individuals	28,297,700	32,645,908	30,598,332	29,865,420	30,787,610
Number establishments	1,898,391	2,543,454	2,537,177	2,476,099	2,103,301
% females	33	35	35	35	33
Number person-year obs.	148,036,432	159,913,897	150,178,132	161,433,500	161,468,712
Mean log wages	4.452	4.445	4.466	4.447	4.506
Std. log wages	0.437	0.466	0.506	0.555	0.539
Std. person effect	0.330	0.342	0.368	0.391	0.406
Std. establ. effect	0.183	0.219	0.239	0.268	0.220
Std. xb	0.127	0.066	0.079	0.081	0.111
Correl. person establ. effects	0.146	0.221	0.236	0.260	0.326
RMSE	0.120	0.118	0.125	0.133	0.133
Adjusted R^2	0.924	0.937	0.939	0.943	0.939

Notes: Sample consists of full-time female and male workers in the connected set, aged 20-60, in their main job. Daily wages are imputed using Tobit models. Source: BeH.

has been superseded by the person effect in contributing to the LFWP. The increasing person effect coefficient suggests that over time, more and more high wage workers sort into large establishments. This development attenuates the decline of the LFWP. Table B.2 in the Appendix shows that this attenuation effect is more important for males than females. Table B.1 in the Appendix shows that all of these results stem from both the Eastern and the Western parts of Germany, however slightly stronger in the latter.

Table 2: The large firm wage premium over time

	Interval 1	Interval 2	Interval 3	Interval 4	Interval 5
log wages	0.070	0.081	0.095	0.109	0.104
person effect	0.025	0.032	0.041	0.049	0.056
establ. effect	0.041	0.048	0.053	0.058	0.048
xb	0.004	0.001	0.001	0.002	0.000
residual	0.000	0.000	0.000	0.000	0.000

Notes: Point estimates from regression equation 2. Source: BeH.

Figure C.1 displays how the LFWP is allocated over the establishment size distribution. We observe that the size effect is almost symmetrical around the center. From interval 4 to 5 (Panel b - c), the spread between the establishment component in the lowest and highest establishment size deciles declines.

4.3. Wage dispersion

4.3.1. Wage variance across and within size deciles

In order to quantify how the changes in the LFWP are related to wage inequality, we first decompose the wage variation both across and within size deciles.

The first rows of Table 3 show that, although we observe large differences in mean wages

across size deciles, the main part of the variation in wages stems from within size groups (84 - 86 percent). The total wage variance increased continuously from interval 1 to interval 4 (from 0.193 to 0.308). Surprisingly, however, from interval 4 to 5, the trend in increasing wage variance has stopped. It declines by around 6 percent. This decline originates to one-third from a drop in the between and to two-thirds from a drop in the within size decile wage variation. The rest of Table 3 yields the following key findings: First, for both the between and within size decile variance the person component increased during all intervals, indicating that worker segregation manifests not only across firms as emphasized by CHK, but also across size groups. Second, the main component of the decline in the total variance from interval 4 to 5 is a drop in the variation of the establishment effects both between and, more pronounced, within size groups. Third, a small decline in the covariance of the person and establishment effects between size deciles contributes to the decline in the overall wage variance in interval 5.

Table 3: Between and within establishment size decile wage variation

	interval 1		interval 2		interval 3		interval 4		interval 5	
	Comp.	Share	Comp.	Share	Comp.	Share	Comp.	Share	Comp.	Share
Total variance	0.191	*100%*	0.218	*100%*	0.256	*100%*	0.308	*100%*	0.290	*100%*
Between size decile variance	0.028	*14%*	0.031	*14%*	0.041	*16%*	0.052	*17%*	0.046	*16%*
Within size decile variance	0.164	*86%*	0.187	*86%*	0.216	*84%*	0.257	*83%*	0.245	*84%*
Between establ. size decile variance of AKM components										
	Comp.	Share	Comp.	Share	Comp.	Share	Comp.	Share	Comp.	Share
Var(mean person)	0.003	*2%*	0.005	*2%*	0.008	*3%*	0.011	*3%*	0.013	*5%*
Var(mean establ.)	0.009	*5%*	0.011	*5%*	0.012	*5%*	0.015	*5%*	0.010	*3%*
Var(mean xb)	0.000	*0%*	0.000	*0%*	0.000	*0%*	0.000	*0%*	0.000	*0%*
Var(mean res)	0.000	*0%*	0.000	*0%*	0.000	*0%*	0.000	*0%*	0.000	*0%*
2x Cov(mean p.e./mean e.e)	0.011	*6%*	0.014	*7%*	0.019	*8%*	0.025	*8%*	0.022	*8%*
2x Cov(mean p.e./mean xb)	0.001	*1%*	0.000	*0%*	0.001	*0%*	0.001	*0%*	0.000	*0%*
2x Cov(mean e.e./mean xb)	0.002	*1%*	0.001	*0%*	0.001	*0%*	0.001	*0%*	0.000	*0%*
Sum	0.028	*14%*	0.031	*14%*	0.041	*16%*	0.052	*17%*	0.045	*16%*
Within establ. size decile variance of AKM components										
	Comp.	Share	Comp.	Share	Comp.	Share	Comp.	Share	Comp.	Share
Var(diff person)	0.106	*55%*	0.112	*51%*	0.128	*50%*	0.143	*46%*	0.152	*52%*
Var(diff establ.)	0.024	*13%*	0.038	*17%*	0.045	*17%*	0.057	*18%*	0.039	*13%*
Var(diff xb)	0.016	*8%*	0.004	*2%*	0.006	*2%*	0.007	*2%*	0.012	*4%*
Var(diff res)	0.014	*8%*	0.014	*6%*	0.016	*6%*	0.018	*6%*	0.018	*6%*
2x Cov(diff p.e./diff e.e)	0.006	*3%*	0.019	*9%*	0.022	*9%*	0.030	*10%*	0.036	*12%*
2x Cov(diff p.e./diff xb)	-0.005	*-2%*	0.000	*0%*	-0.002	*-1%*	0.000	*0%*	-0.012	*-4%*
2x Cov(diff e.e./diff xb)	0.001	*1%*	0.000	*0%*	0.001	*1%*	0.003	*1%*	0.000	*0%*
Sum	0.164	*86%*	0.187	*86%*	0.216	*84%*	0.257	*83%*	0.245	*84%*

Notes: $mean$ indicates the average of a wage component within an establishment size decile. $diff$ indicates the difference of a worker's wage component and the average within a size decile. Source: BeH.

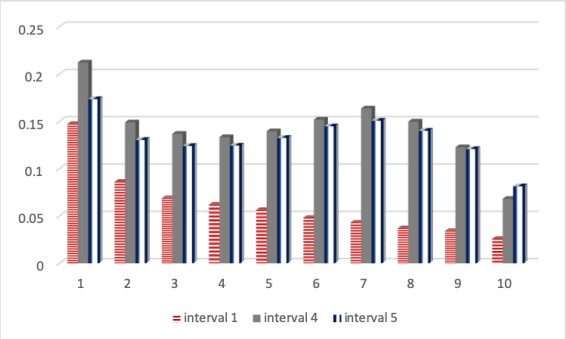
4.3.2. Wage variance within size deciles

Our previous decomposition reveals that wage variation is most prominent within size groups, which originates from differences in wages between and within establishments. Figures 2 and

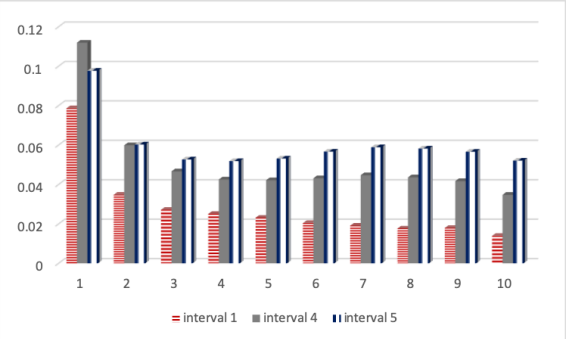
3 show the three most important contributors, that is, the variance of person and establishment effects, as well as their covariance.

Figure 2: Between establishment variance decomposition within size deciles

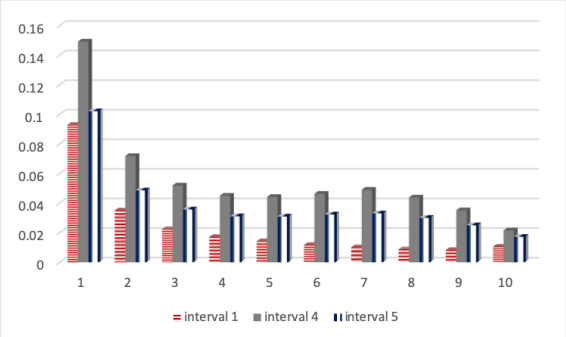
(a) Variance of log wages



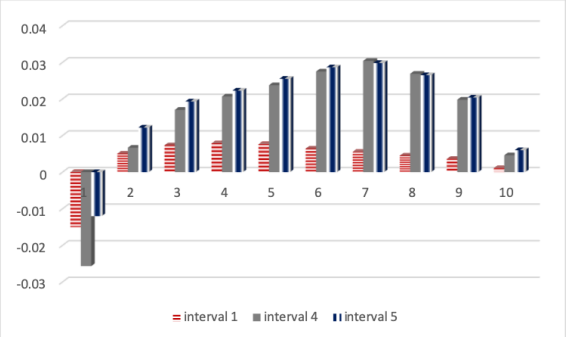
(b) Variance of person effects



(c) Variance of establ. effects



(d) 2xCovariance of person/establ. effects



Source: BeH.

The first striking result is that while in time interval 1, the between establishment wage variance was monotonically decreasing in size, in the most recent time intervals we see the highest wage variance in size decile 1 and 7.

Between interval 1 and 4, we confirm the results of CHK, at least for most of the size deciles: wage dispersion has increased from a combination of rising heterogeneity between workers, rising dispersion in the establishment wage premiums, and increasing sorting, with the exception of size decile 1 where sorting declined.

In the most recent time interval however, the between establishment wage variance has decreased for size deciles 1 to 9, while it only increased for the highest size decile 10. For size decile 1, there is a clear-cut story: On the one hand, the variance of the person effects decreased, indicating that worker segregation has declined among very small establishments. On the other hand, the employer-specific wage premiums aligned in these establishments as the variance of the establishment effects decreased. Figure C.3 shows that for these very small establishments the assortativeness between workers and establishments increased in the most recent years.

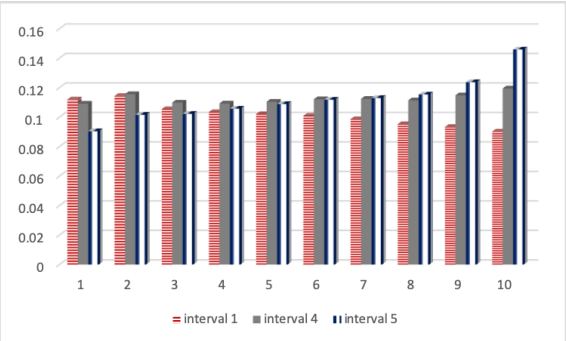
In all other size deciles, the variance of the person effects increased and the variance of the

establishment effects decreased. Furthermore, the covariance component increased (except for decile 6 and 7.)

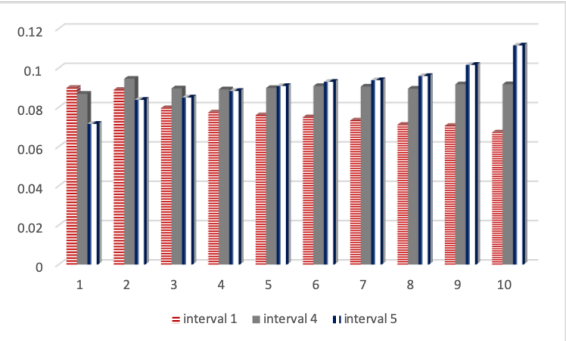
Figure 3 shows that wage dispersion within establishments is almost entirely driven by the variation in the person effects which is consistent to what Song et al. (2019) find for the US. We observe that this variation decreased within size deciles 1 to 6 and the rise is concentrated within deciles 7 to 10.

Figure 3: Within establishment variance decomposition within size deciles

(a) Variance of log wages



(b) Variance of person effects



Source: BeH.

5. Discussion and Conclusion

Bloom et al. (2018) show that in the US the LFWP has collapsed since the 80s most likely because of large shifts in employment away from manufacturing, where the LFWP is relatively stable, into the services sector, where the LFWP has been declining. In related work, Song et al. (2019) find that the rise in wage inequality was driven by a widening gap between firms in the composition of their workers and, to a large extent, by a rise in wage variation within very large firms. In contrast, we find that in Germany the LFWP has risen since the 80s and only recently slightly declined. One potential reason is that the manufacturing sector did not shrink as much as in the US (see Table B.3). We find a declining wage dispersion that is mostly due to a decline in the heterogeneity of establishment wage premiums both between and within size groups. In addition, we find that for small firms worker segregation has decreased. All in all, our results show that some of the trends reported by CHK have stopped.

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A. Descriptive Tables

Table A.1: Establishment size over time

Average number of full-time workers across size deciles					
size decile	interval 1	interval 2	interval 3	interval 4	interval 5
1	4	4	4	4	4
2	11	10	9	9	10
3	23	20	18	18	19
4	46	36	33	33	36
5	90	65	58	58	64
6	171	118	104	102	110
7	328	217	186	176	185
8	669	422	349	322	336
9	1,681	970	786	704	736
10	13,749	7,976	6,984	6,315	6,949
Median number of full-time workers across size deciles					
size decile	interval 1	interval 2	interval 3	interval 4	interval 5
1	4	3	3	3	3
2	10	9	8	8	9
3	21	18	16	16	18
4	43	33	30	30	33
5	85	60	55	54	60
6	164	110	98	96	105
7	315	204	177	168	178
8	640	399	334	308	323
9	1,553	887	722	652	688
10	6,784	3,656	2,987	2,656	2,830

Notes: Establishment size is measured as the number of full-time workers aged 20 to 60.
Source: BeH.

B. Additional Estimation Results

Table B.1: LFWP by region

	Western Germany				
	Interval 1	**Interval 2**	**Interval 3**	**Interval 4**	**Interval 5**
log wages	0.070	0.077	0.090	0.105	0.101
person effect	0.025	0.031	0.039	0.049	0.056
estal. Effect	0.041	0.044	0.049	0.054	0.045
xb	0.004	0.002	0.002	0.002	0.000
residual	0.000	0.000	0.000	0.000	0.000
	Eastern Germany				
		Interval 2	**Interval 3**	**Interval 4**	**Interval 5**
log wages		0.067	0.087	0.098	0.090
person effect		0.022	0.038	0.039	0.040
estal. Effect		0.045	0.048	0.058	0.051
xb		0.000	0.001	0.001	-0.001
residual		0.000	0.000	0.000	0.000

Notes: Point estimates from regression equation 2.
Source: BeH.

Table B.2: LFWP by Gender

			Females		
	Interval 1	**Interval 2**	**Interval 3**	**Interval 4**	**Interval 5**
log wages	0.077	0.083	0.098	0.111	0.099
person effect	0.027	0.035	0.044	0.051	0.053
establ. effect	0.046	0.047	0.053	0.059	0.048
xb	0.003	0.001	0.001	0.001	-0.001
residual	0.001	0.000	0.000	0.000	0.000
			Males		
	Interval 1	**Interval 2**	**Interval 3**	**Interval 4**	**Interval 5**
log wages	0.053	0.072	0.086	0.099	0.101
person effect	0.013	0.024	0.033	0.042	0.054
establ. effect	0.036	0.046	0.051	0.056	0.047
xb	0.003	0.001	0.001	0.002	0.000
residual	0.000	0.000	0.000	0.000	0.000

Notes: Point estimates from regression equation 2.
Source: BeH.

Table B.3: LFWP by industry

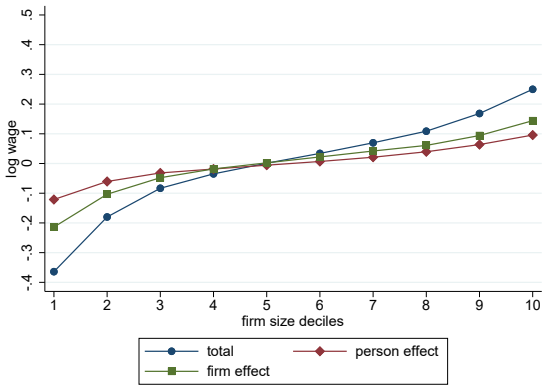
	Interval 1	Interval 2	Interval 3	Interval 4	Interval 5
			Manufacturing		
log wage	0.067	0.084	0.094	0.109	0.112
person effect	0.025	0.032	0.038	0.051	0.065
firm effect	0.038	0.052	0.056	0.057	0.047
xb	0.003	0.001	0.001	0.001	0.000
residual	0.000	0.000	0.000	0.000	0.000
			Services		
log wage	0.082	0.072	0.079	0.076	0.067
person effect	0.033	0.033	0.036	0.037	0.038
firm effect	0.045	0.038	0.040	0.039	0.031
xb	0.004	0.001	0.000	0.000	0.000
residual	0.000	0.000	0.000	0.000	0.000
			Construction		
log wage	0.077	0.070	0.086	0.105	0.096
person effect	0.027	0.029	0.043	0.050	0.051
firm effect	0.040	0.038	0.040	0.052	0.045
xb	0.009	0.002	0.002	0.002	-0.001
residual	0.000	0.001	0.001	0.001	0.000
			Trade		
log wage	0.077	0.092	0.104	0.119	0.093
person effect	0.028	0.038	0.045	0.051	0.046
firm effect	0.044	0.053	0.058	0.065	0.047
xb	0.004	0.000	0.001	0.002	0.000
residual	0.000	0.000	0.000	0.000	0.000
			Transportation, Storage		
log wage	0.102	0.069	0.087	0.101	0.093
person effect	0.027	0.026	0.039	0.050	0.055
firm effect	0.034	0.044	0.048	0.050	0.038
xb	0.001	0.000	0.000	0.000	-0.001
residual	0.000	0.000	0.000	0.000	0.000
			Accomodation		
log wage	0.102	0.111	0.121	0.137	0.110
person effect	0.035	0.037	0.041	0.041	0.035
firm effect	0.070	0.077	0.083	0.100	0.080
xb	-0.003	-0.003	-0.003	-0.003	-0.006

Notes: Point estimates from regression equation 2. We excluded the smallest industries, that is agriculture, energy, information and communications, and the public sector.
Source: BeH.

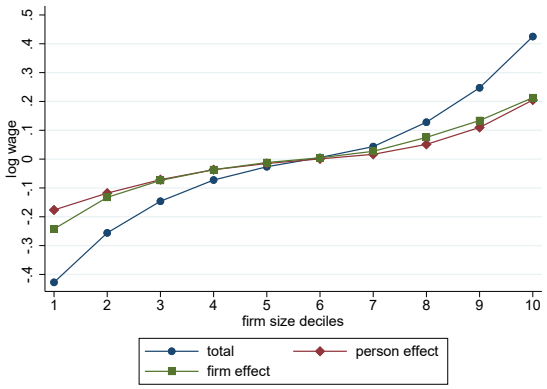
C. Additional Graphics

Figure C.1: LFWP - decomposition

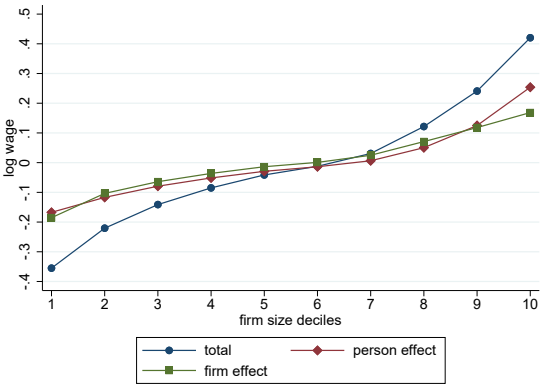
(a) Interval 1



(b) Interval 4

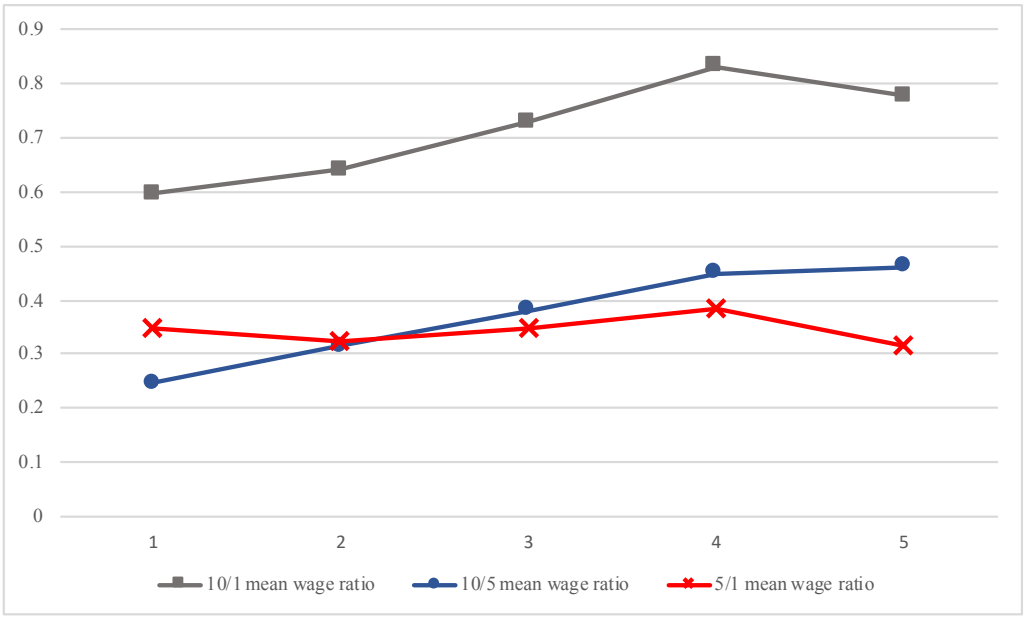


(c) Interval 5



Note: The Figure shows the employment-weighted average of log daily wages within each establishment size decile relative to the employment-weighted average of log daily wages across all size deciles. We exclude the figures for interval 2 and 3 as they show a similar trend as compared to interval 1 and 4. Source: BeH.

Figure C.2: Differences in mean wages across establishment size deciles



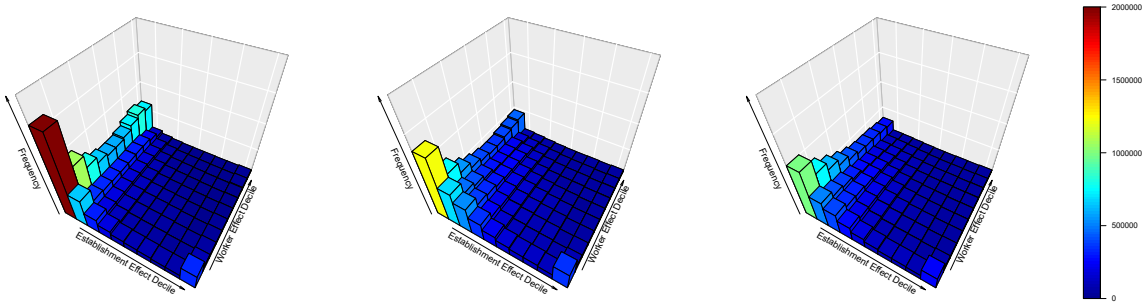
Note: X-axis shows time intervals. Y-axis shows log differences in employment-weighted mean log daily wages in certain establishment size deciles. Source: BeH.

Figure C.3: Joint distribution of worker and establishment fixed effects deciles, across size deciles and intervals

(a) Size decile 1 in interval 1
corr(person/establ.FE)=-0.119

(b) Size decile 1 in interval 4
corr(person/establ.FE)=-0.149

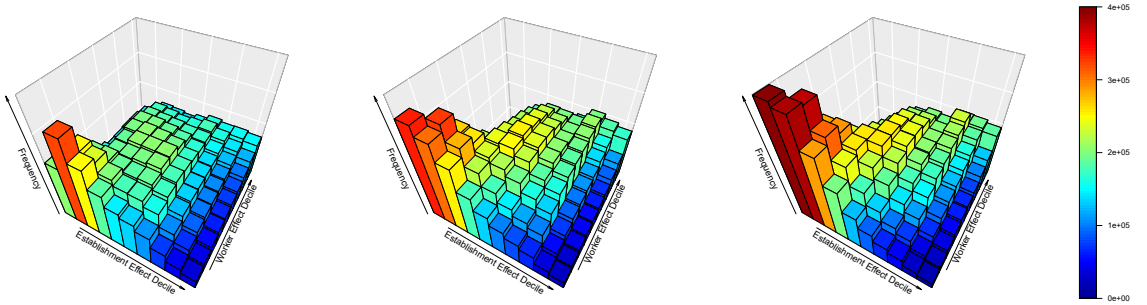
(c) Size decile 1 in interval 5
corr(person/establ.FE)=-0.092



(d) Size decile 5 in interval 1
corr(person/establ.FE)=0.207

(e) Size decile 5 in interval 4
corr(person/establ.FE)=0.311

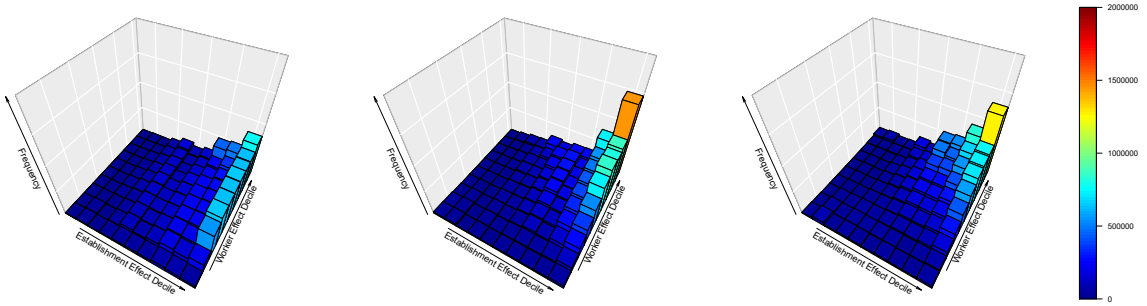
(f) Size decile 5 in interval 5
corr(person/establ.FE)=0.383



(g) Size decile 10 in interval 1
corr(person/establ.FE)=0.040

(h) Size decile 10 in interval 4
corr(person/establ.FE)=0.091

(i) Size decile 10 in interval 5
corr(person/establ.FE)=0.115



Note: The Figure shows the joint distribution of person and establishment effect deciles for certain size deciles and time periods. The distributions for all size deciles and periods are available upon request. Source: BeH.

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