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Nicole Gürtzgen

Non-technical summary: In recent decades, German industry-level bargaining has often been blamed for the deterioration of firms' competitiveness, as centrally negotiated wages are perceived to be particularly harmful to those firms who perform below the industry average. However, the extent to which a uniform industry wage deteriorates the position of less successful firms ultimately depends on the degree to which a centralised union internalises negative implications for below-average performing firms. If, for example, an industry-level union takes into account the job losses a wage increase produces in less successful firms, this may induce the union to moderate its wage demands. Clearly, the need to do so should critically depend on the variability in firm performance within the industry under consideration. As there is surprisingly little evidence on how the extent of firm heterogeneity affects centrally negotiated union wages, the aim of this paper is to study the relationship between wages and the degree of firm heterogeneity in a given industry under different wage setting structures. To provide some theoretical guidance, we first set up a simple theoretical model that analyses the sensitivity of wages to the variability in productivity conditions in a unionsised oligopoly framework. The model distinguishes centralised and decentralised wage determination. The theoretical results predict wages to be negatively associated with the degree of firm heterogeneity under centralised wage-setting, as unions internalise negative externalities of a wage increase for low-productivity firms. We test this prediction using a linked employer-employee panel data set from the German mining and manufacturing sector. Consistent with our hypotheses, the empirical results suggest that under industry-level bargaining workers in more heterogeneous sectors receive lower wages than workers in more homogeneous sectors. In contrast, the degree of firm heterogeneity is found to have no negative impact on wages in uncovered firms and under firm-level contracts.

Das Wichtigste in Kürze: In der wirtschaftspolitischen Diskussion mussten sich Flächentarifverträge häufig dem Vorwurf aussetzen, die Wettbewerbsfähigkeit insbesondere unterdurchschnittlich produktiver Unternehmen zu beeinträchtigen. Das Ausmaß negativer Konsequenzen für schwächere Unternehmen hängt jedoch nicht zuletzt davon ab, ob negative Externalitäten hoher Lohnabschlüsse für unterdurchschnittlich produktive Unternehmen bei den Verhandlungen berücksichtigt werden. Sofern Beschäftigungsverluste in schwächeren Unternehmen internalisiert werden, ist denkbar, dass dies zu moderateren Lohnforderungen seitens der Gewerkschaften führt. Das Ausmaß der Rücksichtnahme auf schwächere Unternehmen sollte hierbei maßgeblich von der Heterogenität der Unternehmen in der betreffenden Branche abhängen. Obwohl eine umfangreiche Literatur zum Zusammenhang zwischen Verhandlungsstruktur und Lohnniveau existiert, gibt es in der empirischen Literatur bislang kaum Evidenz dafür, inwiefern eine größere Branchenheterogenität zu moderateren Lohnabschlüssen führt. Ziel der vorliegenden Studie ist es daher, den Zusammenhang zwischen Branchenheterogenität und Löhnen zu analysieren. Um testbare Hypothesen abzuleiten, wird zunächst in einem Oligopolmodell mit endogenen Löhnen der Zusammenhang zwischen Branchenheterogenität und gleichgewichtigen Löhnen hergeleitet. In dem Modellrahmen wird zwischen zentralisierter und dezentralisierter Lohnsetzung unterschieden. Während sich den theoretischen Ergebnissen zufolge unter zentralisierter Lohnfindung ein negativer Zusammenhang zwischen Branchenheterogenität und gleichgewichtigen Löhnen ergibt, hat das Ausmaß der Heterogenität unter dezentralisierten Abschlüssen keinen Einfluss auf die Löhne. Die aus dem theoretischen Modellrahmen abgeleiteten Hypothesen werden schließlich auf Basis deutscher Linked Employer-Employee Paneldaten getestet. Die empirischen Ergebnisse zeigen, dass - konsistent mit den theoretischen Überlegungen - unter Flächentarifverträgen Individuen in heterogeneren Branchen niedrigere Löhne erhalten als Individuen in homogeneren Sektoren. Im Gegensatz dazu lässt sich - ebenfalls konsistent mit den abgeleiteten Hypothesen - kein signifikanter Zusammenhang zwischen Branchenheterogenität und Löhnen unter Firmentarifverträgen und in nicht tarifgebundenen Unternehmen nachweisen.

Firm heterogeneity and wages under different bargaining regimes: Does a centralised union care for low-productivity firms?

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Abstract

This paper studies the relationship between wages and the degree of firm heterogeneity in a given industry under different wage setting structures. To derive testable hypotheses, we set up a theoretical model that analyses the sensitivity of wages to the variability in productivity conditions in a unionsised oligopoly framework. The model distinguishes centralised and decentralised wage determination. The theoretical results predict wages to be negatively associated with the degree of firm heterogeneity under centralised wage-setting, as unions internalise negative externalities of a wage increase for low-productivity firms. We test this prediction using a linked employer-employee panel data set from the German mining and manufacturing sector. Consistent with our hypotheses, the empirical results suggest that under industry-level bargaining workers in more heterogeneous sectors receive lower wages than workers in more homogeneous sectors. In contrast, the degree of firm heterogeneity is found to have no negative impact on wages in uncovered firms and under firm-level contracts.

Keywords: Wage-Setting Structure, Unions, Oligopoly, Linked Employer-Employee Data

JEL Code: C23, J31, J51, L13

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1 Introduction

The degree of bargaining centralisation has long been recognised as an important determinant of macroeconomic performance and economic competitiveness. The economic rationale behind this idea dates back to the seminal work by Calmfors and Driffill (1988), who established the hypothesis of a hump-shaped relationship between centralisation and wages. The authors argue that centralised wage setting, on the one hand, may enable unions to secure higher wages, since they internalise positive externalities from demand spill-overs across firms producing substitutable goods. On the other hand, centralised bargaining may induce unions to take into account negative price externalities since the impact of the negotiated wage on the general consumption price-level becomes larger as centralisation increases. Further important negative externalities that are likely to be internalised by centralised unions include adverse employment prospects for unemployed outsiders (see e.g. Moene et al. 1993, Fitzenberger and Franz 1999) as well as fiscal externalities (Calmfors 2001).

While much of this theoretical literature has focused on the impact of centralisation on wage outcomes in homogeneous firms, very few studies explicitly address the issue of firm heterogeneity.[1] This is particularly surprising as an important argument against bargaining centralisation typically refers to the insensitivity of centrally negotiated wages to local firm conditions. This view is confirmed by recent empirical evidence for Germany supporting the view that wage agreements on sectoral and regional levels (*Flächentarifverträge*) suppress firm wage differentials across heterogeneous firms (Guertzgen 2005). Against this background, German industry-level bargaining has often been blamed for the deterioration of firms' competitiveness, as centrally negotiated wages are perceived to be particularly harmful to those firms who perform below the industry average (see e.g. Hassel and Schulten 1998, German Council of Economic Experts 2002, 2005).

However, the extent to which a uniform industry wage deteriorates the position of less successful firms ultimately depends on the degree to which a centralised union internalises negative implications for below-average performing firms. If, for example, an industry-level union takes into account the job losses a wage increase

[1] Other authors who have analysed the impact of bargaining centralisation on wage outcomes are e.g. Davidson (1988), Dowrick (1989) and Cahuc and Zylberberg (1991) and Hoel (1991). Among the few studies that address the issue of firm heterogeneity are the analyses by Barth and Zweimüller (1995) and Haucap and Wey (2004), who analyse the impact of centralisation on firm wage differentials between two heterogeneous firms.

produces in less successful firms, this may induce the union to moderate its wage demands. Clearly, the need to do so should critically depend on the variability in firm performance within the industry under consideration. While the impact of collective bargaining coverage on wage outcomes in Germany has received much attention by researchers (Stephan and Gerlach 2005, Guertzgen 2006, Kohn and Lembcke 2007, Fitzenberger et al. 2008), there is surprisingly little evidence on how the extent of firm heterogeneity affects centrally negotiated union wages. The purpose of the present paper is to fill in this gap by examining the relationship between wage outcomes and the degree of firm heterogeneity under different bargaining regimes. To formalise our main argument, we first set up a theoretical model that analyses the sensitivity of wages to the variability in productivity conditions in a unionsised oligopoly framework. The model distinguishes centralised and decentralised wage determination. The core result of the model establishes a negative association between wages and the degree of firm heterogeneity under centralised wage-setting. The basic mechanism at work is that in more heterogeneous industries a centralised union has the incentive to settle for a lower wage, in order to prevent jobs losses in low-productivity firms.

In a second step, we test our predictions using a linked employer-employee panel data set from the German mining and manufacturing sector. This data set is particularly useful for our purposes as it provides detailed information on whether an establishment is subject to an industry-wide wage agreement, a firm-specific wage agreement or to no wage agreement at all. Moreover, the data allow us to retrieve a productivity measure at the firm level, which enables us to construct a measure for the industry-wide dispersion of productivity conditions as a proxy for the degree of firm heterogeneity.

The remainder of the paper is structured as follows: the institutional background of German wage determination is presented in Section 2. Section 3 sets up the theoretical model that analyses the sensitivity of wages to the degree of firm heterogeneity under different wage-setting regimes. From this we derive testable hypotheses for the empirical analysis in Section 4. While Section 4.1. presents the general empirical model, Section 4.2. describes the data set and the main variables used in the empirical analysis. Section 4.3. reports the estimation results. The final Section 5 concludes.

2 Institutional Background

In Germany, basically three forms of wage determination may be distinguished: central collective wage agreements, firm-specific collective wage agreements as well as wage determination without any collective bargaining coverage. Within the system of wage bargaining, regional and industry-wide collective wage agreements (*Flächentarifverträge*) rank among the most important contract type. These agreements are negotiated between an industry-specific trade union and an employers' association. In general, bargained wages under industry-level contracts merely represent a lower bound on wages, i.e. firms are free to pay wages above the negotiated rate. However, in contrast to other European countries, there is no two-tier system with subsequent firm-level agreements, since higher wages than those stipulated in the centralised agreement are paid on a voluntary basis and do not arise from a legally binding supplementary firm-level contract. Moreover, flexibility provisions in central agreements may also allow for a downward adjustment of wages. These flexibility provisions, whose most important components may be summarised as opt-out clauses and hardship clauses, generally delegate issues that are usually specified in the central agreement to the plant-level. In particular, such clauses may allow firms to settle for wages below those set at the industry-level. Even though contractual opt-out and hardship clauses have become an important (formal) element of centralised agreements, empirical evidence on the use of such clauses indicates that only a very small fraction of firms appears to exploit these clauses (see e.g., Franz and Pfeiffer 2003, Guertzgen 2005, Kohaut and Schnabel 2007, Heinbach and Schröpfer 2008).

Second, firms who are not party to centralised agreements may be engaged in bilateral negotiations with a trade union and conclude firm-specific agreements. A noteworthy feature of those agreements is that they are concluded by industry-specific trade unions and do not involve uncoordinated wage bargaining of independent firm-specific unions. That is, decentralisation here merely refers to the *level* of bargaining and not to the *degree of coordination*. Third, there is wage determination without any bargaining coverage. In firms that are not covered by an collective agreement wage determination may either take the form of individual wage contracts or of plant-specific agreements (*Betriebsvereinbarungen*) between works councils and the management.[2] In contrast to firm-specific collective wage agreements, this kind

[2] According to the German Works Constitution Act, works councils are not allowed to negotiate about issues that are normally dealt with in collective agreements, even in firms that are not parties of a collective agreement. In practice, however, works councils may be expected to play a crucial role in wage determination (see e.g. Hübler and Jirjahn 2003).

of wage determination can be characterised as decentralised and uncoordinated.

3 Theoretical Framework

The purpose of the present section is to derive testable hypotheses about the relationship between wages and the degree of firm heterogeneity within a particular industry. To formalise the idea that collective bargaining coverage may affect the relationship between wages and the degree of firm heterogeneity, we employ a unionised oligopoly framework with heterogeneous firms and different wage-setting structures. The wage-setting structures and their empirical counterparts are illustrated in Table 1.

Table 1: Wage setting structures

Abbr.	Wage-setting structure	Empirical counterpart
(D)	Decentralised and uncoordinated	No bargaining coverage
(I)	Decentralised and coordinated (Intermediate centralised)	Firm-specific collective agreement
(C)	Centralised and coordinated	Industry-wide collective agreement

As to the empirical counterparts, our data allow us to distinguish industry-level contracts, firm-level contracts and no coverage. To mirror the institutional variety reflected in our data, we therefore distinguish three theoretical wage setting structures: Regime (D) reflects a decentralised and uncoordinated wage-setting structure, with wages being determined non-cooperatively at the firm level. This regime is assumed to represent the wage determination process in firms without collective bargaining coverage.[3] Regime (I) represents an intermediate centralised structure with one encompassing industry union which can adjust wages to the firm level. This regime is intended to match firm-specific collective contracts, since it reflects the coordinated nature and the decentralised level of wage determination. Note that, empirically, this regime may also refer to central agreements with the adoption of flexibility provisions. However, as the data used in this study unfortunately lack explicit information on the use of these provisions, we are not able to distin-

[3] Although we are aware of the fact that regime (D) assuming uncoordinated union wage-setting does not exactly match the institutional conditions in firms without any bargaining coverage, we consider it here as a benchmark scenario for the following two reasons. First, it reflects the uncoordinated nature of wage determination in firms without any bargaining coverage. Second, at least in codetermined firms a collective wage determination framework appears to be appropriate since empirical evidence suggests that German works councils affect wage outcomes even in firms that are not covered by a collective wage contract (Hübler and Jirjahn 2003).

guish industry-level contracts with and without opt-out clauses.[4] Finally, regime (C) refers to a completely centralised structure, where an industry union sets one uniform wage for the entire industry. As to its empirical counterpart, regime (C) is assumed to reflect a central wage agreement without any adoption of hardship or opening clauses.

3.1 The Model

The theoretical model builds upon the modelling framework by Haucap and Wey (2004) who consider a unionised Cournot oligopoly with two heterogeneous firms. We extend their duopoly model to an n-firm oligopoly to derive as general conclusions as possible. We assume a right-to-manage framework where unions set wages and firms unilaterally decide on the employment level. Heterogeneity among firms is introduced by imposing heterogeneous labour productivities of otherwise homogeneous labour.

More specifically, consider a homogeneous Cournot oligopoly with n firms each producing output q_i, $i = 1, ..., n$. Product demand is assumed to be linear with

$$P = a - b\sum_{i=1}^{n} q_i, \tag{1}$$

where P is the homogeneous good price. Firms produce with a constant marginal product of homogeneous labour, the only variable factor of production. To generate heterogeneity in firms' productivity, suppose that each firm i requires c_i units of labour to produce a unit of the homogeneous good, so that labour demand l_i equals $c_i q_i$. With w_i denoting the wage each firm i has to pay for one unit of labour, marginal costs are therefore $c_i w_i$. Firms' profit functions take the form

$$\pi_i = (a - b\sum_{j=1}^{n} q_j)q_i - q_i c_i w_i, \quad i = 1, ..., n. \tag{2}$$

Maximising each firm's profit function for given wages w_i and given c_i with respect to q_i, taking q_j, $j \neq i$, as given yields equilibrium quantities

$$q_i = \frac{a - nc_i w_i + \sum_{j \neq i} c_j w_j}{b(n+1)}, \ i = 1, ..., n. \tag{3}$$

Industry output Q is given by

[4] Information on the existence and use of opt-out clauses under industry-level contracts is only available for the year 2005. As this wave of the data set will be exploited for retrospective information to construct a firm performance measure in 2004, we are not able to exploit information on the use of these clauses.

$$Q = \frac{na - n\sum_{i=1}^{n} c_i w_i + (n-1)\sum_{i=1}^{n} c_i w_i}{b(n+1)} = \frac{na - \sum_{i=1}^{n} c_i w_i}{b(n+1)}. \tag{4}$$

A right-to-manage framework results in a two-stage game structure, with unions setting optimal wages in the first stage of the game while anticipating the Cournot equilibrium quantities from the second stage. Distinguishing three wage-setting regimes as outlined above gives rise to the following wage-setting games:

1. Decentralisation (D): Completely decentralised wage-setting takes place with n firm-unions each setting its optimal (firm-specific) wage independently from the other $(n-1)$ unions, taking their wages as given.

2. Complete centralisation (C): Centralised wage-setting takes place with one industry-wide union representing the interests of all workers in the industry and setting a uniform wage for all n firms.

3. Intermediate centralisation (I): Under intermediate centralised wage-setting one industry-wide union settles for firm-specific wages while coordinating the wage demands in all firms of the industry.

Unions are assumed to maximise the wage bill. Equilibrium wages are therefore solutions of the following programs

$$w_i = \arg\max_{w_i} \; U_i^r(w_1, ..., w_n) \quad \text{s.t. } eq.\ (3), \tag{5}$$

with $r = D, I, C$. More specifically, for the different union structures we have

$$U_i^D(w_1, ..., w_n) = (w_i - \overline{w})l_i, \;\; i = 1, ..., n, \tag{6}$$

$$U^I(w_1, ..., w_n) = \sum_{i=1}^{n}(w_i - \overline{w})l_i, \tag{7}$$

and

$$U^C(w_1, ..., w_n) = \sum_{i=1}^{n}(w - \overline{w})l_i, \tag{8}$$

with $\overline{w}$ denoting the alternative wage level, which workers may expect to earn elsewhere in the economy. This gives rise to n first-order conditions in the decentralised and intermediate centralised regime (D) and (I) and to one first-order condition in the completely centralised case (C).

3.2 Theoretical Results

Proposition 1 *Under the three wage-setting structures we obtain the following equilibrium wage outcomes:*

(i)

$$w_i^D = \frac{(2n+1)a/c_i + n\overline{w}\left[(n+1) + n(\overline{c}/c_i)\right]}{(n+1)(2n+1)},\ i = 1, ..., n, \tag{9}$$

(ii)

$$w_i^I = \frac{\overline{w}}{2} + \frac{a}{2c_i},\ i = 1, ..., n, \tag{10}$$

(iii)

$$w^C = \frac{\overline{w}}{2} + \frac{a}{2\left[(n+1)VAR(c)/\overline{c} + \overline{c}\right]}, \tag{11}$$

where $\overline{c} = \frac{1}{n}\sum_{j=1}^{n} c_j$ *denotes the average labour-input coefficient, that is the average inverse labour productivity in the industry and* $VAR(c) = \frac{1}{n}\sum_{j=1}^{n}(c_j - \overline{c})^2$ *represents a measure of the industry-wide dispersion of* c_i*.*

Proof. See the Appendix. ■

Proposition 1 provides a generalisation of a variety of results that have already been derived for a homogeneous oligopoly.[5] Eqs. (9) and (10) show that the firm-specific wage outcomes are a decreasing function of the firm-specific labour-input coefficients c_i, if wages are determined in the decentralised and intermediate centralised wage-setting regime. The reason is that the union's marginal cost of a wage increase, $\partial l_i/\partial w_i$, unambiguously increases with c_i. That is the higher the labour-input coefficient the larger is the incentive to lower the firm-specific wage w_i in order to improve firm's i competitive position in the product market. Conversely, if c_i decreases, this induces unions in regimes (D) and (I) to settle for a higher wage as the marginal cost of a wage increase in terms of foregone employment is reduced. Moreover, in the decentralised regime (D) the firm-specific wage is the higher the lower firm's i labour-input coefficient c_i relative to the industry average, $\overline{c}$. The reason is that in the decentralised case unions generally have an incentive to cut wages in order to gain a larger share of industry employment. A low average industry productivity lowers this incentive by reducing the competitive pressure on firm i, thereby enabling its union to settle for a higher wage. Note that this is not the case in the intermediate centralised regime (I), where the wage is solely a function

[5] See e.g. Corneo (1995) among others, who derives expressions for w_i^C and w_i^D under the assumption $c_i = 1$ for all i. Moreover, our analysis generalises the results of Haucap and Wey (2004), who consider the case $n = 2$, $c_1 = (1-d)$ and $c_2 = 1$.

of each firm's own labour-input coefficient c_i. The reason is that the competitive mechanism being at work in the decentralised regime completely disappears with an industry-wide union, which fully internalises positive externalities arising from wage increases in firm i for the employment level in the rival firms j, $j \neq i$.

Finally, from eq. (11) it can be seen that the completely centralised regime (C) suppresses any wage response to firm-specific productivity conditions, which simply arises from the assumption that the uniform industry wage applies to all firms in the industry. Instead, the uniform industry-wage is shown to be a function of the average industry labour-input coefficient $\overline{c}$ and the variability in productivity conditions, as measured by the industry-wide dispersion of the inverse labour productivity c_i, $VAR(c)$. Note that in a homogeneous industry with all firms exhibiting an identical labour-input-coefficient $\overline{c}$, the uniform industry wage reduces to

$$w^C = \frac{\overline{w}}{2} + \frac{a}{2\overline{c}}. \tag{12}$$

Compared to the wage outcome in a homogeneous industry with all firms exhibiting an identical labour-input-coefficient $\overline{c}$, an industry union in a heterogeneous industry therefore settles for a lower wage, since $VAR(c) > 0$. The intuition behind this result is that an industry-union setting a uniform industry-wage takes into account the marginal cost of a wage increase for all firms in the industry, that is also for those firms which have a labour-input coefficient above the average. Employment in those firms is affected more than proportionally negatively after a given wage increase. The reason is that a wage increase does not only reduce the output level to a larger extent, but also implies for a given output reduction a higher employment loss (since $l_i = c_i q_i$). In contrast, the heterogeneity in firm-level productivity has no impact on wage outcomes in regimes (D) and (I) as these regimes allow wages to respond to local productivity conditions. From Proposition 1 we derive the following central hypotheses for our empirical analysis:

Hypothesis 1: Under firm-level contracts and in uncovered firms (regimes (I) and (D)), firm-specific productivity should to have a positive impact on wages, whereas under industry-level contracts (regime (C)) wages are expected to be completely insensitive to local productivity conditions.

Hypothesis 2: Under industry-level contracts (regime (C)) we expect wages to be negatively related to the degree of firm heterogeneity in the industry under consideration, whereas under firm-level contracts and in uncovered firms (regimes (I) and (D)) the degree of firm heterogeneity should have no impact on wages.

4 Empirical Analysis

4.1 Data and Variable Description

The data used in this paper are taken from the IAB Linked Employer-Employee Panel (LIAB) which combines data from the *IAB-Establishment Panel* and the *Employment Statistics Register* (see e.g. Alda et al. 2005). The *IAB-Establishment Panel* is based on an annual survey of German establishments, whose sampling frame encompasses all German establishments that employ at least one employee paying social security contributions. The individual data stem from the *Employment Statistics Register,* which is an administrative data set based on reports from employers in compliance with the notifying procedure for the German social security system. This procedure obliges employers to provide a notification at the beginning and the end of each employment relationship for all employees who are covered by the German social security system. In addition, there is at least one annual compulsory notification on the 31^{st} December of each year.

To construct the linked employer-employee data set, we first select establishments from the *IAB-Establishment Panel*. The establishment data span from 1995 to 2005 and give detailed information on a great deal of establishment characteristics, such as establishment size, collective bargaining coverage and the existence of a works council. As to collective bargaining coverage, establishments are asked to report whether they are bound to an industry-wide collective wage agreement or, alternatively, to a firm-specific wage agreement.[6] A more detailed description of the remaining establishment variables is provided in Guertzgen (2005, 2006).

To operationalise the theoretical model's source of firm heterogeneity, we compute establishment-specific per-capita value-added as a measure for firm-specific productivity conditions. Per capita value-added is calculated as the difference between annual sales and material costs divided by establishment size. We then proceed to construct a measure of firm heterogeneity at the industry-level. From the theoretical analysis in Section 3 it is clear that an ideal measure of firm heterogeneity would exactly refer to those industries that are covered by the specific industry-level agreements. However, the data only provide information on coverage at the industry or firm-level and lack explicit information the specific contract an establishment is

[6]Moreover, since 1999 establishments without any binding collective contract are asked whether they follow informally the terms of an industry-wide agreement. However, for the available waves respondents are not asked to provide any information on the precise nature of the voluntarily applied contract terms. As a result, the informational content of this question remains rather elusive.

subject to. For this reason, we have to resort to the two-digit industry-level classification (WZ93) provided by the establishment data in order to obtain a reasonable classification for the measure of firm heterogeneity at the industry-level. On the basis of this classification, we compute the mean, the standard deviation and the coefficient of variation of value-added for each of the two-digit industries separately for eastern and western Germany and for each year of the time period under consideration.[7] Table 2 displays for each of the two-digit industries mean and standard deviation of per-capita value-added averaged over all time periods from 1995 to 2004 separately for western and eastern Germany. The figures indicate that among the industries that are characterised by a relatively high degree of heterogeneity are the western Chemicals, Coke and Petroleum industry as well as Food, Beverages and Tobacco in both western and eastern Germany. Sectors that appear to be comparably homogeneous are most notably the Basic and Fabricated Metal industries.As

Table 2: Dispersion of value-added in two-digit industries

Two-Digit Industry	MEAN	SD	CV	MEAN	SD	CV
	Western Germany			Eastern Germany		
Mining, energy, water supply	1.311	1.431	1.07	0.833	0.749	0.86
Food, beverages, tobacco	0.630	0.984	1.58	0.446	0.819	1.82
Textiles and leather	0.548	0.477	0.86	0.293	0.302	1.04
Pulp, paper, publishing	0.652	0.638	0.98	0.541	0.595	1.03
Wood (excluding furniture)	0.497	0.386	0.76	0.297	0.278	0.93
Chemicals, coke, petroleum	1.152	1.448	1.22	0.682	0.598	0.87
Rubber and plastic products	0.650	0.459	0.70	0.467	0.411	0.87
Non-metallic mineral products	0.589	0.499	0.82	0.432	0.378	0.88
Basic metals	0.658	0.460	0.70	0.428	0.278	0.65
Fabricated metals	0.578	0.368	0.63	0.398	0.373	0.92
Machinery	0.756	0.640	0.81	0.470	0.341	0.73
Motor vehicles	0.853	0.810	0.87	0.484	0.412	0.85
Other transport equipment	0.832	0.585	0.69	0.425	0.329	0.77
Electrical equipment	0.864	0.907	1.03	0.495	0.437	0.86
Optical equipment	0.585	0.390	0.72	0.339	0.266	0.78
Furniture, N.E.C.	0.449	0.280	0.62	0.257	0.161	0.62

Source: *IAB* Establishment Panel 1995-2005.

Mean and standard deviation of per-capita value-added are measured in 100.000 €.

[7] Strictly speaking, the theoretical model establishes a relationship between wages and the variability in the labour-input coefficient, the inverse of value-added. In what follows, we consider the variability in value-added as the use of the inverse of value-added would result in a division by zero for a number of observations. Moreover, it can be shown that a second-order Taylor approximation of $Var(1/x)$ is $\frac{1}{\overline{x}^2} \cdot (\frac{Var(x)}{\overline{x}^2} - (\frac{Var(x)}{\overline{x}^2})^2)$. Hence, with a coefficient of variation of x smaller than one, $Var(1/x)$ is a monotonic transformation of $Var(x)$.

we apply panel data methods, the final estimation sample comprises establishments with consistent information on the establishment characteristics of interest (see Table A1 in the appendix) and at least two consecutive time series observations. In a second step, we merge the establishment panel data with individual data for the entire population of workers who are employed by the selected establishments by using a unique establishment identifier which is available from both data sets. In particular, the data allow us to merge the selected establishment data with notifications for all those employment spells comprising the June 30^{th} of each year. From the individual data we keep individuals with at least two consecutive time-series observations.[8] The final linked sample comprises 816,227 individuals in 3,358 establishments with a total of 3,370,807 individual observations. The individual data provide information on the gross daily wage, age, gender, nationality, employment status (blue/white-collar), educational status (six categories) and on the date of entry into the establishment. Table A1 in the appendix presents summary statistics for the main variables used in the empirical analysis.

4.2 Results

In order to quantify the relationship between the degree of firm heterogeneity and wages across different wage-setting regimes, we consider the following wage equation:

$$\ln w_{ijt} = \mu + \beta \cdot SD\_VALUE_{kt} + \gamma \cdot MEAN\_VALUE_{kt} + \delta \cdot \mathbf{x}'_{ijt} + \lambda_t \cdot D_t + \epsilon_{ijt}. \quad (13)$$

In eq. (13), j refers to the establishment that employs individual i at time t, while the index k denotes the industry affiliation of establishment j. The explanatory variable of main interest is the industry-specific standard deviation of value-added (SD_VALUE) as a proxy for the degree of firm heterogeneity at the industry-level. We control further for the industry-specific mean of value-added ($MEAN\_VALUE$) as a proxy for the inverse of $\overline{c}$ and for a vector of additional individual and establishment covariates $\mathbf{x}'_{ijt}$. Time dummies D_t are included to capture common macroeconomic effects, while ϵ_{ijt} denotes an unobserved time-varying component.

Table 3 reports the results from estimating eq. 13) by Pooled OLS separately by bargaining regime. The estimated coefficients on SD_VALUE and on $MEAN\_VALUE$ are represented in row 1 and 2. Consistent with the predictions

[8]Further, we exclude observations for apprentices, part-time and homeworkers from the individual data and drop individuals younger than 19 and older than 55. Moreover, as we consider only full-time workers, we eliminate those whose wage is less than twice the lower social security contribution limit.

Table 3: POLS estimation results

	Industry-level *(C)*		No-coverage *(D)*		Firm-level *(I)*	
POOLED OLS ESTIMATES						
SD_VALUE	-.015**	0.006	0.023*	(0.011)	-.009	(0.002)
MEAN_VALUE	0.014	0.044	-.006	(0.068)	0.060	(0.111)
INDIVIDUAL CHARACTERISTICS						
FEMALE	-.205***	(0.013)	-.266***	(0.007)	-.206***	(0.017)
AGE	0.022***	(0.003)	0.024***	(0.002)	0.024***	(0.005)
AGE^2	-.000***	(0.000)	-.000***	(0.000)	-.000***	(0.000)
TENURE	0.001***	(0.000)	0.001***	(0.000)	0.001***	(0.000)
$TENURE^2$	-.000***	(0.000)	-.000***	(0.000)	-.000***	(0.000)
FOREIGN	-.003	(0.003)	-.002	(0.005)	0.006	(0.010)
WHITECOLL	0.272***	(0.010)	0.291***	(0.009)	0.234***	(0.026)
VOCATIO	0.077***	(0.007)	0.079***	(0.006)	0.076***	(0.012)
HIGH SCHOOL	0.120***	(0.003)	0.098***	(0.031)	0.083***	(0.021)
VOC-HIGH	0.120***	(0.016)	0.150***	(0.014)	0.110**	(0.088)
TECHN-UNI	0.329***	(0.011)	0.288***	(0.015)	0.310***	(0.023)
UNI	0.386***	(0.018)	0.344***	(0.010)	0.331***	(0.026)
ESTABLISHMENT CHARACTERISTICS						
log(SIZE)	0.029***	(0.008)	0.047***	(0.006)	0.050***	(0.008)
VALUE	0.034***	(0.007)	0.065***	(0.007)	0.062***	(0.020)
WCOUNCIL	0.088**	(0.032)	0.051**	(0.026)	0.055***	(0.014)
K/L	0.005***	(0.001)	0.008***	(0.002)	0.004**	(0.002)
Observations	2,766,702		343,702		260,403	
Adj. R^2	0.693		0.737		0.721	

Source: LIAB 1995-2005.

Note: The dependent variable is the individual log real daily wage.

Standard errors are in parentheses and are adjusted for clustering at the industry-level.

The models include 15 regional dummies, 16 industry dummies and 9 time dummies.

***Significant at 1%-level, **Significant at 5%-level.

from the theoretical model, SD_VALUE enters the regression with its expected negative sign and is significant at the 5%-level under centralised contracts (C). On the contrary, in uncovered plants SD_VALUE enters with a positive and significant sign, whereas under firm-level contracts the coefficient on SD_VALUE is not significantly different from zero. As shown in Table 3, these results are robust to the inclusion of a number of individual and establishment controls. Because the coefficients on these covariates are broadly consistent with what has been found earlier in the literature (Guertzgen 2005, 2006), we do no comment on these estimates further. The coefficients on $MEAN\_VALUE$ are estimated to be insignificant for each bargaining regime. [9]

Even though we have controlled for a large number of observable individual and establishment characteristics, it might be conceivable that the negative association between firm-heterogeneity and individual wages is due to sorting of unobservably better workers and firms into more homogeneous industries. If this were the case, the coefficient on SD_VALUE would be downward biased. This potential bias raises the question as to whether the pattern of previous results holds if unobserved firm and worker effects are accounted for. An important concern is that the negative association between firm heterogeneity and wages might be simply caused by a potential downward-bias. To address this problem, we also estimate eq. (13) in spell first-differences, i.e. after first-differencing eq. (13) within each individual-establishment combination in order to eliminate unobserved plant and individual heterogeneity. The results from this differenced specification are shown in Panel A of Table 4. While the coefficients on SD_VALUE exhibit a similar pattern as in Table 3, the coefficient is found to be somewhat smaller (in absolute magnitude) under industry-level contracts, but still negative and significant at the 10%-level. Even though these findings indicate that the OLS estimates appears to be somewhat downward biased, they still confirm the theoretical predictions suggesting a negative association between firm heterogeneity and wages under centralised wage-setting.[10]

Thus far, the estimates are based upon the unweighted moments of per-capita value-added, which do not account for the fact that large establishments are more

[9] Note that according to our theoretical results the relationship between the average industry productivity and the negotiated wage is ambiguous for a given variablilty in productivity conditions under industry-level contracts. See eq. (11) where the derivative of w^C with respect to $\overline{c}$ is negative only if $Var(c) < \overline{c}^2/(2(n+1))$.

[10] To test the hypothesis that the wage moderating effect of between-firm heterogeneity should be less relevant for above-average performing establishments, I have also included an interaction between SD_VALUE and 1) a dummy variable indicating whether plants pay wages above the going rate and 2) a dummy indicating whether an establishment's value-added exceeds the industry-average. Unfortunately, these interactions enter the equations with their expected positive (but insignificant) signs only in case of the unweighted heterogeneity measure (Table 3).

likely to be overrepresented in our dataset. As a robustness check, we therefore also calculate the weighted mean and standard deviation of per-capita value-added, where the weights are derived using the sample weights from the *IAB Establishment Panel*.[11] The results from re-running the specifications with these weighted moments are shown in Panel B and C of Table 4. While the signs of the coefficients on *SD_VALUE* confirm the previous pattern of results as in Table 3 and Panel A, *MEAN_VALUE* now enters the equations with a positive sign and is found to be weakly significant at the 10%-level in both the OLS and differenced specification. In terms of the economic significance of the estimates, the results imply that a one-standard deviation increase in *SD_VALUE* (which is 0.402 in the unweighted and 69.33 in the weighted case)[12] lowers wages by about 2 to 4 per cent.

Table 4: Robustness checks

	Industry-level *(C)*		No-coverage *(D)*		Firm-level *(I)*	
A.			DIFFERENCED			
SD_VALUE	-.005*	(0.003)	0.005	(0.005)	0.004	(0.006)
MEAN_VALUE	-.003	(0.001)	-.001	(0.002)	-.001	(0.003)
B.			OLS - WEIGHTED MOMENTS			
SD_VALUE	$-6.0e^{-05}$***	($2.0e^{-05}$)	$7.0e^{-05}$	($8.0e^{-05}$)	-5.0	($4.0e^{-05}$)
MEAN_VALUE	0.013*	(0.006)	-.001	(0.002)	0.030	(0.020)
C.			DIFFERENCED - WEIGHTED MOMENTS			
SD_VALUE	$-3.0e^{-05}$*	($1.6e^{-05}$)	$1.3e^{-05}$	($2.0e^{-05}$)	$1.8e^{-06}$	($1.3e^{-05}$)
MEAN_VALUE	0.008*	(0.004)	-.004	(0.007)	0.005	(0.003)

Source: LIAB 1995-2005.

Note: The dependent variable is the individual log real daily wage. The differenced specifications include all variables in first-differences. Standard errors are in parentheses and are adjusted for clustering at the industry-level. The OLS models include 15 regional dummies, 16 industry dummies and 9 time dummies (differenced 8 time dummies).

***Significant at 1%-level, **Significant at 5%-level.

[11] The weights take into account that the *IAB-Establishment Panel* oversamples large establishments. In particular, the weighted mean of x is calculated as $x_w = \sum_{j=1}^{n} w_j \cdot x_j$, where $w_j = h_j / \sum_{j=1}^{n} h_j$ with h_j denoting the number of plants a particular observation is representative for. The weighted standard deviation is the square root of $\sum_{j=1}^{n} w_j \cdot (x_j - \overline{x_w})^2$.

[12] See Table A1, which display the unweighted mean and standard deviation of SD_VALUE .

5 Conclusions

The purpose of the present paper was to study the relationship between wages and the degree of firm heterogeneity under different wage setting structures. To derive testable hypotheses, we have set up a theoretical model that analyses the sensitivity of wages to the variability in productivity conditions in a unionised oligopoly framework with centralised and decentralised wage determination structures. The theoretical results predict wages to be negatively associated with the degree of firm heterogeneity under centralised wage-setting, as unions internalise negative externalities of a wage increase for below-average performing firms. We have tested this prediction using a linked employer-employee panel data set from the German mining and manufacturing sector. Consistent with the hypotheses from our theoretical model the empirical results suggest that, everything else equal, workers in more heterogeneous sectors receive lower wages if wages are determined by industry-level bargaining, whereas the degree of firm heterogeneity appears to have no impact on wages in uncovered firms and under firm-level contracts. The results therefore support the notion that the internalisation of negative externalities is not only confined to macroeconomic externalities, but may also extent to negative externalities that concern adverse survival prospects of firms in the industry under consideration.

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6 Appendix

Proposition 1:

Regime (D) : With $U_i = (w_i - \overline{w})l_i = (w_i - \overline{w})c_i q_i$, $i = 1, ..., n$, the first-order condition for each union i is

$$\frac{\partial U_i}{\partial w_i} = l_i + \frac{\partial l_i}{\partial w_i}(w_i - \overline{w}) = c_i \frac{a - n w_i c_i + \sum_{j \neq i} w_j c_j}{b(n+1)} - n c_i^2 \frac{(w_i - \overline{w})}{b(n+1)} = 0, \tag{14}$$

yielding n reaction functions

$$w_i = \frac{a + n c_i \overline{w} + \sum_{j \neq i} w_j c_j}{2 n c_i}, \ i = 1, ..., n. \tag{15}$$

Regime (I) : With $U^I = \sum_{j=1}^{n} (w_j - \overline{w}) l_j = \sum_{j=1}^{n} (w_j - \overline{w}) c_j q_j$, the first-order condition for each wage w_i is

$$\frac{\partial U}{\partial w_i} = \frac{\partial \sum_{j=1}^{n} U_j}{\partial w_i} = (l_i + \frac{\partial l_i}{\partial w_i}(w_i - \overline{w}) + \sum_{j \neq i} \frac{\partial U_j}{\partial w_i}) = 0 \tag{16}$$

$$\Leftrightarrow c_i \frac{a - n w_i c_i + \sum_{j \neq i} w_j c_j}{b(n+1)} - n c_i^2 \frac{(w_i - \overline{w})}{b(n+1)} + \sum_{j \neq i} c_i c_j \frac{(w_j - \overline{w})}{b(n+1)} = 0, \tag{17}$$

yielding n reaction functions

$$w_i = \frac{a + n c_i \overline{w} + 2 \sum_{j \neq i} w_j c_j - \overline{w} \sum_{j \neq i} c_j}{2 n c_i}, \ i = 1, ..., n. \tag{18}$$

Regime (C) : With $U^C = \sum_{j=1}^{n} (w - \overline{w}) l_j = \sum_{j=1}^{n} (w - \overline{w}) c_j q_j$, the first-order condition for the uniform industry-wage w is

$$\frac{\partial U}{\partial w} = \frac{\partial \sum_{j=1}^{n} U_j}{\partial w} = (\sum_{j=1}^{n} (l_j + (w - \overline{w}) \frac{\partial l_j}{\partial w}) = 0 \tag{19}$$

$$\Leftrightarrow \sum_{j=1}^{n} c_j \frac{a - n w c_j + \sum_{i \neq j} w c_i}{b(n+1)} + \frac{c_j (w - \overline{w})}{b(n+1)} (-n c_j + \sum_{i \neq j} c_i) = 0. \tag{20}$$

Variable	Definition	Mean	Std.-Dev.	Mean	Std.-Dev.
		Individual level		Establishm. level	
Individual characteristics		*(1)*		*(2)*	
ln$w$	Real log daily wage in €	4.561	0.343	4.248	0.349
FEMALE	Female worker	0.190	—	0.245	—
AGE	Age in years	39.458	8.926	39.508	3.898
TENURE	Tenure in months	130.725	89.357	100.106	49.248
FOREIGN	Foreign worker	0.093	—	0.046	—
WHITECOLL	White-collar worker	0.378	—	0.321	—
VOCATIO	Vocational Degree	0.673	—	0.773	—
HIGHSCHOOL	Highschool Degree	0.007	—	0.004	—
VOC-HIGH	Voc. and Highschool Degree	0.034	—	0.027	—
TECHN-UNI	Technical Univ. Degree	0.062	—	0.041	—
UNI	University Degree	0.061	—	0.037	—
Establishment characteristics					
VALUE	Per-capita value-added	0.893	0.541	0.588	0.456
MEAN_VALUE	Mean of value-added[1)]	0.778	0.244	0.606	0.228
SD_VALUE	Standard deviation of value-added[1)]	0.716	0.402	0.587	0.356
SIZE	Establishment size	4,297.861	8,689.63	316.740	1,183.221
CENT	Centralised agreement	0.805	—	0.497	—
FIRM	Firm-specific agreement	0.102	—	0.099	—
WCOUNCIL	Works council	0.942	—	0.512	—
K/L	Capital-labour ratio	1.175	2.050	0.928	3.174
EAST	Eastern Germany	0.156	—	0.440	—
Individuals		816,227			
Establishments				3,358	

Source: LIAB 1995-2005. 3,358 establishments, 816,227 individuals, 3,370,807 observations.

Note: Per-capita value-added and the capital-labour ratio are measured in 100,000 €.

[1)] Mean and standard deviation are measured at the two-digit sectoral level.

Table A1: Descriptive Statistics