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Union Bargaining and Intra-Industry Productivity Differentials¹

Theory and Evidence from Germany

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Abstract

This paper indicates that the extent of collective bargaining coverage in an industry may depend on the differences in firms' productivity levels within the industry. Less pronounced differences in productivity levels make it easier to design collective wage contracts that are accepted by a wider range of firms within an industry. Higher dispersion in productivity levels gives rise to the use of firm-level wage agreements reached by unions, while coverage by industry-wide contracts is likely to decrease. We measure correlations between productivity variation and collective bargaining coverage in various industries using German linked-employer-employee data from 2000-2008 and find that the share of industry-wide collective bargaining agreements may indeed be negatively correlated with the dispersion of plant productivity within an industry, while the opposite might hold true for firm-level contracts.

JEL-Classification: D22, J24, J51, L16

Keywords: collective bargaining, trade unions, labor productivity, industry structure

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1. Introduction

Collective bargaining coverage has been declining in recent decades in various developed countries (Visser, 2011). One explanation in the economic literature is that an increase in international activity of firms reduces the bargaining power of unions and may therefore decrease collective coverage in developed countries. Indeed, during the last two decades, both an increase in internationalization of firms and a decline in collective bargaining coverage can be observed, for example in Germany (Antonczyk et al. 2011) and in the US (Dinlersoz and Greenwood, 2012).⁴

From a theoretical point of view, a number of new international trade models (aka Melitz (2003)-style models) also predict the opposite. Due to exporter sorting, highly productive firms can more easily pay higher (collectively bargained) wages. However, if increased international trade raises the productivity dispersion within an industry, this could increase the coordination costs of industry-wide collective bargaining. Collective contracts become less binding, either because high productivity plants pay above the bargained wages or because low productivity plants leave coverage or apply flexible measures to reduce labor costs. In this paper we take up the argument that differences between firms' productivity levels within an industry might be an important factor in determining the coverage rate of collective wage agreements. This line of reasoning can be outlined as follows. Firms can decide whether to bargain individually with their employees or to join collective wage-setting arrangements on the industry-level. They face a trade-off between higher transaction costs in the case of individual wage bargaining and a wage set in the centralized agreement that is potentially less related to the firm's actual productivity level and might therefore require higher wage payments. Wages set within the collectively bargained contract are thereby likely to be oriented at the average productivity levels of the plants covered. Accordingly, for plants characterized by rather low productivity levels, it might not be worthwhile to join such an agreement, even if it allows for the saving of transaction costs. When comparing different industries which vary in the dispersion of productivity levels among plants, centralized wage coverage rates should be higher in those industries described by a more narrow productivity distribution, because fewer plants opt out, making it easier for unions to organize such wage agreements.

The argument can be extended for the case in which firm-level union wage bargaining is allowed for as an alternative to individual or central collective bargaining. A highly productive firm might be interested in a separate contract with a union, since an exceedingly large divergence between wages paid and a much higher true productivity level of the firm might result in demoralized employees and lower work effort (see for considerations of fairness, wages and a firm's profits, e.g., Akerlof and Yellen, 1988). Employees and unions

⁴ Antonczyk et al. (2011) conclude, however, that the recent rise in wage dispersion in Germany can barely be explained by the decline in collective bargaining coverage. Instead, changing wage differentials across and within industries are the main explanation for the rise in wage inequality.

gain from the firm-level agreement due to, first, higher wages. Second, the associated decrease in average productivity of firms covered by the industry-wide agreement results in fewer firms at the lower end of the productivity distribution opting out of the centralized contract. In contrast to the dependence of industry-wide coverage on the dispersion of productivities, the occurrence of firm-level wage contracts should be propelled by a more uneven productivity distribution, which itself will have repercussions on the coverage rate by industry-wide arrangements. We outline our corresponding hypotheses in a simple theoretical framework.

The hypotheses are tested on representative quasi-official linked-employer-employee data for Germany (LIAB) using the time period between 2000 and 2008. We are able to make use of extensive firm-level information on a representative panel of German plants (the IAB Establishment Panel) together with official register data from the social security records of employees working in these plants. We cover the mass of potential determinants of union bargaining coverage and can distinguish between the share of plants covered by industry-level collective contracts and of plants which forge firm-level contracts with unions separately. Using both a simple OLS, a fixed-effects model, as well as a structural equations model, we find that the share of plants covered by a central collective bargaining agreement can indeed fall with a rising dispersion of productivity between plants within an industry, but that it increases the share of plants covered by firm-level contracts. Moreover, intra-industry productivity dispersion seems to be of explanatory power in addition to the inclusion of the mean productivity level in an industry.

Our research also indirectly contributes to the effects of internationalization of firms on industrial relations. The results of the paper can be interesting in this context because recent evidence shows that, possibly due to differences in industrial relations, union bargaining in Germany has been found to have different effects on wages or employment growth, compared to Anglo-Saxon countries (Fitzenberger et al., 2012; Brändle and Goerke, 2012).

The outline of the paper is as follows. In Section 2, we provide a discussion regarding related literature. Section 3 describes a simple theoretical justification for the hypotheses to be investigated. The data for the empirical analysis are described in Section 4. The results from the empirical investigation are reported in Section 5. Section 6 concludes our study.

2. Literature and Institutions

It has long been established (see, for example, Freeman and Medoff, 1984), that unions are able provide employees with a voice at the workplace, can smoothen industrial relations, and can thus raise productivity of unionized plants or industries. But unionization could also hurt firms by increasing pay and imposing restrictive work rules that depress productivity. Furthermore, unions might ‘hold up’ innovative firms by demanding higher wages once a firm has incurred the sunk costs of investment. What unions exactly do to productivity and

firm performance has been the topic of extensive research (see, e.g., Hirsch, 2004, for a survey).

Given that context, however, recent theoretical literature on collective bargaining is sparse. In most Anglo-Saxon countries, union bargaining takes place at the firm level. A company, instead of bargaining with each employee separately, bargains with a union representing all union members in the firm. If not every employee is a union member, there can be a secret ballot as to whether the company has to pay all employees according to the union.⁵ Dinlersoz and Greenwood (2012) develop a model to analyze the resulting relationship between union membership and the distribution of income in 20th century US. Firms hire capital, skilled and unskilled labor. Unionization is a costly process. A union decides how many firms to organize and chooses its members' wage rate. Their analysis suggests that skill-biased technological change is an important factor in de-unionization. European-style union bargaining works quite differently. Here, industry-wide collective agreements usually exist between an industry union and the respective employers' association. They are legally binding for all union members and member firms, but usually are extended to all employees working in the firms covered.⁶ In order to incorporate such a setting, other recent models of endogenous union coverage determination such as Boeri and Burda (2009), who use the matching framework established by Mortensen and Pissarides (1994), distinguish between different industries described by varying skill levels of employees. They establish that industry-wide collective agreements might arise in the presence of firing costs. Since firing costs distort the decision to lay off an employee and may therefore result in inefficiencies, it is possible that both employees as well as employers prefer the more rigid wage regime provided by an industry-wide wage agreement. However, since it may close down some markets for low skilled employees, a hybrid system will emerge in which some industries are characterized by individual wage bargaining while in other industries wages adhere to collective bargaining at the industry level. In most European countries, such as Spain or Sweden, industry-wide collective bargaining agreements are often topped-up by firm-level contracts for the more productive firms or watered-down for less productive firms. However in some countries, such as Germany, both types exist parallel to each other such that the employers can choose the level of bargaining (individual, firm-level or industry-level). Jimeno and Thomas (2013), for example, allow for a distinction between firm-level and industry-wide bargaining. In a matching model they conclude that industry-wide bargaining will result in an increase in the unemployment rate as the hiring rate decreases, while the separation rate is higher than for bargaining at the level of the firm. Only if industry-wide bargaining is amended by opt-out clauses, can the lower unemployment rate of the firm-level bargaining

⁵ The ballot is successful if more than 50% of votes cast are in favour of union bargaining. Otherwise, only union member are paid the union wage and there are strong incentives for employees to join a union such that unionization rates play a more important role when analysing union bargaining in Anglo-Saxon countries.

⁶ Therefore, in industry-wide union bargaining, union membership is not such an important factor as compared to the Anglo-Saxon model. Instead of the employees casting ballots or joining the union, it is mostly the firms that decide whether to pay union wages.

scheme be obtained. Our paper relates to these studies in that we also allow for heterogeneous productivity levels within an industry and, for deriving our hypotheses, assume that wages are co-determined by individual or average productivity levels depending on the bargaining regime.

The endogenous emergence of different bargaining regimes is also allowed for in Ebell and Haefke (2006). In contrast to the studies mentioned before and our own analysis, the focus of Ebell and Haefke (2006) is on the interdependence between the bargaining regime, product market competition, and the equilibrium unemployment rate in an economy. The study's focus differs in addition due to the fact that Ebell and Haefke (2006) include a choice between individual bargaining and union wage bargaining at the firm level while our focus is on industry-wide arrangements. Likewise, for example, Spector (2004) concentrates on firm-level wage bargaining and differentiates between the right-to-manage and the efficient bargaining approach, but takes the form of union bargaining as given. Corneo (1995) allows for country-specific bargaining systems but, given the focus of his paper, also does not consider the decision which bargaining regime emerges in equilibrium. The work of Pagel and Wey (2013) is a recent example from the industrial organizations literature on unionized oligopolies. They examine how competition in international markets affects a union's choice of wage regime. For heterogeneous firms, rising international competition increases the probability that unions choose a discriminatory wage regime, which could increase overall welfare in the economy. Braun (2011) analyzes how collective bargaining at the firm level and at the industry level in a heterogeneous firm model of Melitz and Ottaviano (2008) changes aggregate industry productivity and firm performance relative to a competitive labor market. While industry-wide bargaining forces the least productive firms to exit and thus increases average productivity, firm-level bargaining allows less productive firms to stay in the market and thus reduces average productivity.

On the empirical side, the decline in unionism has long been studied based on data on union density derived from household information (see, for example, Blanchflower, 2007; Fitzenberger et al., 2011; Hirsch, 2008; Millward et al., 2000). However, in a large number of countries, the level of bargaining does not depend on employees' union membership, but on a decision by firms or plants to pay in accordance to an (industry-wide) collective wage agreement or to bargain with unions directly.⁷ The determinants of collective bargaining coverage have also been analyzed, but in a smaller number of studies. As regards the Anglo-Saxon literature, Braun (2011) states that in most empirical studies, which relate union bargaining and productivity (and firm performance), the net effect of unionization on firm productivity remains inconclusive, with the sign and magnitude of the effect differing across countries, industries and systems of industrial relations (see Doucouliagos and Laroche, 2003; Metcalf, 2003, for surveys). Addison et al. (2011) and Schnabel et al. (2006) present comparative analyses of the decline in collective bargaining in two European countries:

⁷ For examples on institutional settings see, for example, Addison et al. (2011) for Great Britain and Germany.

Germany and Great Britain. Using comparable plant-level data over the period 1998–2004 (the German IAB Establishment Panel and the British Workplace Employee Relations Survey), Addison et al. (2011) decompose changes in collective bargaining. They find that within-effects dominate compositional changes as the source of the recent decline in unionism, i.e. that plants decide to leave coverage, not that a change in the characteristics of plants leads to a fall in coverage. Schnabel et al. (2006) find comparable results when analyzing the structure of collective bargaining in an ordered probit model and conclude that the determinants explaining the structure of collective bargaining are similar in both countries; these include plant size and age, foreign ownership, public sector affiliation and subsidiary status. They also present overviews on earlier quantitative evidence on the structure and coverage of collective bargaining suggesting similar results. Kohaut and Schnabel (2003) analyze the determinants of collective agreements in Germany and the reasons for leaving collective coverage. Their findings suggest that the probability of being bound by an industry-wide collective agreement increases with plant size and with the share of qualified employees. Branch plants are more likely, and family-name, and newly founded firms are less likely to be bound by such agreements. Larger plants and those that have a works council or that pay above the collectively bargained wage are less likely to withdraw from industry-wide agreements. Antonczyk et al. (2011) provide evidence for Germany using register data from the Structure of Earnings Survey. They find, however, similar results, namely that industry affiliation and plant size are very relevant, but that personal characteristics are not. Machin (2000), among others, finds that for Great Britain especially, the failure to organize new plants consolidates the decline of union bargaining. Furthermore, he suggests evidence that it is the age of a workplace, rather than the age of its employees, that is the critical age-based factor behind union decline.

3. Hypotheses

In the following, we outline the hypotheses that underlie our empirical analysis in the sections to follow. The basic framework in which the hypotheses are derived is concerned with a setup in which firms are heterogeneous with respect to productivity and decide whether to join industry-wide collective bargaining agreements or choose to bargain individually with their employees. In joining collective bargaining agreements, they can save transaction costs, but may pay higher wages since in the collective bargaining regime wages are orientated at average productivity of the firms covered. It results that higher productivity dispersion within an industry will be associated with fewer firms choosing to join the collective wage agreement.

Afterwards, we present a first extension of the basic model by allowing for firm-level bargaining in addition to collective bargaining at the industry level, a feature observed in the data used for the empirical analysis. Firms characterized by high productivity levels might prefer to sign a firm-level contract with unions instead of joining the industry-wide wage

agreements. The reasoning for this is given by the idea that employees' effort will be seriously diminished if wages paid according to the collective wage agreement fall noticeably lower than the firm's actual productivity level. Accordingly, firms may opt out of the industry-wide settlement and adopt a firm-level contract bargained with the union. This will allow them to still profit from the reduction in transaction costs, but at the cost of even higher wages than in the individual bargaining case. Firms from the upper part of the productivity distribution which choose a firm-level contract reduce the average productivity of firms covered by the industry-wide agreement. The result is that a higher variance in firms' productivity within an industry leads to an increase in the share of firm-level contracts, while a negative effect on coverage by the industry-wide contract remains, although it is weaker than without allowing for firm-level contracts.

Assume that an industry can be characterized by a uniform productivity distribution among firms. Productivity levels a are distributed on the interval $[m-z; m+z]$ where m is average productivity and z characterizes the dispersion of the distribution. The corresponding density function is given by $h(a) = 1/(2z)$, the cumulative distribution function amounts to $H(a) = (a-m+z)/(2z)$. In the first step, firms might either join the collectively set wage level originating from negotiations with an industry-wide trade union or choose to individually bargain with their employees. The latter option is associated with additional transaction costs b per employee due to the necessary bargaining process. The collectively set wage depends on the average productivity of those firms covered by the union contract. Further simplifying the analysis for the moment, we assume that in general wages account for half of the relevant productivity level. For the union wage, this implies:

$$w^u = \frac{1}{2} E[a | a > a^*], \quad (1)$$

where a^* is the productivity level of the firm just indifferent between the union wage and an individually bargained wage. For the individually bargained wage we obtain:

$$w^i = \frac{1}{2} a, \quad (2)$$

such that labor costs amount to $w^i + b = \frac{1}{2} a + b$ in this case. The critical productivity level a^* follows from:

$$w^u = w^i + b, \quad (3)$$

from which we obtain:

$$a^* = m + z - 4b. \quad (4)$$

It can easily be ascertained that the critical productivity level increases in the distribution parameter z .

The share of firms who do not enter into the collective negotiation is given by $H(a^*)$ and amounts to:

$$H(a^*) = 1 - 2b/z \quad (5)$$

in equilibrium. Accordingly, the share of firms covered by the collective agreement shrinks with the distribution parameter z .

Next, we extend the model to allow for firm-level contracts in addition to individual bargaining and industry-wide collective bargaining. We introduce a second benchmark productivity level a^{**} , such that firms with productivity level above a^{**} will choose a firm-level contract resulting in wages equal to:

$$w^f = \frac{1}{2} a, \quad (6)$$

which accordingly will be higher than the wage w^u . The incentive for choosing the firm-level contract is that a too large difference between the wage w^u and a firm's actual productivity level will result in resentment felt by employees and a decrease in work effort. Taking the decrease in employees' effort as opportunity costs equal to d for firms, the sum of labor costs per employee for high-productivity firms sticking to the collective wage w^u amount to $w^u + d$. At the same time, the average productivity level of firms covered by the industry agreement is now given by $\frac{1}{2}(a^{**} + a^*)$. Consequently, we obtain a^* from:

$$\frac{1}{2} a^* + b = (a^{**} + a^*)/4, \quad (7)$$

as:

$$a^* = (a^{**} - 4b)/3. \quad (8)$$

A higher value of a^{**} increases average productivity of firms covered by the industry-wide contract and makes the wage w^u less inviting. Accordingly, the critical productivity threshold a^* increases in a^{**} . Higher transaction costs b lower the critical productivity level a^* as before. The firm that is indifferent between choosing the industry-wide contract or to bargain with a union at the firm level is characterized by:

$$\frac{1}{2} a^{**} = w^u + d = (a^{**} + a^*)/4 + d. \quad (9)$$

Employing a^* from above and solving for the second critical productivity level a^{**} , we obtain:

$$a^{**} = 2b(1-d)/(4d-1), \quad (10)$$

which implies:

$$a^* = b(2-6d)/(4d-1). \quad (11)$$

The two threshold values are now independent of the dispersion parameter z and imply that the share of firms covered by firm-level contracts, F , is given by:

$$F = 1 - H(a^{**}) = (2z - a^{**} + m - z)/(2z) = (m + z - a^{**})/(2z), \quad (12)$$

whereas the share of firms covered by the industry-wide agreement, C , amounts to:

$$C = H(a^{**}) - H(a^*) = 2 b d / (z (4d - 1)). \quad (13)$$

In conclusion, it still holds true that a more dispersed productivity distribution will result in a lower share of firms covered by an industry-wide collective agreement. For the share of firms covered by firm-level union contracts, the direction of the dependence with respect to productivity dispersion cannot be determined unambiguously for the general case. However, the share of these firms will increase in the dispersion of productivity as long as the critical productivity level a^{**} is above average productivity m , which seems likely to be the case.

Accordingly, the hypotheses to be tested can be presented in the following form:

Hypothesis 1: A higher degree of productivity dispersion within an industry results in a decrease in coverage by industry-wide collective agreements.

Hypothesis 2: A higher degree of productivity dispersion within an industry results in an increase in the coverage by firm-level collective agreements.

The next section presents the data used to test these hypotheses, descriptive statistics along with institutional information on union bargaining in Germany, and a short overview of empirical methods employed.

4. Data and Empirical Methods

To test our hypotheses, we use information from a representative quasi-official linked-employer-employee data set from the IAB in Nürnberg, Germany: the Linked Employer-Employee Data from the IAB (LIAB).⁸ In this dataset we can make use of extensive firm-level information on a representative sample of German plants (the IAB Establishment Panel), together with official data from the social security records of almost all employees working in these plants. Our data covers the years 2000 to 2008 of the LIAB QM 2 9308. This dataset allows us both to cover the mass of potential determinants of union bargaining coverage (see, e.g., Schnabel et al., 2006) and use state-of-the-art panel methods to control for unobserved time-invariant heterogeneity. Since both our dependent and independent variables of interest, collective bargaining coverage and productivity dispersion, are measured at the industry level, we aggregate the individual-level and plant-level information. We do so first by aggregating the relevant individual-level information such as sex, age and qualification to the plant level. Then we aggregate the plant-level information

⁸ For more information, see Jacobebbinghaus and Seth (2010).

and the plant-level means of the individual information on the industry-region level.⁹ We restrict our sample to plants from the private manufacturing and service sector, excluding farming, non-profit organizations, public administration and private households. We only use plants with at least five employees in order to be able to reasonably compute plant-level averages of individual covariates. With regard to further data restrictions, we have checked whether the exclusion of plants that do not state turnover as their business volume, plants that are public or other non-private corporations, and plants that have experienced restructuring affects our analyses. Since it does not, we prefer to include as many plants as possible to increase the external validity of our analysis. We potentially analyze 4104 observations in 37 industries and 12 regions over time, but exclude industry-region-time pairs with missing covariates or less than five observations.¹⁰

With respect to the dependent variable of interest, the distinction can be made between plants covered by industry-level collective agreements and plants which forge firm-level contracts with unions separately. While the basic concept of collective bargaining is valid independent of the type of contract, both types should be affected differently by intra-industry productivity differentials (see Section 3). While central collective bargaining coverage should be lower in an industry with very heterogeneous plants, the opposite should be true for firm-level contract coverage. As we aggregate the plant-level information of bargaining coverage on the industry level, we directly use the share of collectively covered plants C or the share of plants covered by a firm-level contract F as our dependent variables. For the measurement of productivity α we rely on labor productivity. It is measured as sales minus the share of intermediate inputs (i.e. value-added) divided by the number of employees.¹¹ In our estimations we use the industry-region mean of the labor productivity m and additionally capture the effect of its dispersion z .

As we have plenty of information on both plants and employees, we can use a rich set of control variables usually employed in empirical studies analyzing the determinants of collective bargaining (Antonczyk et al., 2011; Kohaut and Schnabel, 2003; Machin, 2000; Schnabel et al., 2006). Using plant-level information, we control for average plant size and age, the share of foreign owned and publicly owned plants, the average share of labor costs on turnover, the share of single plants, publicly listed plants and public corporations, the mean export share, the share of plants with a good economic outlook, the average job

⁹ The industry classification comprises 43 industries comparable to the NACE-1 classification. Further information is provided at (http://doku.iab.de/fdz/Klassifikationen_de_en.xlsx). The regional classification comprises of the German Bundesländer, but we have combined some of the smaller ones (mainly city states and adjoining Länder): Saarland and Rheinland-Pfalz, Bremen and Niedersachsen, Hamburg and Schleswig Holstein, and Berlin and Brandenburg. When aggregating, we have experimented with using the cross-sectional weights provided by the IAB as well as employee-weighted aggregates that use the information from the register data of the LIAB without relevant changes to our results.

¹⁰ In our final specification this reduces the maximum number of observations to 2965.

¹¹ Some studies argue that there could be selection bias, because a large number of plants do not provide information in intermediates (cf. Beckmann and Kraekel, 2012). We have checked for this by using sales only. The same holds for using other denominators such as full-time equivalents or standard-hours worked.

growth rate and churning rate in the industry, the average wage cushion, and the average share of net investments on total investments. From the individual information we use the average shares of female employees, of white-collar employees and of flexible employees (part-time, temporary, agency employees etc.) as well as mean tenure. On the industry level we use the mean regional unemployment rate. To control for the business cycle, we use, additionally to year flag variables, the IFO Business Climate Index, a closely followed leading indicator for economic activity in Germany prepared by the IFO Institute for Economic Research in Munich.¹² An overview and summary statistics of all variables used can be found in Table A1 in the Appendix.

We estimate the union bargaining coverage using the following simple model:

$$Y_{kit} = \alpha_{k0} + \alpha_{k1} \cdot prod_{kit} + \alpha_{k2} \cdot sdprod_{kit} + \gamma_k \cdot X_{kit} + \mu_{kt} + \delta_{ki} + \varepsilon_{kit}, \quad (13)$$

where Y_{it} represents the share of collectively bargaining plants in industry i at time t and can measure central collective bargaining C for $k = 1$ and firm-level bargaining F for $k = 2$. We test our hypothesis by explaining these shares using the industry averages of labor productivity $prod_{kit}$ and its dispersion $sdprod_{kit}$ in such a way that the coefficients α_{k1} and α_{k2} show how a one percent increase in the independent variables changes the value of the dependent variable (log-linear model). The model further includes a vector of control variables X_{kit} explained further above, a constant α_{k0} , time dummy variables μ_{kt} , and a two-way error component $\delta_{ki} + \varepsilon_{kit}$. The first part of the error terms captures time-invariant heterogeneity, which we control for in fixed-effects estimations, and the second part captures the remaining errors, for which we control intra-industry correlation using cluster-robust standard errors.

In a second step of the empirical framework we control for the fact that both our dependent variables, the share of plants using central collective bargaining C and the share of plants using firm-level bargaining F , depend on the same set of covariates and on each other. Therefore we employ a structural model, a special case of seemingly unrelated regression (SUR), where the different dependent variables share the same exogenous variables: multivariate regression.¹³ In this type of model, we allow for the disturbances to be correlated and the sets of exogenous variables to overlap.

¹² It is generated via a survey questionnaire on German managers. An index value of over 100 corresponds to better business climate (and vice versa). We use the business climate and the business outlook variables from the indicator. The first gives an overview of the recent business situation, while the second is forward-looking. For more information, see (<http://www.cesifo-group.de/ifoHome/facts/Survey-Results/Business-Climate.html>).

¹³ For the original paper, see Zellner (1962), for a modern approach to SUR, see Cameron and Trivedi (2010), Chapter 5.

5. Results

The results of our empirical analysis are summarized in Table 1. The outcomes for the full set of covariates are shown in Table A2 in the Appendix. We present the results for the share of plants with central collective bargaining C in the left panel and for the share of plants with firm-level contracts F in the right panel. The effect of our variable of interest, productivity dispersion, should be just the opposite for both. In each panel we also present results for pooled OLS in the first two rows, for fixed-effects estimation in the next two rows, and for the simultaneous equations model in the last two rows. This should give an idea how much of a role time-invariant unobserved heterogeneity, and cross-correlation of disturbances plays in our empirical model. While it is not accounted for in the pooled OLS case, it is when using FE or SEM, respectively. Furthermore, the uneven specifications contain only the independent variables of interest as well as time dummy variables and a constant, while the even specifications contain all control variables explained in Section 4 and summarized in Table A1 in the Appendix. This should allow us to interpret uneven specifications as capturing the raw differences or total effect of productivity on bargaining coverage, while the even specifications control for indirect effects by checking covariates or confounding factors. Last, the bottom rows contain the number of observations and clusters as well as, where possible, goodness of fit indicators, namely F-statistics, the R^2 and the Akaike Criterion, to assess the explanatory power of our model.

Table 1: Regression Results

Dependent Variable Model	Collective Bargaining						Firm-Level Contract					
	OLS		FE		SEM		OLS		FE		SEM	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log. Mean Productivity	0.1363*** (0.0277)	0.0357 (0.0275)	0.0107 (0.0149)	-0.0159 (0.0156)	0.1198*** (0.0255)	0.0362 (0.0244)	0.0069 (0.0088)	-0.0227* (0.0102)	0.0119 (0.0100)	0.0045 (0.0096)	0.0057 (0.0090)	-0.0129 (0.0111)
log. Productivity Dispersion	-0.0575*** (0.0156)	-0.0085 (0.0124)	-0.0031 (0.0065)	0.0068 (0.0065)	-0.0435*** (0.0144)	-0.0107 (0.0113)	-0.0013 (0.0054)	0.0098+ (0.0051)	-0.0045 (0.0046)	-0.0024 (0.0045)	-0.0017 (0.0057)	0.0067 (0.0049)
Control Variables		Yes		Yes				Yes		Yes		
Year Dummy Variables	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	
Constant	-0.3612+ (0.1861)	0.5397* (0.2409)	0.4436*** (0.1133)	-0.0573 (0.2419)	-0.3329+ (0.1776)	0.4917 (0.2309)	0.0196 (0.0600)	0.0763 (0.0971)	0.0009 (0.0686)	-0.0119 (0.1204)	0.0382 (0.0612)	-0.0841 (0.1067)
N. of Obs.	2965	2965	2965	2965	2965	2965	2965	2965	2965	2965	2965	2965
N. of Clusters	386	386	386	386	386	386	386	386	386	386	386	386
F-Stat	21.367	46.84	14.916	238.90			41457	29434	32509	19238		
R ²	0.05	0.49	0.12	0.20	0.04	0.43	0.01	0.21	0.01	0.06	0.00	0.18
Aikaike Criterion	-462.67	-2263.55	-6153.87	-6389.13			-6572.29	-7205.47	-9415.74	-9521.55		

Source: LIAB QM2 9308 waves 2000 to 2008; own calculations (controlled remote data access via FDZ). Note: control variables as in Table A2 in the Appendix; standard errors clustered at the industry-region level in parentheses; + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The results for our variables of interest do not conflict with the predictions from our theoretical model. While not always being significant, the log productivity dispersion in an industry seems to be negatively correlated with central collective bargaining coverage and positively correlated with firm-level contract coverage. This can be seen most strikingly in 12

specification (1) and (5). A one percent increase in the productivity dispersion within an industry-region pair is associated with a 0.05 percentage points lower coverage rate of collective bargaining agreements. However, when including covariates or using the FE model in the collective bargaining estimation, this effect is not significantly different from zero anymore. In the firm-level contract estimation, we see significant results in specification (8), where we estimate OLS using all covariates. Here, the effect is somewhat smaller: a one percent increase in the productivity dispersion inside an industry-region pair is associated with a 0.01 percentage points higher coverage rate of firm-level contracts. In the other specifications, however, the effect is also not significantly different from zero.

Also, both dependent variables seem to be correlated with the average productivity in an industry, such that the latter raises central collective bargaining coverage but leads to a reduction in the coverage by firm-level contracts. Interestingly, these coefficients point in the opposite direction from the ones for the productivity dispersion. For example in specification (1) or (5) it can be seen that a one percent increase in mean industry-region productivity is associated with a 0.13 or 0.12 percentage points higher coverage by collective bargaining agreements, while from specification (8) one can see that the same increase would be associated with a 0.02 percentage points lower coverage by firm-level contracts.

When analyzing the covariates, they seem to be in line with the literature. In the OLS model, the share of collectively covered plants in an industry is larger when average plant size (at a decreasing rate), plant age, labor costs and mean employee tenure are higher. It is smaller the more single plants exist in an industry, the more firms export and invest, and the larger the share of white-collar workers is. In the FE model most covariates are not significantly different from zero anymore, but some gain in explanatory power. A rising share of public corporations increases collective coverage, while the opposite is true for the average share of flexible employees. For firm-level contracts, the model cannot explain a comparably larger part of variance than for collective bargaining agreements. Only the share of publicly owned plants, average labor costs and mean employee age (OLS) as well as the share of publicly listed plants (FE) are strongly significantly different from zero. For all models, however, the regional unemployment rate and the IFO business cycle indicators seem to be of larger explanatory power. The goodness of fit indicators suggest that once we control for covariates, the model explains a large part of the variation, but also that the use of fixed-effects might be advised here (much smaller Aikaike criteria). Most importantly regarding the focus of our study, we note that the inclusion of productivity measures per se has a significant amount of explanatory power on the model and that the inclusion of a dispersion measure seems to be of similar importance as the inclusion of average productivity.

To sum up, the empirical analysis cannot falsify our theoretical hypotheses. A larger dispersion of productivity between plants within an industry reduces the share of plants covered by central collective bargaining agreements and increases the share of plants covered by firm-level contracts.

6. Conclusion

The decline in union-coverage rates in the last decades has attracted much attention among economists as well as among politicians. The observed development raises the question of what determines the rate of coverage by collective wage agreements. Our paper adds to this discussion. The starting point of our approach is the idea that differences in the distribution of firms' productivity levels within an industry are a likely factor co-determining the range of such collective agreements. Less pronounced differences between firms concerning their productivity allow for an easier implementation of industry-wide wage agreements in that the resulting compressed wage distribution is closer to actual productivity levels within firms. Accordingly, the first hypothesis we arrive at is that a higher degree of dispersion of firms' productivity levels within an industry is likely to reduce the breadth of industry-wide collective agreements, as more firms will opt out and bargain individually with their employees. In contrast to industry-wide wage agreements, union contracts at the level of the firm show a more direct link between wages and the actual productivity level of the firm at hand. Consequently, we expect the prevalence of firm-level agreements to increase in the level of productivity dispersion within an industry in contrast to the results for industry-wide agreements.

These hypotheses are tested using German linked-employer-employee data. Controlling for a large number of covariates and employing panel data methods we cannot reject the predictions from our theoretical model. The dispersion of labor productivity within an industry is possibly negatively correlated with the share of plants covered by industry-wide bargaining agreements, while the opposite is the case for firm-level contracts. Further empirical work will have to check for the robustness of the results regarding different productivity measures, as well as to try to find identifying restrictions for the structural model.

Our results contribute to the discussion of what determines coverage by union wage contracts by establishing productivity dispersion as a further important aspect. These results might help explain trends in union coverage over the past decades, as technological progress and international integration of markets may have altered the productivity distribution to a varying degree in different industries. The results of the paper can also be interesting in an international context because recent evidence shows that, possibly because of differences in industrial relations, union bargaining in Germany has been found to have different effects compared to Anglo-Saxon countries (Antonczyk, 2012; Fitzenberger et al., 2013; Brändle and Goerke, 2012).

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8. Appendix

Table A1: Overview of Variables Used

Variable	Obs	Mean	Std. Dev.	Min	Max
Year	2965	2003,92	2,57	2000	2008
Sector	2965	19,27	10,73	2	38
Region	2965	6,14	3,37	1	12
Collective Coverage	2965	0,49	0,24	0	1
Firm-Level Coverage	2965	0,08	0,10	0	1
log Mean Productivity	2965	10,94	0,62	5,17	15,38
log Disp. of Productivity	2965	10,63	0,89	6,63	15,62
Average Wage Cushion	2965	0,11	0,05	0,01	0,91
Firm Size	2965	267	522	6	7274917
Firm Size squared	2965	343940	2257733	36	52900000
Firm Age	2965	15,81	2,75	2,00	20,00
Foreign Owned Plants	2965	0,08	0,10	0	1
Publicly Owned Plants	2965	0,05	0,11	0	0,80
Labour Costs on Turnover	2965	0,45	23,71	0	1,35
Single Plants	2965	0,68	0,20	0	1
Public Corporatiron	2965	0,08	0,18	0	0,96
Publicly Listed Plants	2965	0,69	0,22	0	1
Mean of Firm Exports	2965	0,13	0,14	0	1
Plants with Good Outlook	2965	0,38	0,18	0	1
Job Growth Rate	2965	0,01	0,06	-0,90	0,50
Share of Net Investments	2965	0,24	0,13	0	1
Share of Women	2965	0,38	0,21	0	0,97
Mean Employee Age	2965	40,73	2,34	30,59	54,58
Mean Tenure in Sector	2965	7,10	2,07	1,60	16,51
Share of White-Collar Workers	2965	0,32	0,18	0	0,92
Share of flexible Workers	2965	0,08	0,07	0	0,60
Mean Churning Rate in Sector	2965	0,05	0,05	0	0,59
Mean Regional Unemployment Rate	2965	12,20	4,87	3,51	22,52
IFO Business Cycle Indicator	2965	100,02	4,18	92,96	105,87
IFO Business Expectations Indicator	2965	101,13	5,66	93,86	110,93

Source: LIAB QM2 9308; Waves 2000-2008; own calculations using remote controlled data access. Mean regional unemployment rates are drawn from the Federal Employment Agency Nürnberg; IFO indicators are drawn from the IFO Institute Munich; Note: the level of observation is on region-year pairs.

Table A2: Regression Results, Full Table

Dependent Variable Model	Collective Bargaining				Firm-Level Contract			
	OLS		FE		OLS		FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log. Mean Productivity	0.1363*** (0.0277)	0.0357 (0.0275)	0.0107 (0.0149)	-0.0159 (0.0156)	0.0069 (0.0088)	-0.0227* (0.0102)	0.0119 (0.0100)	0.0045 (0.0096)
log. Productivity Dispersion	-0.0575*** (0.0156)	-0.0085 (0.0124)	-0.0031 (0.0065)	0.0068 (0.0065)	-0.0013 (0.0054)	0.0098+ (0.0051)	-0.0045 (0.0046)	-0.0024 (0.0045)
Firm Size		0.0002*** (0.0000)		0.0001* (0.0000)		-0.0000 (0.0000)		0.0000 (0.0000)
Firm Size squared		-0.0000*** (0.0000)		-0.0000 (0.0000)		0.0000** (0.0000)		-0.0000 (0.0000)
Firm Age		0.0152*** (0.0036)		0.0064* (0.0025)		0.0000 (0.0015)		-0.0004 (0.0014)
Foreign Owned Plants		0.1346+ (0.0741)		0.0078 (0.0518)		0.0175 (0.0341)		0.0366 (0.0328)
Publicly Owned Plants		0.1797 (0.1124)		0.0451 (0.0825)		0.2296*** (0.0515)		0.1130+ (0.0576)
Labour Costs on Turnover		0.0001*** (0.0000)		0.0001*** (0.0000)		0.0000*** (0.0000)		-0.0000 (0.0000)
Single Plants		-0.1863*** (0.0485)		-0.0789* (0.0318)		-0.0417* (0.0179)		-0.0372+ (0.0199)
Publicly Listed Plants		0.0100 (0.0641)		0.0376 (0.0421)		0.0462* (0.0206)		0.0772** (0.0240)
Public Corporation		0.1192 (0.0894)		0.3500*** (0.0940)		0.0044 (0.0348)		-0.0307 (0.0530)
Mean of Firm Exports		-0.4115*** (0.0725)		-0.0612 (0.0610)		0.0538+ (0.0277)		0.0287 (0.0330)
Plants with Good Outlook		-0.0932** (0.0346)		-0.0159 (0.0200)		0.0113 (0.0141)		0.0025 (0.0115)
Job Growth Rate		-0.0863 (0.0809)		0.0298 (0.0533)		-0.0181 (0.0335)		-0.0166 (0.0279)
Average Wage Cushion		0.0241 (0.0932)		0.0703 (0.0525)		-0.0351 (0.0436)		-0.0337 (0.0293)
Share of Net Investments		-0.2287*** (0.0484)		0.0139 (0.0294)		0.0214 (0.0213)		-0.0194 (0.0179)
Mean Employee Age		-0.0034 (0.0040)		-0.0042 (0.0030)		0.0053*** (0.0013)		0.0004 (0.0019)
Share of Women		-0.0783 (0.0556)		-0.1115 (0.0919)		0.0075 (0.0197)		-0.0323 (0.0484)
Mean Tenure in Sector		0.0253*** (0.0065)		0.0117* (0.0051)		-0.0027 (0.0030)		0.0012 (0.0030)
Share of White-Collar Workers		-0.3935*** (0.0585)		-0.0923 (0.0924)		-0.0384* (0.0183)		-0.0109 (0.0537)
Share of Flexible Workers		0.0588 (0.1550)		-0.2887** (0.1018)		-0.0418 (0.0498)		-0.0425 (0.0602)
Mean Churning Rate in Sector		0.1372 (0.1169)		-0.0215 (0.0867)		-0.0099 (0.0462)		-0.0812+ (0.0428)
Mean Regional Unemployment Rate		-0.0094*** (0.0023)		-0.0044 (0.0030)		0.0024** (0.0008)		0.0032* (0.0016)
I/O Business Cycle Indicator		-0.0245*** (0.0032)		-0.0037*** (0.0011)		0.0002 (0.0014)		0.0019** (0.0006)
I/O Business Expectations Indicator		0.0236*** (0.0029)		0.0116*** (0.0019)		-0.0010 (0.0013)		-0.0019+ (0.0011)
Year Dummy Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.3612+ (0.1861)	0.5397* (0.2409)	0.4436*** (0.1133)	-0.0573 (0.2419)	0.0196 (0.0600)	0.0763 (0.0971)	0.0009 (0.0686)	-0.0119 (0.1204)
N. of Obs.	2965	2965	2965	2965	2965	2965	2965	2965
N. of Clusters	386	386	386	386	386	386	386	386
F-Stat	21.367	46.84	14.916	238.90	41.457	29.434	32.509	19.238
R ²	0.05	0.49	0.12	0.20	0.01	0.21	0.01	0.06
Aikaike Criterion	-462.67	-2263.55	-6153.87	-6389.13	-6572.29	-7205.47	-9415.74	-9521.55

Source: LIAB QM2 9308 waves 2000 to 2008; own calculations (controlled remote data access via FDZ). Note: standard errors clustered at the industry-region level in parentheses; + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.