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We Want them all Covered! Collective Bargaining and Firm Heterogeneity. Theory and Evidence from Germany

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We Want them all Covered! Collective Bargaining and Firm Heterogeneity.

Theory and Evidence from Germany[1]

Florian Baumann[2] Tobias Brändle[3]

Abstract

This paper establishes a link between the extent of collective bargaining and the degree of productivity dispersion within an industry. In a unionised oligopoly model we show that for only small differences in productivity levels. a sector-union can design a collective wage contract that covers a wide range of heterogeneous firms. In sectors with higher productivity dispersion, an industry union has an incentive to demand firm-level wage contracts with the most productive firms, so that they can prevent low-productivity firms from leaving collective coverage. However, such firm-level contracts may not prevent firms at the lower end of the productivity distribution from avoiding collective coverage in sectors with high productivity dispersion. We test the predictions of the model using German linked employer-employee data between 1996 and 2010 and find support for our theoretical results.

Keywords: Collective bargaining; trade unions; heterogeneous firms; unionised oligopoly; linked employer-employee data

JEL-Code: D22, D43, J51

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1 Introduction

In most developed countries, union membership and collective coverage have been in decline in recent years (see, e.g. Visser 2013 for an international perspective or Ellguth and Kohaut 2014 for Germany). With German data, Fitzenberger and Sommerfeld (2013) conclude that the decline in union representation is a common trend, not well explained by changing employer or employee characteristics. In fact, the more general question of what are the determinants of the extent of union coverage in different countries and industries has not yet been answered convincingly in the economic literature. The question seems especially relevant because union wage bargaining is still of major importance in the vast majority of European countries. Furthermore, we observe that different kinds of bargaining modes exist at the same time and even within the same industry. For example, in Germany, within some industries we observe some firms covered by an industry-level agreement, some by a firm-level agreement with the industry union, and others coexisting which are not bound by union wages at all (see, e.g., Addison et al. 2013). In this paper, we argue that, in addition to firm-level productivity, the productivity dispersion between firms explains the parallel existence of bargaining regimes within an industry. Moreover, we show that the differences in productivity dispersion between industries is a relevant and until now unexplored factor in the equation determining the bargaining status of single plants.

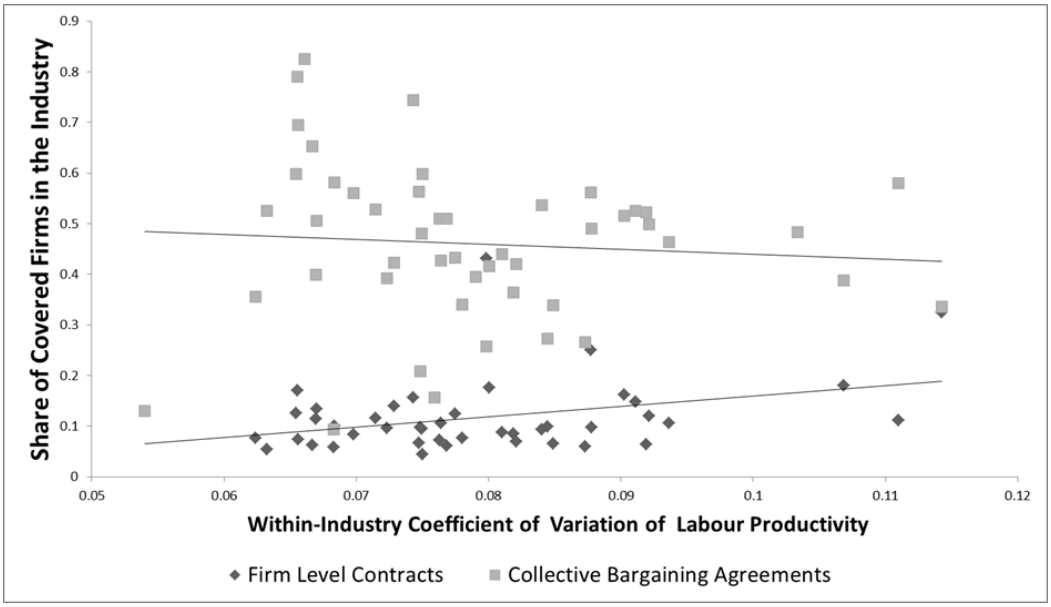
This paper contributes to the explanation of the occurrence of different wage bargaining regimes and, especially, their co-existence. The argument for the observed differences in wage bargaining that we develop in this analysis is based (a) on the fact that firms are heterogeneous with regard to productivity and (b) the idea that collective bargaining can be a means to save on the transaction costs of individual negotiations. The fact that transaction costs determine the extent of collective bargaining is described in, for example, Arrowsmith et al. (2003)[4]. Card et al. (2013), among others, find that heterogeneous firms have diverging wage demands, and Hirsch et al. (2014) establish, for Germany, that more productive firms are more likely to be under collective coverage.[5] The argument in Hirsch et al. (2014) is that high-productivity firms like to pool with less productive firms in wage bargaining as this allows them to pay lower wages. Indeed, Gürtzgen (2009) establishes that collectively bargained wages at the industry level should fall with productivity dispersion within the industry.

[4]See also Dinlersoz and Greenwood (2012).

[5]For a detailed literature review see Section 2.

Building on these insights, we endogenise the resulting bargaining regime and allow for the co-existence of collective bargaining at the industry level, firm-level bargaining with the industry union, and bargaining outside union coverage in the same industry. In doing so, we establish that productivity dispersion within industries is an important determinant of the mode of collective bargaining; more dispersed productivity levels among firms lead to lower collective coverage and greater importance of firm-level agreements. We develop the argument theoretically and provide empirical tests with German linked employer-employee data using a measure of within-industry productivity dispersion to explain firms' bargaining regimes.

Figure 1: Wage Bargaining and Productivity Dispersion Within German Industries



Source: Own calculations based on LIAB QM2 9310, years 1996-2010 using controlled remote data access via FDZ. Calculated using employee-representative sample weights. As industry classification we use the WZ-93 2-digit level.

The empirical data illustrated in Figure 1 provide a starting point: the scatter plot shows within-industry labour productivity dispersion on the abscissa and the percentage of firms covered by collective and firm-specific union wage contracts on the ordinate. It can be seen that there is a negative association between within-industry productivity dispersion and collective bargaining coverage at the industry level, and a positive relationship between productivity dispersion and coverage by firm-level contracts.

To help explain this relationship, we use a stylized unionised oligopoly model. We consider an industry in which heterogeneous firms (one low productivity firm, two medium productivity firms, one high productivity firm) compete in quantities. Principally, the workforce is represented by an industry union. Firms pay wages resulting either from a collective wage agreement covering the industry, from firm-level negotiations with the industry union or wages bargained by its own employee representatives. The industry wage contract set by the union depends on the productivity distribution of firms covered. Firms agreeing to wages according to the collective agreement do not have to bargain individually with their workforce and therefore save on additional negotiation costs.[6] However, as firms differ with respect to productivity, the uniform wage imposes a greater burden on relatively unproductive firms, making coverage less attractive. These firms might want to abstain from coverage by the industry contract and instead bargain directly with their own workforce. In this case, first, the lower productivity level is recognised within the negotiations, and, second, wages are lower due to the ensuing competition in wage setting. Accordingly, the firm has to trade-off the increase in transaction costs and a likely worsening of industrial relations on the one hand with lower wages on the other. At the same time, highly productive firms in the industry reap extra profits as the collective wage is relatively low for them. Therefore, the union has an incentive to conclude separate firm-level agreements involving higher wages for the employees in these firms. This is a costly strategy for the union, however, as it includes additional transaction costs and requires overcoming opposition by the management of the highly productive firms. Nevertheless, concluding a separate contract with highly productive firms may be profitable since it can entail an additional benefit for the industry union: the union's optimal wage for the industry-wide contract falls, preventing low-productivity firms from leaving collective coverage. The industry union thereby prevents competition in wage setting. However, where the spread in productivity is large, low productivity firms will still choose to leave coverage even if the industry union concludes a separate contract with high-productivity firms.

[6]These can be information costs regarding the level of wages in other companies and bargaining costs with every employee. Additionally, the firms potentially save on strike costs as the sector-level union usually calls strikes only in a fraction of the industry's firms. Also, the firm might benefit from peaceful industrial relations in the workplace.

We test the predictions of the theoretical model in our empirical analysis. We investigate the determinants of a firm's decision to be covered by an industry-level collective bargaining agreement (CBAs) or a firm-level contract with a sector union (FLC). In contrast to other studies, for example by Hirsch et al. (2014), we also take firm heterogeneity within an industry into account: by using the industry average labour productivity and its dispersion as factors influencing the bargaining mode of plants. For this analysis we use linked-employer-employee data for Germany from the IAB (LIAB) for the years 1996-2010, where we can control for a large number of individual- and plant-level characteristics. By applying linear probability and probit models, as well as panel estimators, we find that the share of plants covered by a central collective bargaining agreement is negatively correlated with the level of intra-industry productivity dispersion. The opposite holds true for coverage by a firm-level contract. We find our results to be very robust across a number of robustness checks as well as for different subsamples. We therefore conclude that one of the driving factors explaining differences in collective bargaining coverage between and within industries is the extent of firm heterogeneity within single industries.

The outline of the paper is as follows. In Section 2, we provide a discussion of the related literature. Section 3 describes a unionised oligopoly model to derive our hypotheses. 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

It has long been established (see, for example, Freeman and Medoff 1984) that unions are able provide employees with a voice in the workplace, can smooth industrial relations, and can thus raise the productivity of unionised plants and industries. But unionisation can 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, Hirsch 2004 for a survey).

In our paper, the endogenous formation of the bargaining regime takes centre stage, where the most important ingredient is the heterogeneity of firms with respect to productivity. The framework used for the analysis is the one of a unionised oligopoly. Accordingly, in this section, we focus on the relevant theoretical literature on unionised oligopolies, heterogeneous firms, different wage setting regimes and the endogenous formation of these regimes, as well as the relevant empirical literature on the determinants of collective bargaining.

2.1 Theory

The literature on unionised oligopolies starts with Davidson (1988) and has recently been surveyed by Goeddeke (2010). Within this framework, different wage bargaining regimes have been studied. Corneo (1995), for example, compares industry-wide and firm-specific contracts in an international trade model, while Gürtzgen (2003), in contrast, distinguishes between occupational and industry unions. Grandner (2001) focuses on the effects of bargaining centralisation in a scenario with upstream and downstream producers. More recently, Pagel and Wey (2013) investigate the effects of industry wage setting in the case of heterogeneous firms where only some firms compete internationally whereas others in the industry only sell domestically. The topic of firm heterogeneity is further analysed in the setting of unionised oligopolies in Gürtzgen (2009) and Haucap and Wey (2004). These contributions point to the fact that industry-wide negotiations in the presence of heterogeneous firms lead to a more compressed wage structure within the industry, which benefits highly productive firms. In Haucap and Wey (2004) this fact increases incentives for productivity-enhancing investments by firms whereas Gürtzgen (2009) finds that industry-wide wages decrease in the dispersion of productivity within an industry because the union also cares about the firms at the lower end of the productivity distribution. Along these lines, Bastos et al. (2009) consider a two-stage bargaining model where firms pay a mark-up on the sector's negotiated base wage according to their productivity level.

Firm heterogeneity and collective bargaining has also been investigated in alternative model frameworks. Braun (2011) incorporates firm-level and sector-level wage setting into the framework of the Melitz and Ottaviano (2008) model; however, he considers only a simplified version of sector-level negotiations by stating a fixed mark-up on competitive wages. Kuhn (1988) constitutes one early example where heterogeneous firms engage in firm-level wage negotiations.

Heterogeneity stems from the fact that firms are founded by employees with heterogeneous entrepreneurial skill. In Ramaswamy and Rowthorn (1993) firms are heterogeneous with respect to the importance of efficiency wages which leads firms to leave collective coverage. More recently, Boeri and Burda (2012) and Jimeno and Thomas (2013) integrate union wage setting at the industry level in a labour market matching model, where again the wage compressing effect of industry-wide wage setting becomes important.[7] Similarly, but in a different setting, Hirsch et al. (2014) show that productive firms have an incentive for centralised wage bargaining as wages are lower for them if they orient to sector-level averages.

The literature described so far takes the wage bargaining regime as exogenously given. In contrast, Lazear (1983) explicitly analyses the endogenous formation of such institutions where firms differ in the costs they incur when they want to avoid becoming unionised. Ebell and Haefke (2006) investigate how the intensity of product market competition alters the incentives for workers to establish efficiently bargained firm-level contracts in contrast to individual bargaining. Petrakis and Vlassis (2004) consider the incentives of firms and firm-level unions to argue for an extension of union wages to the whole industry, a topic also considered by Haucap et al. (2001). Spector (2004) integrates the decision regarding firm-level contracts into a political-economy model, whereas Taschereau-Dumouchel (2014) develops a search model in which labour unions arise endogenously through voting within the firm and pose a threat to non-unionised firms, which, in turn, react to this threat by making bargaining less profitable for the unions.

Otherwise, firm heterogeneity and collective bargaining coverage has most often been investigated in settings in which this heterogeneity distinguishes different group of workers. Lindbeck and Snower (2001) argue that the change from occupational jobs to multi-tasking increases productivity differences among workers and lets firms demand more flexible wage arrangements. Ortigueira (2013) assumes that skill-based technological change, caused by growing productivity differences between skill groups, leads to a process of decentralization in wage bargaining.[8]

To our knowledge, the parallel existence of several types of bargaining in the same industry at the same time has not been investigated theoretically thus far. However, several papers from the industrial relations literature point to the importance of this phenomenon. Although they

[7] Also in a search and bargaining framework, but with homogeneous firms, Bauer and Lingens (2014) show that unions can, under certain conditions, reduce the over-employment that arises in such models.

[8] Freeman and Gibbons (1995) have a similar argument in that the unionisation of new groups such as white-collar workers lead to an increased reliance on decentralized wage bargaining.

emphasize the divergent interest of heterogeneous firms, they do not provide a fully formed hypothesis. For this, see, for example, Visser (2007), Behrens and Helfen (2009), and Thelen and van Wijnbergen (2003).

2.2 Empirics

On the empirical side, studying the determinants of union coverage has long focused on union membership. A large number of studies have therefore relied on data on union density derived from household information (see, for example, Fitzenberger et al. 2011 or Hirsch 2008). However, in a large number of (non-Anglo-Saxon) 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.[9] For a detailed description of the German system of industrial relations, see Silvia (2013). The determinants of collective bargaining have also been analysed, for example by Addison et al. (2011) and Schnabel et al. (2006), who present comparative analyses of the determinants of collective bargaining in two European countries: Germany and Great Britain. Using plant-level data Addison et al. (2011) find that within-effects dominate compositional changes as the source of changes in collective coverage, i.e., that plants decide to leave or join coverage, not that a change in the characteristics of plants leads to a fall or rise in coverage. Schnabel et al. (2006) find 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.[10] For Germany, Kohaut and Schnabel (2003) analyse 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 the share of qualified employees, and that being a branch plant increases, while being a family-name or newly founded firm decreases, the likelihood of being covered.

[9] While the exact institutional settings vary, firms usually have a wide range of discretion when deciding on collective coverage. Some examples: In Germany firms can decide on collective bargaining by becoming a member of an employers' association. While unions can push for this decision, low levels of union membership in uncovered plants limits their power to do so. In the USA, unions can call a vote on collective coverage in a plant. However, various government legislation severely hinders this process. In France, a country where coverage is very high due to general application rules, most of the industry-wide collective contracts merely serve as minimum standards. In fact, it is usually additional firm-level contracts that determine wages actually paid.

[10] They also present overviews on earlier quantitative evidence on the structure and coverage of collective bargaining suggesting similar results, e.g. by Machin (2000).

More recently, Addison et al. (2013) use random effects probit model to estimate union coverage and survival models to estimate coverage duration. They use the typical control variables. More recently, Hirsch et al. (2014) introduce a new variable, based on a theoretical model: total factor productivity. They find that more productive firms are more likely to be covered by a collective agreement, conditioned on firm size and a limited set of firm-level control variables. In addition, Capuano et al. (2014) investigate whether exporters are more likely to be collectively covered, dependent on firm size. They find that especially small exporters are less likely to bargain collectively. Martensen (2014) uses recent waves of the IAB EP data to analyse the relationship between collective coverage and a subjective measure of competition, finding a non-linear effect. Antonczyk et al. (2011) and Fitzenberger and Sommerfeld (2013) are the only studies for Germany using linked employer-employee data from the Structure of Earnings Survey. They find similar results to the studies above, namely that industry affiliation and plant size are very relevant whereas employee characteristics are not, and that these determinants can only explain a small fraction of changes in coverage.

Some studies analyse the relationship between firm heterogeneity and collectively-set wages. Gürtzgen (2009) finds, for Germany, that under centralized wage setting, wages decline with firm heterogeneity. Bastos et al. (2009) analyse the effect of firm heterogeneity on wages in a multi-stage bargaining setting for Portugal and show that firm heterogeneity decreases wages in general, but that the wage cushion, i.e. the mark-up unions can demand from more productive firms, increases (see also Section 2.1) .

3 The model

The model developed in this section is based on Gürtzgen (2009) who considers a unionised oligopoly with heterogeneous firms and compares different bargaining regimes. The novelty of our approach lies in that we, first, allow different wage setting regimes to apply to different firms at the same time, and, second, derive these wage setting regimes endogenously.

We consider an industry with four firms producing a homogeneous good. The firms compete on quantity (Cournot-competition) and can be distinguished according to their productivity levels. More precisely, the industry consists of one highly productive firm, H, for which labour productivity is given by $m(1+s)$, two firms M_1 and M_2 with intermediate labour productivity

equal to m, as well as one low-productivity firm L with labour productivity $m(1-s)$. Labour productivity denotes the number of units of the homogeneous good one worker produces, where m is a measure for median/mean productivity and s a measure for relative productivity dispersion within the industry. In the following, we assume $m > 0$ and $0 < s < 1/5$, which will assure positive output levels for all firms in equilibrium. The industry faces a linear inverse demand function $P(Q) = 1 - Q$, where Q is total output produced and $P(Q)$ the resulting equilibrium price.

Labour is the only factor of production and the wage level for one unit of labour for the different firms is denoted by w_H, $w_M (= w_{M_1} = w_{M_2})$ and w_L. Wages are the outcome of wage setting before product market competition takes place. Wages may either be determined in a collective agreement, covering more than one firm, or in a firm-specific agreement. With respect to firm-specific agreements, two scenarios can be distinguished. The first one is a firm-level union wage contract. In this case, representatives of the industry union (also in charge of the collective agreement for the industry) set wages, so that coordination between the different wage setting processes takes place. The second firm-level contract is a decentralized one, in which the firm only meets with representatives of its own workforce. These three bargaining types (collectively at the industry level, firm-level contracts by the industry union, and no union coverage) describe the situation currently in Germany quite well. With respect to wage negotiations, we assume that in each case, either the union or the firm's employee representatives are able to set wages whereas firms decide on employment levels (monopoly union model).This excludes the motive of leaving collective coverage only to circumvent the higher bargaining power of the industry union.

In the following, we assume that the industry union's utility is given by the wage sum of those workers covered by its own wage agreements. If wage setting is conducted by a firm's employee representatives, they too seek to maximize the respective firm's wage sum. The equilibrium bargaining regimes are determined endogenously within the model as specified below in the description of the model's time structure.

The timing of the model is as follows. At stage 1, the sector union decides whether to conclude an individual and firm-specific contract with firm H instead of holding it to the collective wage agreement. As in, for example, Dinlersoz and Greenwood (2012), concluding such a separate wage contract is associated with costs C for the union. Next, at stage 2, firm L decides on whether or not it will bargain over a collective agreement or leave collective coverage and instead

bargain separately with its workforce. Concluding a separate wage contract is costly, such that firm L has to bear costs of T when leaving joint coverage (see, for example, Lazear 1983). At stage 3, the union and possibly firm L's employee representatives set wages before finally product market competition takes place at stage 4 and pay-offs are realized. The idea that the decision on the wage setting regime is taken prior to wage setting itself implies that the choice of regime is the more long-term decision. This can be justified by the fact that union wages may apply to firms for some time even after leaving collective coverage.[11]

3.1 Stage 4: Product market competition

At stage 4, the four firms choose quantities un-cooperatively for given wages. Firm i's profit equation, $i = H, M_1, M_2, L$ is given by

$$\pi_i = \left(1 - Q - \frac{w_i}{\delta_i}\right) q_i \tag{1}$$

where q_i denotes the quantity produced by firm i and $\delta_H = m(1+s)$, $\delta_{M_1} = \delta_{M_2} = m$, and $\delta_L = m(1-s)$. Profit maximization gives rise to equilibrium quantities

$$q_H^* = \frac{m - \frac{4w_H}{1+s} + 2w_M + \frac{w_L}{1-s}}{5m} \tag{2}$$

$$q_M^* = q_{M_1}^* = q_{M_2}^* = \frac{m + \frac{w_H}{1+s} - 3w_M + \frac{w_L}{1-s}}{5m} \tag{3}$$

$$q_L^* = \frac{m + \frac{w_H}{1+s} + 2w_M - 4\frac{w_L}{1-s}}{5m}. \tag{4}$$

Equilibrium profits obtained by firms amount to

$$\pi_i^* = (q_i^*)^2 \tag{5}$$

[11] For Germany, this rule is established in §4(5) Tarifvertragsgesetz (Collective Bargaining Act).

where $i = H, M_1, M_2, L$. Finally, employment levels are given by

$$N_H^* = \frac{q_H^*}{m(1+s)} \tag{6}$$

$$N_M^* = N_{M_1}^* = N_{M_2}^* = \frac{q_M^*}{m} \tag{7}$$

$$N_L^* = \frac{q_L^*}{m(1-s)}. \tag{8}$$

3.2 Stage 3: Wage setting

In this section, we distinguish between four possible regimes, representing the possible outcomes of the decisions taken by actors at stages 1 and 2. All firms may be covered by a uniform collective agreement (scenario *coll.*); all firms except L may be covered by a uniform collective agreement (scenario *coll. without* L); all firms except H may be covered by a collective agreement (scenario *coll. without* H); or the collective agreement applies only to the two firms with medium productivity (scenario *coll. only* M). If firm H is not under the rule of the collective agreement, the sector union sets a separate wage for this firm. If firm L is not covered by the collective agreement, its employees representatives set a separate wage for firm L. In the following, we establish equilibrium wages for each regime.

Scenario *coll.*: In this scenario, a uniform wage which is chosen by the industry union applies to all firms. We denote the wage by w_{C1}, where for this case $w_H = w_M = w_L = w_{C1}$. Since the union's wage applies to all firms in the sector, the union's objective function reads

$$U = w_{C1}\left(N_H^* + 2N_M^* + N_L^*\right) \tag{9}$$

from which we obtain the optimal wage as

$$w_{C1}^* = m\frac{2 - 3s^2 + s^4}{4 + 6(s^2 + s^4)}. \tag{10}$$

As can easily be established, the wage decreases in the degree of heterogeneity in firms' productivity levels, a result already established by Gürtzgen (2009). Since the union represents employees in all firms, it also has to take into account the reduction in productivity of firm L when s increases. This concern dominates the higher productivity level of firm H insofar as the uniformly set wage decreases.

Scenario *coll. without L*: In this scenario, the collectively set wage, denoted by w_{C2}, applies to firm H and the two firms M, $w_H = w_{M1} = w_{M2} = w_{C2}$, whereas the wage for firm L, denoted by w_{L2}, is set by the employee representatives of firm L. Accordingly, since the employees of firm L do not receive wages set by the union, the sector union's utility is given by[12]

$$U = w_{C2}\left(N_H^* + 2N_M^*\right) \tag{11}$$

The objective function of the employees representatives of firm L reads

$$V = w_{L2}N_L^*. \tag{12}$$

Both players choose wages simultaneously. The resulting wages are given by

$$w_{C2} = m\frac{9(1+s)(3+2s)}{87+4s(29+23s)} \tag{13}$$

$$w_{L2} = m(1-s)\frac{21+4s(7+4s)}{87+4s(29+23s)}. \tag{14}$$

Wages are lower for firm L compared to the collective wage. This holds not only because due to the lower productivity level of firm L but even when $s = 0$, i.e., in the event of symmetric firms. The latter is due to the fact that the sector union internalizes the externalities between the employees in its objective function, whereas the employee representatives of firm L do not.[13] Concerning the dispersion in productivity levels, the difference in wages increases in s.

Scenario *coll. without H*: In this case, the collective agreement is binding for the two firms M as well as for the low-productivity firm L, whereas a separate wage is set by the sector union for the high-productivity firm H. We denote the collective wage by w_{C3}, $w_{M1} = w_{M2} = w_L = w_{C3}$,

[12] One might also consider a scenario in which the sector union also cares, at least so some extent, about wage income of workers at firm L even if it does not set the wage itself. We performed a corresponding analysis and found that the main results of the theoretical analysis remain qualitatively unaltered.

[13] The lower level of coordination in wage negotiations implies that the wage w_{C2} is also lower than w_{C1}.

and the wage applying to firm H by w_{H3}. Since all firms are represented by the sector union, its utility is given by

$$U = w_{H3}N_H^* + w_{C3}\left(2N_M^* + N_L^*\right). \tag{15}$$

The sector union chooses both wages simultaneously, from which we obtain

$$w_{C3} = m\frac{(1-s)(3-2s)}{6-8s(1-s)} \tag{16}$$

$$w_{H3} = m\frac{(1+s)(3-2s(2-s))}{6-8s(1-s)}. \tag{17}$$

In this scenario wage, setting is fully coordinated. Accordingly, for $s = 0$, i.e., in the event of symmetric firms, the two wages are the same and coincide with the collective wage in scenario *coll.*. An increase in productivity dispersion leads to a rise in the wage applying to the high-productivity firm mirroring its productivity increase, whereas the collective wage goes down. The latter is due to the fact that the productivity of the firms covered by this wage contract decreases.

Scenario *coll. only M*: In this scenario, only the two medium-productivity firms pay the collective wage which we denote by w_{C4}, $w_{M1} = w_{M2} = w_{C4}$. The sector union sets a idiosyncratic wage for firm H, w_{H4}, while the representatives of employees in firm L independently set the wage w_{L4} for this firm. The objective functions for the sector union (U) and the representatives of employees in firm L (V) can be stated as

$$U = w_{H4}N_H^* + w_{C4}2N_M^* + w_{L4} \tag{18}$$

$$V = w_{L4}N_L^*. \tag{19}$$

With simultaneous wage setting, we arrive at

$$w_{C4} = m\frac{9}{29} \tag{20}$$

$$w_{H4} = m(1+s)\frac{9}{29} \tag{21}$$

$$w_{L4} = m(1-s)\frac{7}{29}. \tag{22}$$

The above equations again indicate that, as in scenario *coll. without L*, the lack of wage coordination leads to lower wages for firm L even for $s = 0$. In this case, the outcomes of *coll. without L* and *coll. only M* completely coincide. As productivity dispersion increases, wages in firm H (L) increase (decrease) whereas, in our setup, the collective wage set for the two medium-productivity firms is unaffected.

Before turning to the decisions that govern the wage setting regime to be established, we briefly summarize the consequences of the different wage setting regimes for profits and union utility. As the decisions on stages 1 and 2 of the game are taken by the sector union and firm L, we will confine ourselves to reporting only their payoffs, which are displayed in Table 1.

Bargaining Regime	Utility and Profits
coll.	$U = \frac{(2-s^2)^2}{10(2+3(s^2+s^4))}$ $\pi_L = \frac{2+s(10-s(3+s(5+8s))))^2}{100(2+3(s^2+s^4))^2}$
coll. without L	$U = \frac{(3+s(4+3s))(162(3+2s)^2)}{5(87+4s(29+23s))^2}$ $\pi_L = \frac{16(21+4s(7+4s))^2}{25(87+4s(29+23s))^2}$
coll. without H	$U = \frac{6-s(8-3s)}{10(3-4s(1-s))}$ $\pi_L = \frac{(3-14(s(1-s))^2}{100(3-4s(1-s))^2}$
coll. only M	$U = \frac{486}{4205}$ $\pi_L = \frac{784}{21025}$

Table 1: Payoffs depending on the wage setting regime

As an intermediate result we obtain:

Lemma 1 *If there were no costs of leaving collective coverage for firm L it would always prefer the firm-specific wage, independently of whether a firm-level contract applies to firm H or not. This is due to the lower wages it can obtain when the wage is set by representatives of its own employees. Likewise, independent of the decision by firm L, the industry union would always choose to conclude a separate contract with firm H (for $s > 0$) if this were not associated with additional costs.*

3.3 Stage 2: Firm L's decision of whether or not to leave collective coverage

As pointed out in Lemma 1, firm L would benefit from a wage contract concluded with its employee representatives. However, leaving the collective agreement is associated with costs T due to, for example, higher transaction costs resulting from the necessity of the firm-specific wage bargaining.[14] In this section, our main interest resides with, on the one hand, how incentives for leaving the collective wage agreement change with the level of productivity dispersion in the market, and, on the other hand, how incentives differ depending on whether the sector union decides to conclude a separate wage contract with firm H at the first stage. In the following, to save on notation, we write firm L's profits as a function of equilibrium wages, $\pi_L = \pi_L(w_H, w_M, w_L)$.

Formally, firm L leaves collective coverage if

$$D_1 \equiv \pi_L(w_{C2}, w_{C2}, w_{L2}) - T - \pi_L(w_{C1}, w_{C1}, w_{C1}) > 0 \tag{23}$$

in the event that no firm-level contract will be concluded with firm H and if

$$D_2 \equiv \pi_L(w_{H4}, w_{C4}, w_{L4}) - T - \pi_L(w_{H3}, w_{C3}, w_{C3}) > 0 \tag{24}$$

should firm H be covered by a separate wage contract. In both cases, it holds that the differences are increasing in productivity dispersion s. This is explained by the fact that, due to lower wages, firm L benefits more from a firm-specific agreement with its employee representatives the farther its own productivity level deviates from the industry average. Accordingly, critical values for the costs T (depending on s) can be established, where T_1 (T_2) is the solution to $D_1(T_1) = 0$ ($D_2(T_2) = 0$), above which firm L will stay under the rule of collective wages, . Finally, comparing the two values T_1 and T_2, it holds that $T_1 < T_2$ for all $s > 0$. The incentives to leave collective coverage are more pronounced in the event that no firm-specific agreement with firm H will be made by the sector union. This is due to the fact that the collective wage is higher in the case that no differentiation between firms of type M and H is made by the union. Accordingly, for $T \in (T_1, T_2)$ firm L will decide to leave collective coverage if no firm-specific wage contract

[14] In a more general setting, these costs could also be firm-specific.

is applied to firm H but will stay under the rule of collectively set wages in the event of a firm-level contract for firm H. The results are illustrated in Figure 2. The darker shaded area indicates parameter constellations where firm L always leaves collective wage setting whereas the lighter shaded area contains those parameter combinations for which firm L only leaves collective coverage should no firm-specific contract with firm H be concluded.

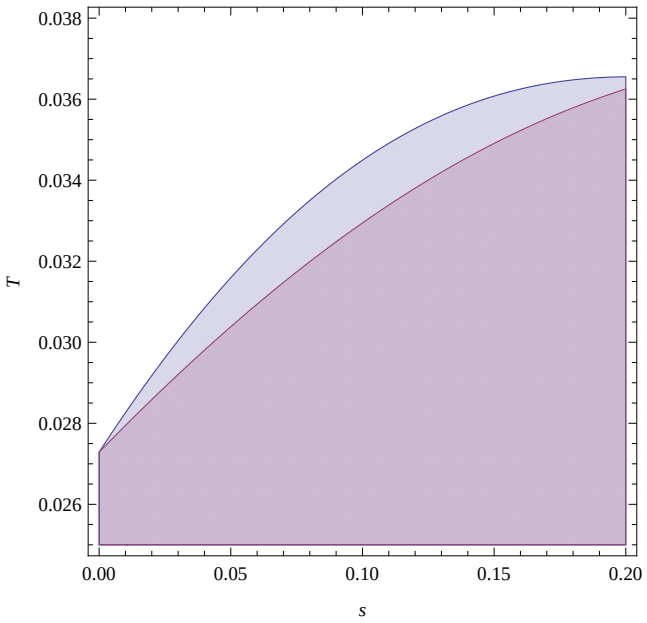


Figure 2: Decision of firm L of whether or not to leave collective coverage - darker shaded area: always leave collective coverage; lighter shaded area: only leave collective coverage if no firm-level contract is concluded with firm H

The main result of this section may be summarized by:

Lemma 2 *For given productivity dispersion s, the incentives for firm L to leave collective coverage are higher if no firm-level contract is concluded between the industry union and firm H. The incentive for firm L to leave collective coverage increases with productivity dispersion.*

3.4 Stage 1: The sector union's decision of whether or not to conclude a firm-level arrangement with firm H

As described in Lemma 1, independent of the firm L's decision at stage 2, the sector union would be better off if it was to set a idiosyncratic wage for firm H in addition to the collective coverage wage. This reasoning is similar to the insight that a monopolist's profits increase if price discrimination is a viable option. However, concluding a separate contract with firm H is costly for the union as it has to withstand opposition by firm H's management.

Besides this standard reasoning about the sector union's preferences regarding the wage setting regime, an important additional aspect has to be taken into consideration in our setup, due to the threat of firm L leaving collective coverage. As shown in the last section, firm L is more likely to leave collective coverage if no firm-level agreement is signed between the sector union and firm H. Firm L leaving collective coverage has a direct negative impact on the union's utility obtained in equilibrium due to, firstly, a lower share of employees being covered by the union wages, and, secondly, due to the imposed competition between the sector union and firm L's employee representatives. Accordingly, the union's incentives for concluding a separate contract with firm H are enhanced if it thereby can induce firm L to stay within the collective wage agreement, i.e., if $T \in (T_1, T_2)$.

Formally, let us denote union utility by $U = U(w_H, w_M, w_L)$. For $T > T_2$, i.e., firm L will never leave the collective wage agreement, the union will conclude a firm-specific contract with firm H if

$$D_3 \equiv U(w_{H3}, w_{C3}, w_{C3}) - C - U(w_{C1}, w_{C1}, w_{C1}) > 0. \tag{25}$$

For $s = 0$ and $C > 0$, the difference D_3 is smaller than zero since all wages would be the same (i.e., $w_{H3} = w_{C3} = w_{C1}$). As firms become heterogeneous with regard to productivity levels, it becomes more and more favourable for the union to differentiate wages between firms such that we will find a critical value C_1 for C such that a firm-level agreement with firm H results for $C < C_1$. From equation (25), the critical value C_1 (which again depends on s) amounts to

$$C_1 = \frac{s^2(2-(2-s)s)^2}{2(3-4(1-s)s)(2+3(s^2+s^4))} \tag{26}$$

and is increasing in s.

Next, consider the case of $T < T_1$, i.e., firm L will always leave collective coverage. The union will conclude a separate wage agreement with firm H if

$$D_4 \equiv U(w_{H4}, w_{C4}, w_{L4}) - C - U(w_{C2}, w_{C2}, w_{L2}) > 0. \tag{27}$$

Again, for $s = 0$ it holds that $D_4 < 0$ due to the sector union's wages being all the same (i.e., $w_{H4} = w_{C4} = w_{C2}$) but the difference may become positive for $s > 0$. The critical value C_2 given below, under which the union will choose to conclude a separate wage agreement with firm H, results from equation (27) as

$$C_2 = \frac{810s^2(609 + 812s + 612s^2)}{841(87 + 4s(29 + 23s))^2} \tag{28}$$

and is increasing in s as well. Comparing the two critical values C_1 and C_2 it can be established that $C_1 > C_2$ for $s > 0$. This results from the fact that the gain achieved by wage differentiation is larger if the union covers firms of a wider productivity range, as is the case if firm L does not leave collective coverage.

Finally, consider $T_1 < T < T_2$. In this case, firm L will leave collective coverage if no firm-level contract is concluded with firm H but will stay under union coverage otherwise. A separate wage agreement with firm H is profitable for the union if

$$D_5 \equiv U(w_{H3}, w_{C3}, w_{C3}) - C - U(w_{C2}, w_{C2}, w_{L2}) > 0. \tag{29}$$

According to the fact that keeping firm L in a collective agreement is always valuable for the sector union in order to avert competition among workers, D_5 is positive for $s = 0$ and for C not too large. An increase in productivity dispersion makes it instead less worthwhile for the union to keep firm L under its coverage due to the downward pressure on the collective wage. Accordingly, the union is only willing to incur lower maximal costs C in order to avoid firm L leaving collective coverage. This effect dominates the finding that setting a firm-specific wage for firm H also becomes more attractive when productivity differences increase. Stated mathematically, the critical value C_3 for costs C above which the union abstains from concluding

a firm-level contract with firm H follows from equation (29) as

$$C_3 = \frac{3834 + 5112s + 2355s^2 - 15640s^3 - 17720s^4 - 11104s^5 + 1986s^6}{2(3 - 4s + 4s^2)(87 + 116s + 92s^2)^2} \tag{30}$$

and is decreasing in s, where it holds that $C_3 > C_1 > C_2$. In summary, the incentives for the sector union to conclude a firm-level agreement with firm H are always strongest if it allows the sector union to prevent firm L from leaving collective coverage.
We summarize:

Lemma 3 *For given productivity dispersion s, the incentive for the industry union to conclude a firm-level contract with firm H is strongest if by doing so it can prevent firm L from leaving collective coverage. The incentive is least pronounced if firm L is going to leave collective coverage for sure. Without an influence on the decision of firm L, the incentive for concluding a separate firm-level contract with firm H increases in productivity dispersion.*

In a final step, we have to take into account that the ranking of T with respect to T_1 and T_2 as well as the ranking of C regarding C_1, C_2, and C_3 both depend on the realization of productivity dispersion s. This gives rise to a quite differentiated picture of how a change in productivity dispersion will actually change the bargaining regime, where different outcomes are possible. In the following, we assume that C is smaller than C_3, i.e., that the sector union will choose to sign a separate contract with firm H should this be the only way to keep firm L under the collective agreement. Table 2 summarizes the (remaining) possible parameter constellations.

	$T < T_1$	$T_1 < T < T_2$	$T_2 < T$
$C < C_2$	*coll. only M*	*coll. without H*	*coll. without H*
$C_2 < C < C_1$	*coll. without L*	*coll. without H*	*coll. without H*
$C_1 < C (< C_3)$	*coll. without L*	*coll. without H*	*coll.*

Table 2: Wage setting regime

According to the analysis conducted above, an increase in s increases all four critical threshold values T_1, T_2, C_1, and C_2, i.e., an increase in productivity dispersion implies a (weak) movement to the left and upwards in Table 2. Let us consider the case where any of the wage setting regimes could potentially occur in equilibrium. This implies $C_1(s = 0) = 0 < C < C_2(s = 1/5)$ and $T_2(s = 0) < T < T_1(s = 1/5)$. In this case, the wage setting regime is *coll.* should productivity

dispersion be absent or small. Considering an increase in productivity dispersion, we obtain that the movement in Table 2 will be either up or to the left at some level of s so that the wage setting regime changes to *coll. without* H, i.e., the sector union applies a firm-level contract to firm H. Letting s increase further, we find that the wage setting regime may either change first to *coll. without* L and later to *coll. only* M or more directly to *coll. only* M.
In summary:

Proposition 1 *Assume the critical costs C_3 to be large. The expected sequence of observed wage setting regimes when productivity dispersion increase from $s = 0$ to $s = 1/5$ is given by either (i) coll., coll. without H, coll. only M or (ii) coll., coll. without H, coll. without L, coll. only M. Overall, the share of firms covered by the collective agreement (weakly) decreases in productivity dispersion. The share of firms covered by firm-level agreements is generally higher for high instead of low levels of productivity dispersion.*

Case (ii) described in Proposition 1 may arise because the sector union might only conclude a separate contract with firm H in order to keep firm L under collective coverage which may no longer be possible when s increases further. At that point, it may be worthwhile for the sector union to draw a separate contract for firm H only after a further (discrete) increase in s.

4 Data and Empirical Procedure

4.1 Data

To test the predictions of our theoretical model, we use the Linked Employer-Employee Dataset (LIAB) from the Institute for Employment Research (IAB), which combines combination of a representative German plant survey (the IAB Establishment Panel) and official data from the social security records of employees working in these plants. We use the waves 1996 to 2010 of the latest cross-sectional version LIAB QM2 9310.[15] This dataset allows us to cover both the mass of potential determinants of union bargaining coverage (see, e.g., Schnabel et al. 2006) and, additionally, a number of individual characteristics of the employees that are not surveyed in

[15]For more information, see Jacobebbinghaus and Seth (2010). We disregard early waves because of missing covariates and because plants in East Germany were not surveyed before 1996.

the IAB EP. By using this dataset, we can also make use of state-of-the-art panel techniques to control for unobserved time-invariant heterogeneity.

Our dependent and independent variables of interest, collective bargaining coverage and productivity dispersion, are measured at the plant and industry level, respectively. Therefore, we aggregate the individual-level information to the plant level.[16] We calculate firm heterogeneity by industry using the NACE-2 classification (WZ-93 2-digit level).[17]

With respect to the dependent variable of interest, we can distinguish between plants covered by industry-level collective agreements (*Branchentarifverträge*) and plants which forge firm-level contracts (*Haus- und Firmentarifverträge*) with unions separately.[18] Average coverage by an industry-level contract is 49% and varies between 9% in the ICT sector and 82% in the energy and water supply sectors. Coverage by firm-level contracts is much lower and averages 9% of all plants.

For the measurement of productivity at the industry level, we rely on labour productivity. It is measured as total sales divided by the number of employees.[19] In our estimations, we use the industry mean of labour productivity m and additionally capture the effect of its dispersion using the coefficient of variation v as a measure for productivity dispersion s.[20] Average (median) productivity of all plants is 652,226 (267,220) Euros. When looking at the industry-level, average productivity ranges between 105,442 Euros in Other Services and 7,589,571 Euros in the Refinery Industry. The coefficient of variation is on average 0.077 (standard deviation of 0.013)), ranging from 0.54 in Banking Services to 0.11 in Communications.

[16]Measuring the information at the individual level would bias our results if larger firms are affected differently by firm heterogeneity. As a possible remedy, employment-weights could be used for equivalent results. Our results can be replicated on the individual level using sample weights provided by the IAB. However, individual-level estimation is computationally cumbersome and some of the methods applied do not allow for the use of sample weights.

[17]The original industry classification of the IAB comprises 43 industries comparable to the NACE-1 classification. Instead, we use the variables obtained by Eberle et al. (2011), which provide for a more detailed classification, which is consistent over time, and which can also be linked to official statistics. Further information is provided at ($http://doku.iab.de/fdz/Klassifikationen_de_en.xlsx$).

[18]As further information on plant-level bargaining, in addition to CBAs, we can observe whether a plant pays above the CBA and whether there is a works council in the plant, which usually indicates higher wages (Addison et al., 2010). We use these measures as robustness checks.

[19]Some studies argue to calculate value added instead. However, when using information on intermediate inputs, there is selection bias, because a large number of plants do not provide information on intermediates and this information is not missing at random (cf. Beckmann and Kräkel 2012). We have checked the results using other denominators such as full-time equivalents or standard-hours worked.

[20]We use the coefficient of variation instead of the standard deviation, because the latter is increasing in size if average productivity m rises within an industry.

Table 3: Productivity Measures by Bargaining Regime

Bargaining Regime	log. TFP	Industry Mean of log. Labour Productivity	Var. Coeff. of Industry Labour Productivity	No. of Obs. (uncond.)
Individual Wage Bargaining	12.32	12.55	0.0772	54,215
Collective Bargaining	12.82	12.59	0.0768	63,844
Firm-Level Contracts	12.92	12.57	0.0796	12,434
Total	12.61	12.57	0.0772	130,493

Source: LIAB QM2 9310 waves 1998 to 2010; own calculations (controlled remote data access via FDZ)

Table 3 gives an descriptive overview on the relationship between productivity and collective coverage. In the data, collectively covered firms are on average more productive, but plants with firm-level contracts are most productive. This is in line with the assumptions of our theoretical model. Table 6 gives an overview of the variables of interest by industries.

We use a rich set of control variables usually employed in empirical studies analysing the determinants of collective bargaining. These studies usually use only firm-level data (Addison et al., 2013; Machin, 2000; Schnabel et al., 2006; Hirsch et al., 2014), or use linked employer-employee data but with only a few control variables (Fitzenberger and Sommerfeld, 2013). Using plant-level information, we control for plant size and age, foreign and public ownership, the share of labour costs on turnover, single plant status, public listing, the export share, economic outlook, the job growth and churning rates, and the 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, and average daily gross wages. We control for the region a plant is located.[21] More importantly, we use a firm-level measure of total factor productivity as a control variable, in addition to the industry-specific average and dispersion. We compute this similar to Hirsch et al. (2014), using the firm fixed effect from a Cobb-Douglas production function. This captures the time-invariant unexplained residual from the estimation. An overview and summary statistics of all variables used can be found in Table 5 of the Appendix.

[21]The regional classification in the IAB comprises of the German Bundesländer, but we have combined some of the smaller ones (mainly city states and adjoining Länder): Saarland and Rhineland-Palatinate, Bremen and Lower Saxony, Hamburg and Schleswig-Holstein, and Berlin and Brandenburg.

We restrict our sample to plants from the private manufacturing and service sector, excluding 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. We further need to exclude all plants that do not state sales as their business volume as this is needed to compute the productivity measures.[22] We further exclude plants with unreasonably low or high productivity levels, missing observations for control variables, and plants in industry-year cells with less than five observations. We potentially analyse 98,065 observations (26,779 plants) in 48 industries over time.

4.2 Empirical Procedure

We estimate the union bargaining coverage status of a plant using the following simple models:

$$Y_{ijt} = \alpha_0 + \alpha_1 \cdot tfp_{ijt} + \alpha_2 \cdot m_{jt} + \alpha_3 \cdot (v)_{jt} + \gamma_k \cdot X_{ijt} + \mu_t + \gamma_j + \epsilon_{ijt}, \tag{31}$$

where Y_{ijt} represents the bargaining status of a plant i in industry j at time t and can measure central collective bargaining C or firm-level bargaining F (with individual bargaining and the respective other category being the control group). We test our hypothesis by explaining these shares using the industry averages of labour productivity m_{jt} and its relative dispersion $(v)_{jt}$ in such a way that the coefficients α_2 and α_3 show how an increase in the independent variables changes the average propensity of a plant to be collectively covered. The model further includes firm-level total factor productivity tfp_{ijt}, a vector of control variables X_{ijt} (explained above), a constant α_0, time dummy variables μ_t, and a three-way error component $\delta_i + \gamma_j + \epsilon_{ijt}$. The first parts of the error term captures time-invariant heterogeneity, which we control for using industry dummy variables (industry fixed effects) and, in the panel estimation, plant fixed effects. The second part captures the remaining errors, for which we control intra-firm correlation using cluster-robust standard errors. In an additional step of the empirical framework, we control for the fact that our dependent variables are binary and that the effects of the independent variables may not be linear using probit/logit and panel probit/logit models. For simplicity and because the results do not change significantly, we only use these estimations as a robustness check.

[22] This drops banks/financial institutions which state the total assets, insurance companies which state total premium paid, and non industrial organizations, regional and local authorities which state a budget volume (administration and property budget).

5 Empirical Results

5.1 Main Results

The results of our empirical analysis are summarized in Table 4. The outcomes for the full set of covariates are shown in Tables 7 and 8 in the Appendix. We present the results for the share of plants with central collective bargaining C in the upper part and for the share of plants with firm-level contracts F in the middle part. We include the variables of interest, regression diagnostics and information on the sets of control variables used. Specifications (1) to (4) and (6) progressively add control variables, while specification (5) serves as a sample selection test.[23] The stepwise adding of control variables allows us to interpret the raw differences or total effect of productivity dispersion on bargaining coverage, as well as the direct effects only, when controlling for indirect effects using covariates or confounding factors.

The results for our variables of interest fit the predictions from our theoretical model. Our main result is that productivity dispersion within an industry, measured by the variation coefficient of labour productivity, is significantly negatively correlated with coverage by a central collective bargaining agreement and significantly positively correlated with coverage by a firm-level contract. The size of the effects suggest that an increase in firm heterogeneity of one standard deviation (0.0132) decreases collective bargaining coverage by 1.5 percentage points (3.4%) and increases coverage by a firm-level contract by 0.76 percentage points (8.5%).

When analysing the covariates, they seem to be in line with the literature. In the OLS model, coverage by collective agreement is larger for plants that have outsourced, that are a head quarter, for older plants, publicly owned plants, for plants with a higher share of female and foreign employees, and for employees with higher tenure. More productive plants are more likely to be collectively covered, similar to the results from Hirsch et al. (2014). This holds also for most of the specifications for firm-level contracts. The share of part-time workers, trainees and skilled blue-collar workers is also positively linked to collective bargaining. Collectively covered plants have higher average daily wages, which are less widely distributed and with fewer employees earning above the social security contribution limit. They have also a higher share

[23] For the latter specification we lose about 30% of our observations. We check, whether this causes sample selection bias by estimating a model that only contains the control variables of specification (4) on the sample of specification (6). If the coefficients change much, this indicates that the additional variables of specification (6) suffer from non-random missing values.

Table 4: Collective Bargaining Coverage and Intra-Industry Productivity Dispersion: Main OLS Results

Dep. Var.: Collective Bargaining Coverage	(1)	(2)	(3)	(4)	(5)	(6)
Mean Sector Productivity	-0.0672***	0.0067	0.0064	0.0078	0.0082	0.0100
	(0.0067)	(0.0094)	(0.0096)	(0.0092)	(0.0095)	(0.0094)
Var. Coeff. of Sector Prod	-1.4280***	-0.7445**	-1.4333***	-1.0333***	-1.0917***	-1.0981***
	(0.2832)	(0.2964)	(0.2854)	(0.2747)	(0.2860)	(0.2859)
F-Stat.	249.32	129.43	128.77	145.43	134.96	127.08
R Squared	0.04	0.15	0.19	0.22	0.22	0.23
Dep. Var.: Firm-Level Contract	(1)	(2)	(3)	(4)	(5)	(6)
Mean Sector Productivity	-0.0251***	-0.0048	-0.0077	-0.0122**	-0.0125**	-0.0123**
	(0.0038)	(0.0054)	(0.0060)	(0.0060)	(0.0060)	(0.0061)
Var. Coeff. of Sector Prod	1.1464***	0.4856***	0.5415***	0.5497***	0.5112***	0.5433***
	(0.1533)	(0.1881)	(0.1932)	(0.1932)	(0.1977)	(0.1979)
F-Stat.	68.01	23.47	19.88	17.54	15.84	14.70
R squared	0.01	0.04	0.05	0.05	0.05	0.05
Firm-Level Control Variables	No	No	Some	Some	Some	All
Individual-Level Control Variables	No	No	No	Yes	Yes	Yes
Dummy Variables	No	Yes	Yes	Yes	Yes	Yes
N. of Obs:	92,104	91,526	91,526	91,526	80,889	80,889
N. of clusters	24,774	24,648	24,648	24,648	23,238	23,238

*Source: LIAB QM2 9310 waves 1998 to 2010; own calculations (controlled remote data access via FDZ). Note: control variables as in Tables 7 and 8 in the Appendix; standard errors clustered at the plant level level in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

of the wage bill on turnover, are larger and have a higher churning rate. Negative determinants of collective bargaining coverage are the share of flexible workers, being a company with limited liability, and having a larger share of white-collar workers. Notably, when controlling for a large number of covariates, the share of exports on sales has a negative effect on collective bargaining coverage, which is a result that complements the findings from Hirsch et al. (2014) and Capuano et al. (2014), that firm size mostly explains the positive relationship between exporters and coverage status. Also, we have a strong negative time trend in our data. The control variables for broad economic sectors and German regions are jointly significant, respectively. The goodness of fit indicators suggest that once we control for covariates, the model explains a large part of the variation.

5.2 Discussion on Robustness

Table 9 in the Appendix shows the results for probit and panel estimations. We have already mentioned that having a binary dependent variable would make non-linear estimation methods such as probit or logit models more appropriate. Our results do not change when employing such methods, as can be seen in specifications (1) and (2) of Table 9. Their coefficients show very similar levels of statistical significance and their marginal effects do not differ much from the coefficients in the linear models. The panel estimators should give an idea of how much of a role time-invariant unobserved heterogeneity plays in our research question. While the results hold regarding the signs of the coefficients, they are not significantly different from zero when using the within group estimator, irrespective of whether we use a linear or binary logit model. This suggests that the results are not driven by plants changing their collective bargaining status, but by a selection of plants with different unobserved characteristics into a bargaining regime, depending on the productivity dispersion of the industry. Our results are similar to the baseline results when applying random effects models, which holds both for a linear and a binary probit model.

Table 10 in the Appendix shows results for subsamples. The results show that the relationship stays the same when we reduce the sample size to the years after 2000 (specification (1)).[24] When excluding plants that belong to a wide definition of the public sector, the results do not change (specification (2)).[25] Differentiating the data by industry, we can see that in specification (3), where only manufacturing plants are used, the results differ such that the coefficient for industry productivity dispersion is not significant any more. Therefore, it is not surprising that specification (4) shows very strong and significant results for the service sector. The results are also robust when looking only at West German plants (specification 5). Specification (6) narrows the sample down to West German manufacturing plants. While the coefficients stay positive, they lose significance. This may be due to the fact that the sample becomes too small.

[24] This has to do with the representativeness of the data, which is only consistent for every German state after the year 2000.

[25] We identify public sector plants if they state they are a public corporation as their form of organization, if they post a budget instead of a turnover volume, and if they employ civil servants. We hence allocate additional plants to the public sector, not just the narrow definition in the Classification of Economic Sectors.

Other robustness checks include a possible non-linear effect of firm heterogeneity on collective coverage, measured by the inclusion of a second degree polynomial. Since it does not have a significant coefficient, the effect of firm heterogeneity is likely to be linear. Furthermore, regarding the specifics of the German system of industrial relations, other forms of firm-level mark-ups on wages exist, that may be explained by our theoretical model, as well. Accordingly, we have also analysed other forms of plant-level bargaining, namely the existence of a wage cushion and the presence of a works council. Wage cushions indicate some form of compensation above the collectively bargained wage. While they are directly measured in our data, it is not clear how they emerge: maybe through additional bargaining at the plant-level or by efficiency wage-setting by the firms (Jung and Schnabel, 2011). Another form of plant-level bargaining might occur when works councils exist. While they are formally not allowed to bargain over items that are part of a collective bargaining contract, they have been found to increase firm-level wages (Addison et al., 2010). We have, therefore, performed regressions that explain the existence of wage cushions or works councils. We find that industry productivity positively correlates with both alternative dependent variables. Therefore, in addition to the existence of firm-level contracts by the sector union, the presence of plant-level agreements, may also be positively affected by firm heterogeneity. Our results are also robust against different measurements of sector heterogeneity, e.g. using the standard deviation instead of the coefficient of variation, the mean average deviation, and the median average deviation. The definition of treatment and control groups, e.g. whether plants with firm-level contracts are counted as zero or missing, when analysing coverage by a collective bargaining agreement etc. does not significantly change the results. When pooling both forms of union bargaining, the results are driven by the larger group, i.e. collective coverage.

6 Conclusion

The decline in union coverage rates in recent decades has attracted much attention to the question of what determines collective wage bargaining. Our paper adds to this ongoing discussion in the economics literature and among policy makers in developed countries.

Our approach combines the frameworks for heterogeneous firms and endogenously determined bargaining regimes. Differences in the distribution of firms' productivity levels within an industry

define the range of collective agreements. This implies that, apart from the position of a firm in the productivity distribution of an industry, the degree of productivity dispersion within the industry will also affect a firms' bargaining status. Less pronounced heterogeneity allows for an easier implementation of industry-wide wage agreements, because the resulting compressed wage distribution is closer to actual productivity levels of firms within an industry. Accordingly, a higher degree of dispersion of firms' productivity levels within an industry reduces the breadth of industry-wide collective agreements, as more firms will opt out and bargain individually with their employees or firm-level contracts will be negotiated by the sector union. In contrast to industry-wide wage agreements, union contracts at the firm level are more responsive to the actual productivity level of firms, implying an incentive for sector unions to cream-skim highly profitable firms. In addition, an industry union may optimally choose to bargain separately with high-productivity firms to prevent low-productivity firms leaving the sector-level collective coverage. Therefore, in contrast to industry-wide agreements, the prevalence of firm-level contracts depends positively on an increase in the productivity dispersion within an industry.

These hypotheses are tested using German linked-employer-employee data. Controlling for a large number of covariates and employing OLS, binary, and panel data methods, we cannot reject the predictions from our theoretical model. The dispersion of labour productivity within an industry is negatively correlated with the share of plants covered by industry-wide bargaining agreements, while the opposite is the case for firm-level contracts. This relationship holds while controlling for firm-level productivity and other determinants of collective bargaining, as well as for various subsamples and possible alternative measures for both the dependent and independent variables of interest.

Our results show that industry-level heterogeneity, and possibly other industry characteristics, also play a role in explaining coverage by union wage contracts. Apart from employee and firm incentives (not) to bargain collectively, there are strategic motives by the unions, which have to be accounted for in future research. Our insights may help explaining trends in union coverage over the past decades, if technological progress and international integration of markets has also influenced the productivity distribution within industries in developed countries.

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7 Appendix

Table 5: Summary Statistics of Variables

Variable	Obser-vations	Mean	Std. Dev.	Min	Max
Variables of Interest					
Labour Productivity	98,351	12.61	1.15	5.86	19.00
Avg. Sector Labour Productivity	130,989	12.57	0.61	10.93	15.12
Std. Dev. of Sector Labour Productivity	130,989	0.97	0.18	0.46	2.33
Var. Coeff. of Sector Labour Productivity	130,989	0.08	0.01	0.04	0.16
Collective Bargaining Agreement	130,493	0.49	0.50	0	1
Firm-Level Contract	130,493	0.58	0.49	0	1
Individual Characteristics (Shares)					
Female Employees	130,989	0.42	0.30	0	1
Employees with Foreign Origin	130,989	0.05	0.10	0	1
Empl. with Tenure 6 Years to 10 Years	130,989	0.17	0.19	0	1
Empl. with Tenure 11 Years to 20 Years	130,989	0.14	0.18	0	1
Empl. with Tenure ¿ 20 Years	130,989	0.05	0.10	0	1
Empl. aged between 30 and 49 Years	130,989	0.54	0.15	0	1
Empl. aged between 50 and 65 Years	130,989	0.25	0.15	0	1
Trainees	130,989	0.06	0.10	0	1
Skilled Employees	130,989	0.61	0.28	0	1
Highly-Skilled Employees	130,989	0.08	0.15	0	1
White-Collar Workers	130,989	0.32	0.27	0	1
Skiled Blue-Collar Worker	130,989	0.26	0.28	0	1
Part-Time Employees	130,989	0.20	0.25	0	1
Average Gross Daily Wage	130,989	64.51	27.39	1.19	186.18
Dispersion of Gross Daily Wage	130,989	26.46	10.69	0	339.64
Firm Level Characteristics					
Insource	130,009	0.03	0.18	0	1
Outsource	130,134	0.05	0.22	0	1
Share of Temporary Workers	130,192	0.06	0.15	0	1
Share of Open Positions	130,426	0.02	0.05	0	1
Share of Trainees	130,968	0.06	0.10	0	1
Share of Flexible Workers	130,989	0.09	0.16	0	1
Churning Rate	130,849	0.06	0.18	0	14
Headquarter	130,485	0.19	0.39	0	1
Branch Plant	130,485	0.12	0.32	0	1
Firm Age (censored at 1975)	130,989	15.62	9.91	0	35
Public Ownership	122,603	0.07	0.25	0	1
Foreign Ownership	122,603	0.06	0.24	0	1
Limited Company	130,549	0.64	0.48	0	1
Public Sector	130,989	0.14	0.35	0	1
Average Firm Age	130,989	14.62	3.26	3.5	35
Share of Intermediate Inputs	93,959	0.50	0.24	0.01	3.6
Share of Wage Bill on Turnover	10,2321	0.31	0.21	0	1
Relative Employment Outlook	48,097	0.98	0.22	0	7.89
Log of Investments	125,563	8.81	5.71	0	22.45
Log of Value Added	85,266	14.42	1.91	4.28	22.79
Share of Temp Agency Workers	90,434	0.18	0.07	0	1
Orientiation to CBA	126,096	0.21	0.41	0	1
Multiple Personnel Problems	130,829	0.65	1.13	0	9
Log. Wage Sum	115,378	11.41	1.79	5.58	19.19
Dummy variables					
Sector:	9 dummy variables for different industries (approx. Nace1)				
Region:	12 dummy variables for German Laender (some combined)				
Firm size:	5 dummy variables for different firm size classes				
Year:	9 dummy variables for each year				

Table 6: Productivity Measures by Nace-2 Industry Classification

Industry (German Classification of Economic Activities, Edition 1993, 2 Digit-Level))	log. Mean Industry Productivity	Var. Coeff. of Mean Ind. Prod.	Share of CBA	Share of FLC	No. of Obs.
Agriculture, hunting and related service activities	12.01	0.06	0.36	0.08	3,245
Forestry, logging and related service activities	11.85	0.07	0.82	0.09	211
Mining of coal and lignite; extraction of peat	13.47	0.09	0.56	0.25	228
Other mining and quarrying	12.78	0.07	0.51	0.13	601
Manufacture of food products and beverages	12.65	0.11	0.58	0.11	4,560
Manufacture of textiles	12.81	0.07	0.42	0.14	833
Manufacture of wearing apparel; dressing and dyeing of fur	12.46	0.09	0.46	0.11	291
Tanning and dressing of leather; manufacture of luggage, etc.	12.91	0.08	0.40	0.07	167
Manufacture of wood and of products of wood and cork	12.53	0.08	0.34	0.07	1,560
Manufacture of pulp, paper and paper products	13.61	0.07	0.69	0.07	638
Publishing, printing and reproduction of recorded media	12.68	0.08	0.51	0.07	1,666
Manufacture of coke, refined petroleum products and nuclear fuel	14.47	0.10	0.48	0.15	116
Manufacture of chemicals and chemical products	13.60	0.08	0.54	0.09	2,339
Manufacture of rubber and plastic products	13.09	0.07	0.40	0.11	2,348
Manufacture of other non-metallic mineral products	12.91	0.07	0.58	0.10	2,215
Manufacture of basic metals	13.37	0.09	0.49	0.10	2,250
Manufacture of fabricated metal products	12.71	0.07	0.39	0.10	5,421
Manufacture of machinery and equipment n.e.c.	13.12	0.07	0.48	0.10	5,923
Manufacture of office machinery and computers	13.24	0.08	0.27	0.10	212
Manufacture of electrical machinery and apparatus n.e.c.	13.14	0.08	0.44	0.09	1,957
Manufacture of radio, television and communication equipment	13.27	0.08	0.36	0.09	894
Manufacture of medical, precision and optical instruments	12.44	0.09	0.27	0.06	2,428
Manufacture of motor vehicles, trailers and semi-trailers	13.49	0.09	0.50	0.12	2,045
Manufacture of other transport equipment	13.46	0.09	0.52	0.15	768
Manufacture of furniture; manufacturing n.e.c.	12.51	0.08	0.43	0.11	1,483
Recycling	12.54	0.07	0.21	0.10	326
Electricity, gas, steam and hot water supply	14.29	0.07	0.74	0.16	1,334
Collection, purification and distribution of water	13.27	0.07	0.79	0.17	516
Construction	12.25	0.07	0.65	0.06	13,243
Sale, maintenance and repair of motor vehicles and automotive fuel	13.10	0.08	0.60	0.04	4,011
Wholesale trade and commission trade	13.61	0.08	0.42	0.07	6,147
Retail trade; repair of personal and household goods	12.77	0.07	0.56	0.07	8,957
Hotels and restaurants	11.62	0.06	0.53	0.05	3,975
Land transport; transport via pipelines	12.27	0.08	0.42	0.18	2,612
Water transport	13.38	0.08	0.26	0.43	248
Supporting and auxiliary transport activities; travel agencies	12.94	0.08	0.43	0.12	2,899
Post and telecommunications	12.29	0.11	0.34	0.33	599
Activities auxiliary to financial intermediation	12.14	0.05	0.13	0.02	170
Real estate activities	13.34	0.09	0.52	0.06	2,055
Renting of machinery and equipment	12.61	0.08	0.16	0.06	261
Computer and related activities	12.56	0.07	0.09	0.06	1,654
Research and development	12.49	0.08	0.51	0.06	1,60
Other business activities	12.01	0.08	0.34	0.08	10,437
Education	11.77	0.09	0.52	0.16	6,065
Health and social work	12.07	0.07	0.53	0.12	14,678
Sewage and refuse disposal, sanitation and similar activities	12.99	0.07	0.60	0.13	1,021
Recreational, cultural and sporting activities	12.30	0.11	0.39	0.18	1,761
Other service activities	11.18	0.07	0.56	0.08	1,465
Total	12.57	0.08	0.49	0.10	130,493

Source: LIAB QM2 9310 waves 1998 to 2010; own calculations (controlled remote data access via FDZ); Note: Industries without observations are dropped, some small industries are merged, see the data section.

Table 7: Industry-Level Collective Bargaining Coverage and Intra-Industry Productivity Dispersion: Main OLS Results

Dep. Var.: Collective Bargaining Coverage	(1)	(2)	(3)	(4)	(5)	(6)
Mean Sector Productivity	-0.0672***	0.0067	0.0064	0.0078	0.0082	0.0100
	(0.0067)	(0.0094)	(0.0096)	(0.0092)	(0.0095)	(0.0094)
Var. Coeff. of Sector Prod	-1.4280***	-0.7445**	-1.4333***	-1.0333***	-1.0917***	-1.0981***
	(0.2832)	(0.2964)	(0.2854)	(0.2747)	(0.2860)	(0.2859)
Total Factor Productivity	0.0937***	0.0196***	0.0200***	0.0156***	0.0180***	0.0232***
	(0.0035)	(0.0044)	(0.0045)	(0.0047)	(0.0049)	(0.0053)
Insourcing Activity			-0.0268***	-0.0110	-0.0088	-0.0070
			(0.0099)	(0.0097)	(0.0103)	(0.0103)
Any Part of the plant closed/outsourced/separated			0.0224***	0.0244***	0.0222**	0.0156*
			(0.0084)	(0.0082)	(0.0088)	(0.0088)
Share of Temp Workers			-0.1741***	-0.0996***	-0.0903***	-0.0903***
			(0.0193)	(0.0190)	(0.0206)	(0.0206)
Share of Vacancies			0.0787**	0.1586***	0.1376***	0.1759***
			(0.0385)	(0.0380)	(0.0398)	(0.0403)
Share of Trainees			0.0910**	0.2531***	0.2462***	0.2453***
			(0.0353)	(0.0521)	(0.0564)	(0.0564)
Share of Flexible Workers			-0.0298	-0.0447**	-0.0445*	-0.0369
			(0.0195)	(0.0224)	(0.0235)	(0.0236)
Churning Rate			0.0165	0.0359***	0.0441***	0.0439***
			(0.0122)	(0.0128)	(0.0157)	(0.0157)
Public Funding			0.0941***	0.0944***	0.0941***	0.0753***
			(0.0252)	(0.0242)	(0.0254)	(0.0262)
Firm Age, censored at 1975			0.0051***	0.0020***	0.0017***	0.0018***
			(0.0004)	(0.0005)	(0.0005)	(0.0005)
Public Ownership			0.1728***	0.1352***	0.1346***	0.1266***
			(0.0139)	(0.0133)	(0.0138)	(0.0139)
Foreign Ownership			0.0122	-0.0013	-0.0014	0.0068
			(0.0133)	(0.0129)	(0.0134)	(0.0134)
Limited Company			-0.0524***	-0.0439***	-0.0444***	-0.0444***
			(0.0074)	(0.0072)	(0.0075)	(0.0075)
Public Sector Plant			0.0275	0.0118	0.0206	0.0195
			(0.0243)	(0.0233)	(0.0242)	(0.0244)
Average Firm Age by Sector			-0.0083***	-0.0066***	-0.0073***	-0.0073***
			(0.0018)	(0.0017)	(0.0018)	(0.0018)
Female Employees				0.1419***	0.1386***	0.1445***
				(0.0162)	(0.0168)	(0.0168)
Foreign origin				0.2502***	0.2542***	0.2538***
				(0.0327)	(0.0350)	(0.0351)
Tenure: 6 to 10 years				0.0808***	0.0848***	0.0766***
				(0.0115)	(0.0120)	(0.0120)
Tenure: 11 to 20 years				0.1116***	0.1224***	0.1137***
				(0.0184)	(0.0190)	(0.0190)
Tenure: over 20 years				0.2388***	0.2606***	0.2548***
				(0.0401)	(0.0416)	(0.0416)
Age: between 30 and 49				-0.1184***	-0.1289***	-0.1390***
				(0.0228)	(0.0239)	(0.0239)
Age: between 50 and 65				-0.0137	-0.0220	-0.0425*
				(0.0246)	(0.0258)	(0.0258)
Other Employees				0.2283***	0.2356***	0.2360***
				(0.0303)	(0.0319)	(0.0319)
Trainees				0.1543***	0.1602***	0.1461***
				(0.0492)	(0.0536)	(0.0536)
Qualification: Skilled				0.0951***	0.0983***	0.0967***
				(0.0129)	(0.0133)	(0.0133)
Qualification: High-Skilled				-0.0396	-0.0258	-0.0235
				(0.0262)	(0.0272)	(0.0272)

Status: White-Collar Worker				-0.3227***	-0.3247***	-0.3274***
				(0.0208)	(0.0216)	(0.0216)
Status: Skilled Blue-Collar W.				0.0175	0.0089	0.0076
				(0.0185)	(0.0193)	(0.0192)
Status: Part-Time Worker				0.1163***	0.1080***	0.1028***
				(0.0235)	(0.0246)	(0.0246)
Mean of gross daily wages				0.0060***	0.0059***	0.0060***
				(0.0003)	(0.0003)	(0.0003)
Std.Dev. of gross daily wages				-0.0032***	-0.0033***	-0.0032***
				(0.0004)	(0.0004)	(0.0004)
Employees at s.s.contr. limit				-0.3343***	-0.3371***	-0.3213***
				(0.0606)	(0.0642)	(0.0643)
Share of Exports						-0.0745***
						(0.0184)
Expected Change in Business						-0.0094***
						(0.0027)
Expected Change in Personnel						-0.0127***
						(0.0036)
Share of Wage Bill on Turnover						0.1147*
						(0.0601)
Dummy variables	No	Yes	Yes	Yes	Yes	Yes
Constant	0.2402***	0.3519***	0.3264***	0.0572	0.0605	0.0248
	(0.0739)	(0.1184)	(0.1199)	(0.1180)	(0.1225)	(0.1242)
N. of Obs:	92,104	91,526	91,526	91,526	80,889	80,889
N. of clusters	24,774	24,648	24,648	24,648	23,238	23,238
F-Stat.	249.32	129.43	128.77	145.43	134.96	127.08
R Squared	0.04	0.15	0.19	0.22	0.22	0.23

*Source: LIAB QM2 9310 waves 1996 to 2010; own calculations (controlled remote data access via FDZ). Note: Dummy variables control, in addition to firm size classes, for Nace-1 industry classification, region, and year; standard errors clustered at the plant level level in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Table 8: Firm-Level Collective Bargaining Coverage and Intra-Industry Productivity Dispersion: Main OLS Results

Dep. Var.: Firm-Level Contract	(1)	(2)	(3)	(4)	(5)	(6)
Mean Sector Productivity	-0.0251***	-0.0048	-0.0077	-0.0122**	-0.0125**	-0.0123**
	(0.0038)	(0.0054)	(0.0060)	(0.0060)	(0.0060)	(0.0061)
Var. Coeff. of Sector Prod	1.1464***	0.4856***	0.5415***	0.5497***	0.5112***	0.5433***
	(0.1533)	(0.1881)	(0.1932)	(0.1932)	(0.1977)	(0.1979)
Total Factor Productivity	0.0262***	0.0095***	0.0055**	0.0021	0.0015	0.0005
	(0.0020)	(0.0025)	(0.0026)	(0.0029)	(0.0030)	(0.0033)
Insourcing Activity			0.0056	0.0070	0.0041	0.0038
			(0.0069)	(0.0068)	(0.0071)	(0.0071)
Any Part of the plant			0.0065	0.0059	0.0053	0.0052
closed/outsourced/separated			(0.0057)	(0.0057)	(0.0061)	(0.0061)
Share of Temp Workers			0.0565***	0.0638***	0.0655***	0.0664***
			(0.0136)	(0.0134)	(0.0139)	(0.0139)
Share of Vacancies			-0.0107	0.0046	0.0119	0.0118
			(0.0186)	(0.0184)	(0.0200)	(0.0203)
Share of Trainees			0.0053	-0.0439	-0.0499	-0.0494
			(0.0212)	(0.0423)	(0.0451)	(0.0450)
Share of Flexible Workers			-0.0147*	0.0378***	0.0329***	0.0321**
			(0.0088)	(0.0122)	(0.0126)	(0.0126)
Churning Rate			-0.0098	0.0007	-0.0060	-0.0062
			(0.0072)	(0.0071)	(0.0079)	(0.0079)
Public Funding			-0.0782***	-0.0850***	-0.0803***	-0.0649***
			(0.0189)	(0.0191)	(0.0195)	(0.0201)
Firm Age, censored at 1975			-0.0005**	-0.0009***	-0.0009***	-0.0010***
			(0.0002)	(0.0002)	(0.0002)	(0.0003)
Public Ownership			0.0188*	0.0111	0.0088	0.0101
			(0.0111)	(0.0110)	(0.0112)	(0.0113)
Foreign Ownership			-0.0207**	-0.0187**	-0.0174*	-0.0149*
			(0.0083)	(0.0086)	(0.0089)	(0.0090)
Limited Company			0.0224***	0.0173***	0.0177***	0.0174***
			(0.0034)	(0.0035)	(0.0036)	(0.0036)
Public Sector Plant			0.0609***	0.0513***	0.0478**	0.0472**
			(0.0184)	(0.0187)	(0.0191)	(0.0191)
Average Firm Age by Sector			0.0022**	0.0015	0.0017	0.0018
			(0.0010)	(0.0010)	(0.0011)	(0.0011)
Female Employees				-0.0349***	-0.0346***	-0.0335***
				(0.0089)	(0.0093)	(0.0093)
Foreign origin				-0.0480***	-0.0513***	-0.0498***
				(0.0140)	(0.0149)	(0.0149)
Tenure: 6 to 10 years				0.0014	0.0034	0.0033
				(0.0071)	(0.0074)	(0.0074)
Tenure: 11 to 20 years				0.0268**	0.0258**	0.0258**
				(0.0117)	(0.0121)	(0.0121)
Tenure: over 20 years				-0.0229	-0.0271	-0.0240
				(0.0228)	(0.0234)	(0.0236)
Age: between 30 and 49				0.0434***	0.0493***	0.0491***
				(0.0103)	(0.0109)	(0.0109)
Age: between 50 and 65				0.1115***	0.1145***	0.1147***
				(0.0129)	(0.0135)	(0.0135)
Other Employees				-0.0342**	-0.0296*	-0.0286*
				(0.0158)	(0.0163)	(0.0163)
Trainees				0.1539***	0.1720***	0.1706***
				(0.0422)	(0.0453)	(0.0452)
Qualification: Skilled				0.0129**	0.0147**	0.0142**
				(0.0066)	(0.0068)	(0.0068)
Qualification: High-Skilled				0.0462***	0.0435**	0.0474***
				(0.0169)	(0.0177)	(0.0178)

Status: White-Collar Worker				-0.0053	-0.0022	-0.0031
				(0.0113)	(0.0118)	(0.0119)
Status: Skilled Blue-Collar W.				-0.0010	-0.0001	-0.0009
				(0.0111)	(0.0115)	(0.0116)
Status: Part-Time Worker				0.0098	0.0146	0.0145
				(0.0123)	(0.0130)	(0.0130)
Mean of gross daily wages				0.0004**	0.0004**	0.0005**
				(0.0002)	(0.0002)	(0.0002)
Std.Dev. of gross daily wages				-0.0003	-0.0003	-0.0003
				(0.0002)	(0.0002)	(0.0002)
Employees at s.s.contr. limit				-0.0849**	-0.0738*	-0.0767**
				(0.0355)	(0.0378)	(0.0377)
Share of Exports						-0.0205*
						(0.0114)
Expected Change in Business						-0.0008
						(0.0017)
Expected Change in Personnel						0.0013
						(0.0023)
Share of Wage Bill on Turnover						-0.0458
						(0.0477)
Dummy variables	No	Yes	Yes	Yes	Yes	Yes
Constant	-0.0157	-0.0050	0.0470	0.1143	0.1152	0.1231*
	(0.0383)	(0.0630)	(0.0677)	(0.0710)	(0.0726)	(0.0741)
N. of Obs.	92,104	91,526	91,526	91,526	80,889	80,889
N. of Clusters	24,774	24,648	24,648	24,648	23,238	23,238
F-Stat.	68.01	23.47	19.88	17.54	15.84	14.70
R squared	0.01	0.04	0.05	0.05	0.05	0.05

*Source: LIAB QM2 9310 waves 1996 to 2010; own calculations (controlled remote data access via FDZ). Note: Dummy variables control, in addition to firm size classes, for Nace-1 industry classification, region, and year; standard errors clustered at the plant level level in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Table 9: Collective Bargaining Coverage and Intra-Industry Productivity Dispersion: Binary and Panel Methods

	Probit		Logit		Fixed Effects LPM		Random Effects LPM		Fixed Effects Logit		Random Effects Probit	
Dep. Variable	CBA	FLC	CBA	FLC	CBA	FLC	CBA	FLC	CBA	FLC	CBA	FLC
Mean Sector Productivity	0.0257	-0.0686*	0.0483	-0.1185*	0.0193	-0.0092	-0.0076	-0.0100**	0.0193	-0.0092	-0.0076	-0.0100**
	(0.0294)	(0.0355)	(0.0494)	(0.0700)	(0.0152)	(0.0130)	(0.0072)	(0.0048)	(0.0152)	(0.0130)	(0.0072)	(0.0048)
Var. Coeff. of Sector Prod.	-3.314***	2.681***	-5.689***	5.127***	-0.148	0.228	-0.908***	0.627***	-0.148	0.228	-0.908***	0.627***
	(0.8710)	(0.9824)	(1.4765)	(1.8972)	(0.2742)	(0.2473)	(0.1920)	(0.1484)	(0.2742)	(0.2473)	(0.1920)	(0.1484)
Marginal Effects	-1.067***	0.389***	-1.095***	0.383***								
Firm-Level Control Variables	Some	Some	Some	Some	Some	Some	Some	Some	Some	Some	Some	Some
Individial-Level Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dummy Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of Obs,	91,526	91,526	91,526	91,526	91,526	91,526	91,526	91,526	91,526	91,526	91,526	91,526
N. of Clusters	24,648	24,648	24,648	24,648	24,648	24,648	24,648	24,648	24,648	24,648	24,648	24,648

*Source: LIAB QM2 9310 waves 1996 to 2010; own calculations (controlled remote data access via FDZ). Note: Control Variables as in specification (4) of Table 7; standard errors clustered at the plant level level in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Table 10: Collective Bargaining Coverage and Intra-Industry Productivity Dispersion: Subsamples

Collective Bargaining Coverage	After 2000	Only Private Sector	Manufacturing	Services	West Germany	Manuf. West Germany
Mean Sector Productivity	-0.0118	0.0068	0.0617***	0.0233*	0.0031	0.0580***
	(0.0098)	(0.0097)	(0.0129)	(0.0136)	(0.0121)	(0.0187)
Var. Coeff. of Sector Prod.	-1.3088***	-0.9655***	-0.1843	-2.0027***	-1.1047***	0.3169
	(0.3403)	(0.3113)	(0.4007)	(0.4221)	(0.3760)	(0.5965)
Firm-Level Control Variables	Some	Some	Some	Some	Some	Some
Individial-Level Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Dummy Variables	Yes	Yes	Yes	Yes	Yes	Yes
N. of Obs	76116	83077	46639	44916	53051	24121
N. of clusters	21815.00	22590.00	11475.00	13246.00	15857.00	6321.00
F-Stat.	177.70	131.05	154.48	88.18	98.99	40.34
R Squared	0.18	0.22	0.23	0.21	0.21	0.14

*Source: LIAB QM2 9310 waves 1996 to 2010; own calculations (controlled remote data access via FDZ). Note: Control Variables as in specification (4) of Table 7; standard errors clustered at the plant level level in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

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