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ORIGINAL ARTICLE

Unions, collective agreements and productivity: A firm-level analysis using Norwegian matched employer–employee panel data

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Abstract

What is the role of collective agreements in explaining how unions affect firm-level productivity? Using matched employer–employee panel data for the Norwegian labour market, comprising almost 21 million individual-year observations in the period 2002–2018, we find that the presence of a collective agreement in a firm is associated with higher productivity. Without a collective agreement, higher union density is estimated to reduce productivity. However, if a collective agreement is implemented in the firm, not only is the estimated negative effect reduced—in some cases it becomes positive. This result remains significant, numerically and statistically, across several model specifications and different estimation methods. In particular, we provide a new source of exogenous variation in union memberships by utilizing information on intergenerational transmission of union preferences. Besides regulating terms and conditions for wage formation and working hours, collective agreements have a profound impact on how firms organize and formally recognize the voice of workers. In this regard, our finding supports the conclusion of Free-

man and Medoff that the quality of institutional systems is crucial to understand what unions do to productivity.

1 | INTRODUCTION

What unions do to productivity, as well as for other aspects of corporate performance, has been the subject of extensive research for decades. In the seminal works by Freeman and Medoff (1979, 1984), unions are portrayed with two faces: the *monopoly face* and the *exit voice/institutional response face*. While the former refers to the monopoly power attained by unionized workers through collective bargaining, the latter covers the various mechanisms through which unions may alter industrial relations. As these effects generally work in opposite directions, the effect of unions on productivity is theoretically ambiguous. The question of how unions affect productivity is therefore a question that must be answered empirically. However, despite the vast body of empirical literature, the evidence is mixed and inconclusive, reflecting various strengths of the two faces of unionism in different contexts (Doucouliagos et al., 2017).

The mixed evidence on what unions do to productivity calls for the scope of union research to extend to more countries, sectors, time periods and institutional contexts (Laroche, 2020). Unions operate in very diverse environments with respect to how institutions and legislation regulate and facilitate their activities and organization. More fundamentally, the impact of unions on firms' performance is likely to vary with the extent of unionization. Union presence may be measured along at least two important dimensions—the first being the union density (UD) at the workplace, the second the union's formal impact on the firm's organization, as measured by the presence of a collective agreement. The former dimension has been utilized in many studies, recently also in Norway (Barth et al., 2020), but less attention has been devoted to the study of collective agreements.

In countries characterized by decentralized bargaining, the introduction of a firm-level collective agreement often requires that the union wins a majority vote. In other words, collective agreements are only implemented in firms with a strong local union. In many European countries, however, there is an important distinction between having unionized workers at the plant and being covered by a collective agreement, as firms may be covered by sectoral agreements without having unionized employees in the firm (OECD, 2019). The rules for implementing a collective agreement in Norway are somewhere in between. In general, collective agreements are invoked by labour unions, but only if the UD is above the threshold determined in higher level agreements, which is usually 10 per cent of the workers in the particular bargaining area. Moreover, participation in the agreements is in principle voluntary for both parties. Both the voluntary engagement and the low threshold for invoking collective agreements, make the distinction between UD and collective agreement coverage (CAC) important in the Norwegian context.

In this article, we argue that collective agreements act as a formal recognition of the unions' right to express their views on working conditions and the organization of firms. A collective agreement thus constitutes an important organizational institution through which unions may alter industrial relations at the firm level. By not taking this dimension of unionization into account, empirical analyses of unions' impact on productivity could be biased, or at best imprecise. We contribute to the discourse on what unions do to productivity by explicitly exploring how the union-productivity relationship is altered by the presence of collective agreements. More

generally, our contribution adds to the growing literature on what unions do to productivity in different contexts by providing evidence from the Norwegian labour market. Norway represents an interesting case because voluntary collective agreements are relatively more important than legislation compared to many other countries. Also, the availability of high-quality register data on all individuals enables more accurate inference. Finally, our article is an important contribution to the limited number of studies providing causal evidence on what unions do to productivity. While we are not able to fully control for the possible correlation between productivity shocks and the presence of a collective agreement, endogenous unionization is handled by instrumenting UD among workers with the UD among the workers' parents.

The remainder of the article is organized as follows. Section 2 reviews previous literature on how unions alter productivity. The section also discusses the few studies that emphasize the role of collective agreements and related labour market institutions. Section 3 then gives a brief introduction to the system and organization of unions and collective agreements in Norway. We present the data in Section 4, while Section 5 describes our methodological approach. Section 6 contains a presentation and discussion of our results. Section 7 provides a conclusion.

2 | RELATED LITERATURE

Theoretically, the influence of unions on productivity is ambiguous. In the traditional neoclassical view, unions act as monopolies that distort labour market efficiency by adding a union premium to the competitive market wage. Union presence may also limit management's flexibility in personnel decisions by introducing rules such as seniority in hiring and firing (Freeman & Medoff, 1984, p. 164). Furthermore, any form of industrial unrest will affect productivity adversely by temporarily reducing the utilization of the firm's resources and causing uncertainty about output levels (Caves, 1980; Flaherty, 1987). However, the direction of causation is not obvious, as poor labour productivity could reflect poor management, which also causes more industrial action (Addison & Schnabel, 2003, p. 123). Unions may also harm productivity by lowering investment, as shareholders' expected return is reduced by the risk of *ex post* rent-seeking by unions in the absence of binding contracts (Grout, 1984). Union rent-seeking could thus be considered a tax on the return on investments, potentially hampering innovation and technological development (Connolly et al., 1986). Finally, militant unions may disrupt industrial relations. If both employers and employees are only concerned with promoting their own interests, both may be worse off in terms of productivity and earnings than if they cooperated. In this regard, Freeman and Medoff (1984) argued that unions would only raise productivity if *'industrial relations are good, with management and unions working together to produce a bigger "pie"'* (p. 165).

However, many authors have argued that unions may promote productivity through institutional channels. Freeman (1976) and Freeman and Medoff (1984) claim that by providing workers with a means of expressing discontent through a collective voice, unions can reduce turnover and improve morale, motivation, job satisfaction and cooperation, thereby enhancing productivity. The additional information provided by a collective voice can moreover enable firms to choose a better mix of working conditions, workplace rules and wage levels (Laroche, 2020). In Norway, for example, the management and the union in firms participating in collective agreements can agree on more flexible working time arrangements than are otherwise permitted by law. A potential means of offsetting efficiency losses may thus arise if unions are able to induce managers to alter methods of production and adopt policies that improve efficiency. Unions may also give workers an increased experience of fairness because their presence reduces the potentially

arbitrary nature of decisions about promotions and layoffs. That is, the union may act as '*the employees' auditor of management, checking that the employer is fulfilling his part of the labour contract'* (Pencavel, 1977, p. 141). Moreover, unions may contribute to higher productivity through the wage channel. By using their monopoly power to raise wages, unionized firms may attract more productive employees (Lazear, 2000). It is also plausible that the wage differentials between unionized and non-unionized firms may reduce turnover in unionized firms, thereby saving them potential firing and hiring costs, as well as conserving firm-specific human capital. Higher wages may give employers incentives to replace some labour by capital, which, although not socially efficient, will increase labour productivity at the firm level (Freeman & Medoff, 1984, p. 164).

Many attempts have been made to estimate empirically how unions influence productivity. The pioneering study of Brown and Medoff (1978) is one of the few studies that finds a large and positive effect of unions on productivity in the U.S. manufacturing industry. However, these estimates were later attributed to serious data limitations (Hirsch & Addison, 1986). Other studies from the United States have found both positive and negative union effects on productivity, with large variations across sectors and industries (Allen, 1988; Clark, 1980). A recent meta-analysis by Doucouliagos et al. (2017) reviews a large number of studies published over the last 30 years that address the impact of unions on productivity. The overall association between unions and productivity is shown to be near zero, but the relationship varies significantly across countries and industries. The authors indicate that the wide diversity of findings makes it hard to adopt a definitive position on what unions do to productivity: it depends on the period of analysis, the industry, the nature of the social climate in both the specific country and the firm, methods of data collection, the productivity indicator used and the econometric frameworks adopted.

It is apparent that the question of what unions do to productivity is far from resolved. To better understand the empirical ambiguity, the literature has considered various mechanisms that might be at play. There is an extensive literature examining the relationship between unionization, job satisfaction and productivity. In a meta-analysis of 235 estimates from 59 studies published between 1975 and 2015, Laroche (2016) finds an overall small negative association between unionization and job satisfaction. However, the study shows that the industrial relations climate has a positive and significant impact on the union-satisfaction effect. Moreover, when taking account of the possibility that unions often organize in firms with poor working conditions, Blanchflower and Bryson (2020) find a positive relationship between unions and several measures of worker well-being, including job satisfaction. Others have investigated how organizational commitment can be a channel through which unions affect productivity. Several studies show a positive correlation between measures of job performance and workers' organizational commitment (Jaramillo et al., 2005; Mathieu & Zajac, 1990), which has been found to be positively related to unionization in the United States and Norway (Kalleberg & Mastekaasa, 1994).

Another strand of literature has looked at how the institutional context in which unions operate affect the way they function (Blanchflower & Freeman, 1992). The focus in these studies is the institutions that enable and constrain union efforts to improve working conditions. In the United Kingdom, Bryson et al. (2006) find that employee perception of managerial responsiveness to worker voice leads to superior productivity. In France, Coutrot (1996) shows that firms with at least one union delegate in the workplace are more productive than other firms. This finding is partly confirmed by Laroche (2004). In general, several studies have shown that measures of the industrial relations climate are positively associated with better economic performance (Belman, 1992; Whitman et al., 2010). As suggested by Freeman and Medoff (1984), unions can improve the quality of labour relations by cultivating voice rather than exit.

A particular feature of the institutional context that has received less attention is the role of collective agreements. Notable exceptions are García-Serrano (2009) and Bryson et al. (2010), who separate the roles of union membership and firm-level collective agreements in their assessment of how unions affect job satisfaction in Spain and the United Kingdom. In a recent study from Belgium, Garnero et al. (2020) investigate how firm-level collective agreements affect firm performance in a multi-level bargaining system. They find that firm agreements increase both wage costs and labour productivity. However, this result must be interpreted within the context of the Belgian national bargaining system, where firm-level agreements act as supplements to agreements at sectoral level, which cover practically the entire Belgian workforce (p. 945). In another recent study, Barth et al. (2020) identify a large positive impact of UD on productivity in Norway. By exploiting exogenous variation in the rules for the tax deductibility of union membership fees, the study is one of a limited number that handle the possibly endogenous behaviour of unionization. The authors interpret the large coefficient as a threshold effect, where the union forces the employer to implement a collective agreement once the UD reaches a particular threshold. However, they do not have information in their data to further investigate this hypothesis.

Our contribution expands the current knowledge of what unions do to productivity in general, and in particular how this relationship is affected by the quality of industrial relations as measured by the presence of a collective agreement. Moreover, our article adds an important contribution to the very limited number of studies providing causal evidence of what unions do to productivity. Although we do not fully control for the possible correlation between productivity shocks and a decision to enter or exit a collective agreement, we provide a new source of exogenous variation in union memberships by utilizing information on intergenerational transmission of union preferences.

3 | UNIONIZATION AND COLLECTIVE AGREEMENTS IN NORWAY

The relationship between employers and employees in Norway is organized through an interaction between legislation and collective agreements, where the importance of the latter is relatively high compared to other countries. The labour market is characterized by strong trade unions and employer's associations. During the last decade, UD has been stable at around 50 per cent, or 38 per cent if we consider the private sector only. In the same period, the organization rate among private sector employers has been steadily increasing and amounted to approximately 71 per cent in 2019 (Alsos et al., 2021).

As shown in Figure 1, UD in Norway is high compared to most other countries in the OECD, and so is the prevalence of collective agreements.[1] About 10 per cent of Norwegian private sector firms participate in collective agreements, which accounted for 46 per cent of all private sector workers in 2018. If we include the public sector, almost 73 per cent of all workers were covered by collective agreements in 2018. However, the coverage rate is lower than in many other Western European countries, where collective agreements at sectoral level may be required by law to extend to all firms and workers irrespective of union membership.[2]

Collective bargaining in Norway has a clear hierarchical structure. As in several other Western European countries, wages in the private sector may be negotiated at three levels: central, sectoral and local. At the national level, a few major confederations determine the content of the basic agreements. The basic agreements form the basis for all lower level agreements in specific industries, set the framework for bargaining and regulate issues such as rights to information and consultation and rules for taking industrial action (most importantly strike and lock-out).

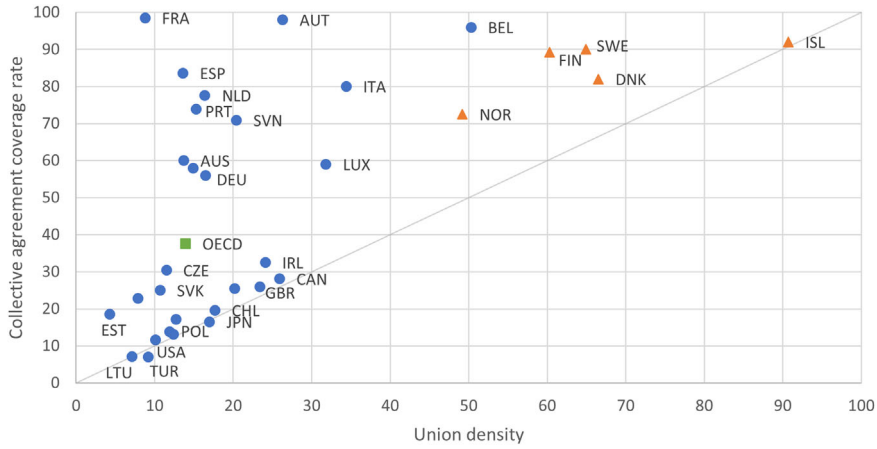

FIGURE 1 Union density and collective agreement coverage in OECD countries. 2018 or last observation. Nordic countries and OECD average are highlighted by orange triangles and a green square, respectively. *Source*: OECD databases on 'Trade union density' and 'Collective bargaining coverage' [Colour figure can be viewed at wileyonlinelibrary.com]

Moreover, the basic agreements include procedures for electing employee representatives, which are important for facilitating the firm-level relationship between employees and employers. The second level in the hierarchy consists of agreements for specific industries, often referred to as business sector agreements. Most of these agreements include the text of the corresponding basic agreement as their first section. The second part typically contains provisions regarding minimum wage and entitlements regarding working hours, overtime payment and welfare leave. Business sector agreements normally apply for 2 years at a time.

Local agreements between employers and employee representatives at company level, which are adapted to local conditions, make up the third level of the bargaining hierarchy. In contrast to sectoral agreements, local agreements automatically extend to all workers in occupations covered by the agreement, irrespective of union membership.[3] CAC in Norway thus depends on the existence of local agreements. In general, if the UD among workers within the same bargaining area in a firm is above a certain threshold, the union will demand a collective agreement. If the employer is organized in an employer's association, the agreement will be ratified more or less automatically. If the employer is not organized, the trade union will enter a direct agreement with the employer—if necessary, through the use of industrial action.

A particular feature of the Norwegian system of collective agreements is that the basic agreements include extensive provisions on co-determination. Specifically, the agreements introduce regulations designed to strengthen and further develop the collaboration between employees, their representatives and the management. Furthermore, they formalize the mutual responsibility of employer and employees for productivity growth and business development (Bergh, 2010). The presence of a collective agreement thus constitutes an important institutional feature when evaluating what unions do to productivity and other aspects of corporate performance.

In short, collective agreements in Norway are not only a means of regulating observable working conditions such as wages and hours; they also establish and codify a system of collaboration, communication and participation, with the explicit purpose of enhancing productivity. The clear focus on co-operation in the collective agreements partly reflects and partly contributes to sustaining the long Nordic tradition of close co-operation between employers' associations and trade

TABLE 1 Observations by collective agreement coverage

	Observations	Firms
Never collective agreement	969,614	158,630
Always collective agreement	88,918	9228
Firms changing status	112,138	10,520
Total	1,170,670	178,438

unions, as well as a high degree of co-determination and participation at company level. A better understanding of the interplay between unions, collective agreements and firm performance is thus paramount when investigating how unions affect productivity in Norwegian firms.

4 | DATA

The empirical analysis utilizes a matched employer–employee dataset, obtained from Statistics Norway (see Table A1 in the Appendix for descriptive statistics). The data cover the Norwegian private sector in the period 2002–2018 and consist of individual data collected by the Norwegian Tax Authorities and Social Services, matched with several other sources of register data related to both firms and employees. The most important data source for the period 2002–2014 is the State Register of Employers and Employees (the 'Aa-register'), which provides information on income, earnings, hours worked and occupation for each individual. For the remaining years, 2015–2018, our data are collected from the 'a-ordning', a coordinated service used by employers to report information about income and employees to the Norwegian Labor and Welfare Administration, Statistics Norway and the Norwegian Tax Administration. Educational statistics are attached, as well as firm-level financial data and several other characteristics. Every individual, workplace and firm has its own unique identifying number, enabling us to track the units across time.

Whether a firm participates in a collective agreement or not is obtained from membership data from the private sector collectively agreed pension scheme ('Fellesordningen for AFP'- the AFP scheme), whereby all firms that are members are also parties to a collective agreement.[4] In a model with firm fixed effects, identifying the effect of a collective agreement requires sufficient time variation in this variable. Although most firms do not change their status during the period in question, Tables 1 and 2 document substantial variation in CAC within firms. On average, 448 firms enter a collective agreement each year, while 275 firms exit. In total, this amounts to 112,138 observations of, in total, 10,520 firms changing their coverage status at least once.

Individual union membership is obtained from data on union membership fees, which are reported to the tax authorities by the unions. From the membership payments, we calculate firm-level UD as the ratio of union members to the number of employees in each firm. Figure 2 shows how the two variables UD and CAC evolve through our period of analysis. While the solid lines show unweighted firm averages, the dashed lines are weighted averages, where the number of employees in each firm are used as weights. They thus illustrate UD and CAC across firms and individuals, respectively. The differences between the weighted and unweighted means reflect the fact that UD and the prevalence of collective agreements are higher among large firms (see Figure A1 in the Appendix).

Our initial individual level dataset contains around 1.5 million yearly private sector jobs, amounting to 25.2 million observations in total for the whole period. The number of yearly jobs is not equal to the number of individuals, as one individual may have multiple jobs within the same

TABLE 2 Observations of entries and exits from collective agreements

	Entry	Exit
2002	578	552
2003	466	169
2004	409	507
2005	460	182
2006	474	388
2007	412	165
2008	453	400
2009	409	165
2010	893	363
2011	439	165
2012	413	318
2013	388	167
2014	353	307
2015	349	157
2016	335	270
2017	383	115
2018	407	286
Total	7621	4676

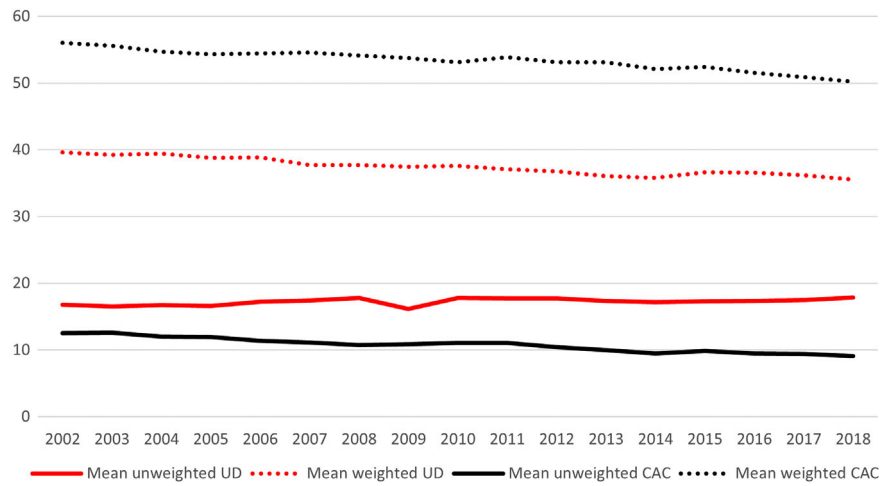

FIGURE 2 Mean union density (UD) and collective agreement coverage (CAC) unweighted and weighted by the number of employees in the firm, in our sample [Colour figure can be viewed at wileyonlinelibrary.com]

year. The total number of firms present in the initial sample is 334,511. However, we have placed some restrictions on the sample. Firms not required by law to provide financial statements, or which for other reasons do not have financial information, are excluded. This restriction leaves us with 20.9 million observations, amounting to just under 80 per cent of all private sector jobs.[5] The individual-level data are then aggregated to firm level using firm-based averages of job and worker

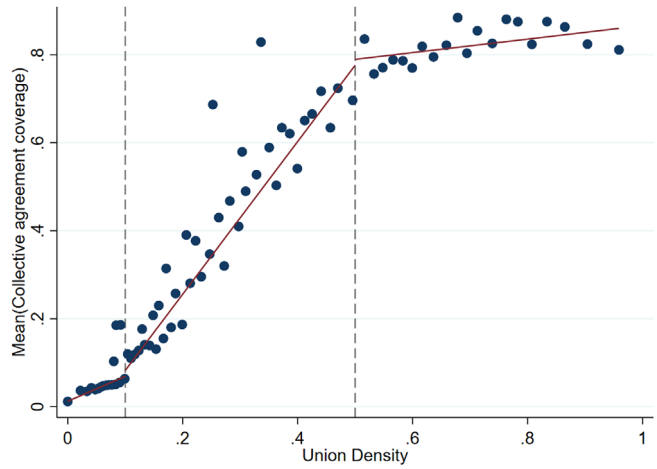

FIGURE 3 The distribution of collective agreements across union density in our sample. Firms with at least 10 employees. Binscatter, 88 bins. $N = 383{,}297$ [Colour figure can be viewed at wileyonlinelibrary.com]

information. The final estimation sample consists of 189,900 firms (corresponding to 58 per cent of all private sector firms, employing 75 per cent of all wage-earners), with a total of 1,170,670 firm-year observations. Because firms are established and dissolved throughout the period of analysis, our panel is unbalanced. Around 10 per cent of the firms are present in all 17 years, while the median number of observations per firm is 5 years. Firms with less than two observations are excluded from most estimations.

The interaction between UD and the presence of a collective agreement is of primary concern in our study. To qualify for a collective agreement, the UD among the firm's workers must exceed a certain threshold. In the largest basic agreement in Norway, this threshold is specified as 10 per cent of the workers.[6] Figure 3 illustrates the distribution of collective agreements as a function of firm-level UD in firms with at least 10 employees. The figure clearly shows a positive relation between unionization and the presence of collective agreements. The lines at 10 and 50 per cent represent two common thresholds where the union may demand a collective agreement. The relationship appears to have a steeper slope when UD passes 10 per cent, indicating an acceleration in the accumulation of collective agreements. When the firm unionization rate exceeds 50–60 per cent, most firms have implemented an agreement.

5 | METHODOLOGY

Productivity can be measured in many ways, with the various methods being confounded by a range of issues (Syverson, 2011). In the following, we use total factor productivity as our measure, in line with Barth et al. (2020). As demonstrated in the Appendix, however, our main conclusions are robust to the choice of productivity measure. As a change in total factor productivity reflects variations in output that cannot be ascribed to observable variation in factor inputs, we use a production function to estimate output conditional on the use of labour and capital. Our theoretical reference point is a skill-augmented production function specified as Cobb–Douglas, which in log-transformed notation is represented by:

$$y_{it} = \alpha + \beta_j k_{it} + \boldsymbol{l_{it}}\phi_j + \gamma_1 UD_{it} + \gamma_2 CA_{it} + \gamma_3 (UD \times CA)_{it} + \boldsymbol{X_{it}}\delta + u_i + \lambda_t + \omega_{it} + \varepsilon_{it}, \quad (1)$$

where y_{it} and k_{it} denote the value added and capital stock, respectively, of firm i in year t, both measured by their natural logarithms. Labour is divided into four skills groups determined by educational attainment, denoted by the row vector l_{it}, and is measured by the log aggregated weekly number of hours worked within each group.[7] The stock of capital and the number of hours worked both represent a measure of firm size, which is strongly correlated with the presence of a collective agreement (see Figure A1 in the Appendix).

The partial elasticities of output with respect to capital and labour are allowed to vary across industries j, as represented by the coefficient β_j and the labour coefficient vector ϕ_j. u_i denotes firm fixed effects, while λ_t represents time-specific effects reflecting both nominal and real trends common to all firms. ω_{it} represents unobservable idiosyncratic productivity shocks known to the firm, while ε_{it} represents measurement errors or random productivity shocks truly unknown to both firms and researchers, assumed to be normally distributed and i.i.d. The model equation is further augmented with our primary variables of interest, which are added successively to the estimated equation: workplace union density (UD_{it}), a dummy variable capturing the presence of a collective agreement (CA_{it}) and a term interacting UD with the presence of a collective agreement. Finally, the model is saturated with a vector of control variables (X_{it}) reflecting demographic, occupational and industry-by-year interactions.

We estimate Equation (1) to identify the impact of union presence on firm-level productivity. Our main parameters of interest are γ_1, γ_2 and γ_3. The marginal effect of an increase in UD is $\gamma_1$for firms without a collective agreement ($CA = 0$) and $\gamma_1 + \gamma_3$ in firms with an agreement ($CA = 1$). The effect of implementing a collective agreement is given by $\gamma_2 + \gamma_3 \times UD$, which may be evaluated for different values of UD.

Our strategy to identify the productivity effect of unionization is not without challenges. Any unobserved heterogeneity across firms will make the ordinary least squares (OLS) estimator inconsistent. We therefore estimate the model using the within estimator that allows for firm fixed effects. However, a key identifying assumption in the fixed effects model is the absence of any idiosyncratic productivity shocks correlated with UD or the presence of a collective agreement. This assumption is violated if, for example, the decision to implement or abolish a collective agreement is taken systematically at a specific stage of the firm's life, and if the firm is moving along a productivity path that would imply higher or lower productivity after this stage irrespective of the presence of the agreement. As the presence of a collective agreement is measured by a dummy variable, which takes on the value 0 for all years before the implementation and 1 as long as the firm participates in the agreement, any such systematic covariation will bias $\hat{\gamma}_2$.

Moreover, as first noted by Marschak and Andrews (1944), the firm's demand for factor inputs is likely to depend on idiosyncratic productivity shocks known to the firm, but unobservable to the econometrician. This is represented by the ω_{it} term in (1) and may, for example, represent the quality of machines and equipment not reflected in the book value of fixed assets. Such (to the firm) observables, and the omission of these by the econometrician, will in general make both the OLS estimator and the within estimator biased and inconsistent, as factor inputs are endogenously determined together with production. However, as proposed by Olley and Pakes (1996) and further developed by Levinsohn and Petrin (2003) and Wooldridge (2009), the issue of idiosyncratic productivity shocks may be handled by forming a control function where a polynomial in investments and/or intermediate inputs is used to proxy such unobserved productivity differences between individual firms.

A more serious problem of selection bias, however, relates to the potential endogenous determination of UD. The presence of a union is likely to not only *affect* but also *reflect* a firm's performance. The individual workers' decisions on whether or not to unionize may depend on the

firm's performance in several ways (Barth et al., 2020; DiNardo & Lee, 2004). On the one hand, the scope for rent sharing is larger in highly profitable firms than in less profitable ones. On the other hand, as unions are usually considered to improve the protection of workers and workers' rights, workers may seek unionization as a matter of job security if productivity is declining.

To identify the impact of union presence on firm-level productivity, as we discuss in more detail below, we instrument UD among the workers in a workplace by the UD among their parents. As we show in Subsection 6.4, parental unionization behaviour has a strong impact on an individual's propensity to join a union. Intergenerational transmission of union membership thus provides a source of exogenous variation in analyses relating unionization to the performance of firms. It is highly unlikely for parents to unionize as a result of changes in performance at their children's workplace, and the variation in parents' union memberships could thus be considered a valid instrument for the individual's decision of whether or not to join a union. One important exception, however, is the case where parents work in the same firm as their children. In such a case, changes in the firm's performance will alter the unionization incentives of both the workers and the workers' parents in a similar manner. This situation may be of particular relevance in sparsely populated areas with one or a few major employers.

Our identification strategy rests on the assumption that any selection bias in the implementation or abolishment of a collective agreement is effectively controlled for by handling the potentially endogenous nature of unionization. In general, this assumption is not likely to hold. Although a collective agreement will often come into place following a recruitment process that results in increasing UD, this is not always the case. In some firms, the UD may be above the threshold required for the union to enter an agreement, without the workers wanting to do so. Furthermore, the decision to enter or exit a collective agreement ultimately depends on the signature of the manager, who is not obliged by law to sign the agreement. As argued in the introduction, the presence of a collective agreement must therefore be treated as a separate and independent dimension of the union's presence in the firm, as must any endogenous decision on whether or not to enter or exit an agreement. The possible selection bias arising from not fully controlling for this problem thus represents a caveat in our study.

6 | RESULTS

Table 3 summarizes the results of estimating Equation (1) by means of different estimators. In Model 1a, we employ the within transformation of Equation (1) to allow for firm fixed effects (FE), which effectively controls for any unobserved time-invariant heterogeneity across firms. In this model, we assume (for the moment) homogeneous input elasticities across industries, and union presence is measured by UD alone. As UD is measured as a rate between 0 and 1, the corresponding estimated coefficient implies a 0.11 per cent increase in productivity from a 10-percentage-point increase in UD. The effect is only significant at the 10 per cent level.[8]

In Model 1b, we include a dummy variable that captures whether the firm is engaged in a collective agreement or not, and in Model 1c we add a term for the interaction between workplace UD and the existence of an agreement. This completely alters the interpretation of how productivity is affected by the presence of a union. To facilitate interpretation, we have included the derived effects of implementing a collective agreement evaluated on average UD, as well as the marginal effects of an increase in UD with and without a collective agreement. When both variables are included in Model 1c, a 10-percentage-point increase in UD is estimated to *reduce* productivity by 0.3 per cent in the absence of a collective agreement. If the firm is covered by a collective

TABLE 3 Estimated effects of union density and collective agreements on total factor productivity

	Model 1a	Model 1b	Model 1c	Model 1d	Model 1e	Model 1f	Model 1g
	FE	FE	FE	FE	LPW-GMM	LPW-GMM	LPW-GMM
Union density (UD)	0.011	−0.013*	−0.026***	−0.025***	−0.098***	−0.130***	−0.138***
	(1.83)	(−2.29)	(−4.19)	(−4.02)	(−14.30)	(−12.87)	(−8.56)
Collective agreement (CA)		0.157***	0.117***	0.117***	0.002	−0.019*	−0.016
		(25.79)	(14.46)	(14.47)	(0.18)	(−2.22)	(−1.53)
UD × CA			0.102***	0.099***	0.159***	0.206***	0.197***
			(7.05)	(6.83)	(10.20)	(12.26)	(8.95)
Marginal effects of:							
UD for $CA = 0$			−0.026***	−0.025***	−0.098***	−0.130***	−0.138***
			(−4.20)	(−4.02)	(−14.30)	(−12.87)	(−8.56)
UD for $CA = 1$			0.076***	0.074***	0.061***	0.076***	0.059**
			(5.59)	(5.44)	(4.17)	(5.19)	(3.28)
CA for $\overline{UD}$			0.135***	0.134***	0.028***	0.024***	0.035***
			(20.14)	(20.08)	(4.07)	(3.53)	(4.52)
Test (p-value): $\hat{\gamma}_1 + \hat{\gamma}_3 = 0$[a]			0.000	0.000	0.000	0.000	0.000
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Occupation and demographics				Yes	Yes	Yes	Yes
Minimum number of employees						5	10
R^2 (within)	0.260	0.261	0.261	0.266	0.075	0.098	0.085
R^2 (between)	0.610	0.613	0.613	0.589	0.048	0.129	0.132
R^2 (overall)	0.654	0.657	0.657	0.640	0.059	0.124	0.122
N	1,109,883	1,109,883	1,109,883	1,109,842	942,084	525,791	282,417
Firms	173,257	173,257	173,257	173,247	152,683	83,536	45,168
Average observations per firm	6.4	6.4	6.4	6.4	6.2	6.3	6.3

Note: Union density measured as a rate between 0 and 1. Collective agreement measured as a dummy variable. All estimations include year dummies. Demographics include age intervals, sex and country of origin. t-Statistics are in parentheses. Models 1e and 1f use as regressand the residuals from an Levinson-Petrin-Wooldridge-GMM (LPW-GMM) estimation of value added on capital and labour inputs only. Input elasticities reported in Table A2 in the Appendix.

[a]The reported test refers to the p-value of an F-test of the sum of the coefficients on UD and UD × CA. Robust standard errors are clustered at firm level.

*$p < 0.05$,
**$p < 0.01$,
***$p < 0.001$.

agreement, however, a similar increase in UD is estimated to *increase* productivity by 0.8 per cent. Furthermore, the implementation of a collective agreement in a firm with an average UD is estimated to increase firm productivity by 13.5 per cent. However, this estimate is likely to be biased upwards, a point we will return to below.

6.1 | Unobserved idiosyncratic productivity shocks

In Model 1d, we control for heterogeneity in workers' skills (other than educational attainment level) by including occupational shares at the 1-digit (ISCO 08) level, as well as demographic characteristics such as age, sex and immigration status. However, this enlargement of the specification has no significant effect on the estimated coefficients, which remain robust. In Table A3 in the Appendix, we demonstrate how using labour productivity as our endogenous variable produces similar results.[9] In Model 1e, however, we consider how factor inputs may be endogenously determined in the production function by allowing time-varying idiosyncratic productivity shocks, represented by ω_{it} in (1). Applying the generalized method of moments (GMM) estimator proposed in Wooldridge (2009),[10] we first estimate the production function, including capital and labour inputs only, where unobserved productivity is proxied by a third-order polynomial in intermediate inputs. We then use the residuals from this regression, which acts as a measure of total factor productivity, as regressand in the fixed-effects model. When this approach is employed, the effect of implementing a collective agreement drops sharply, suggesting that the estimated effect above is partly caused by idiosyncratic productivity shocks correlated with the decision to implement or abolish a collective agreement. However, the presence of a collective agreement still constitutes an important factor in understanding how unionization alters productivity. The implementation of a collective agreement, evaluated on average UD, is estimated to increase productivity by 2.8 per cent. Moreover, while a 10-percentage-point increase in UD is estimated to *decrease* productivity by almost 1 per cent in the absence of an agreement, a similar increase in UD in the presence of an agreement is estimated to *increase* productivity by 0.6 per cent.

The influence of collective agreements may be limited in small organizations. In Models 1f and 1g, we therefore constrain our sample to firms with at least 5 and 10 employees, respectively, to make sure our results are not driven by variation generated by small firms. The restriction is not trivial, as the models then exclude 43 and 69 per cent of the firms in our sample. Nevertheless, the results remain robust and somewhat strengthened.

6.2 | Industry heterogeneity

To control for industry heterogeneity, we start by including industry-by-year interactions to capture potential heterogeneity in technological trends across industries.[11] The results are presented in Model 2a of Table 4. In Model 2b, we expand the scope for industry heterogeneity by relaxing our previous assumption of homogeneous input elasticities. Specifically, we use the residuals from industry-specific GMM estimations as left-hand side variables in the fixed effects model, thereby recognizing heterogeneous capital and labour elasticities while assuming the impact of unions on productivity to be homogeneous. This more flexible specification changes the results slightly, but the overall pattern remains quite robust.

Finally, in Models 2c–2i, we present the results of separate GMM estimations for selected groups of industries.[12] Most noteworthy is how robust the interaction term is estimated across most industries. Although higher UD is estimated to lower productivity in the absence of a collective agreement, this effect is moderated, and in many cases becomes positive, in the presence of an agreement. Moreover, the implementation of a collective agreement is estimated to increase productivity in all industries but professional services (evaluated at average UD), with an estimated elasticity ranging from 1 to 10 per cent.

TABLE 4 LPW-GMM estimates of union density and collective agreements on total factor productivity allowing for various forms of industry heterogeneity

	Model 2a	Model 2b	Model 2c	Model 2d	Model 2e	Model 2f	Model 2g	Model 2h	Model 2i
Union density (UD)	−0.099***	−0.103***	−0.139***	−0.149***	−0.130***	−0.127***	−0.129**	−0.032	−0.135***
	(−14.43)	(−15.44)	(−5.52)	(−8.97)	(−10.17)	(−4.88)	(−3.15)	(−1.37)	(−3.78)
Collective agreement (CA)	0.002	0.018*	0.024	0.022	0.026	0.080**	−0.048	−0.037	−0.036
	(0.23)	(2.25)	(1.19)	(1.28)	(1.92)	(3.08)	(−0.84)	(−0.77)	(−0.81)
UD × CA	0.148***	0.130***	0.118**	0.199***	0.109***	0.136*	0.335**	0.0944	0.288**
	(9.60)	(8.70)	(3.05)	(5.97)	(3.92)	(2.18)	(3.17)	(1.23)	(3.29)
Marginal effects of:									
UD for $CA = 0$	−0.099***	−0.103***	−0.139***	−0.149***	−0.130***	−0.127***	−0.129**	−0.032	−0.135***
	(−14.43)	(−15.44)	(−5.52)	(−8.97)	(−10.17)	(−4.88)	(−3.15)	(−1.37)	(−3.78)
UD for $CA = 1$	0.050***	0.027	−0.021	0.050	−0.021	0.010	0.207*	0.063	0.153
	(3.44)	(1.91)	(−0.66)	(1.66)	(−0.82)	(0.17)	(2.04)	(0.83)	(1.87)
CA for $\overline{UD}$	0.030***	0.040***	0.051**	0.048**	0.040***	0.097***	0.026	−0.014	0.006
	(3.90)	(6.02)	(3.17)	(3.16)	(3.35)	(4.16)	(0.61)	(−0.41)	(0.16)
Test (p-value): $\hat{\gamma}_1 + \hat{\gamma}_3 = 0$[a]	0.001	0.056	0.507	0.097	0.414	0.864	0.041	0.404	0.062
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Occupation and demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry by year dummies	Yes	Yes							

(Continues)

TABLE 4 (Continued)

	Model 2a	Model 2b	Model 2c	Model 2d	Model 2e	Model 2f	Model 2g	Model 2h	Model 2i
Heterogeneous input elasticities		Yes							
Industry	All	All	Manufacturing	Construction	Sales & Retail	Hotel & Restaurants	ICT	Professional service	Industrial service
N	941,995	941,969	101,571	187,111	291,121	59,801	33,950	65,923	34,472
Firms	152,658	152,651	13,363	30,272	42,934	11,327	6643	14,287	7225
Average observations per firm	6.2	6.2	7.6	6.2	6.8	5.3	5.1	4.6	4.8

Note: Union density measured as a rate between 0 and 1. Collective agreement measured as a dummy variable. Industries are divided into 19 groups. Demographics include age intervals, sex and country of origin. All models use as regressand the residuals from LPW-GMM estimation of value added on capital and labour inputs only. Standard errors of marginal effects are calculated using the delta method.

[a]The reported test refers to the *p*-value of an *F*-test of the sum of the coefficients on UD and UD × CA. *t*-Statistics are in parentheses. Robust standard errors are clustered at firm level.

*$p < 0.05$,

**$p < 0.01$,

***$p < 0.001$.

We estimate that the implementation of a collective agreement, also in manufacturing industries, has a positive and significant effect on productivity. As firms operating in manufacturing industries are generally exposed to international competition—especially in a small, open economy like that of Norway, their market power is limited. This suggests that our findings are not merely price effects caused by firms passing on the union wage premium to consumers, which is a general concern in studies using value measures of output (Freeman & Medoff, 1984, p. 167).

6.3 | Further investigation of robustness

Our estimations rely on an unbalanced panel of observations, with new firms entering and others exiting the sample along the period of analysis. On the one hand, an unbalanced panel eliminates the potential bias caused by low-productivity firms going into bankruptcy. On the other hand, the productivity effect of collective agreements and unionized workers may differ systematically between new entrants and existing firms in the market. It is therefore interesting to investigate how our results are influenced by imposing various restrictions on the sample of included firms.

Table A4 in the Appendix shows the results of estimating Model 2b with only firms present all years, only entrant firms and only entrants that remain in our sample, respectively. The effect of implementing a collective agreement evaluated at average UD is estimated to be close to zero when only firms that are present all years are considered. The estimated positive impact of collective agreements on productivity thus seems to be driven mainly by new market entrants during our sample period. However, our main result that collective agreements act as an important moderator of what unions do to productivity, remains robust across all the mentioned restrictions.

We also investigate how our results are affected by only including firms with or without changes in their CAC throughout the sample. In Table A4 in the Appendix, we first restrict the sample to firms that always or never, respectively, are covered by a collective agreement. Although the effect of collective agreements naturally cannot be identified under these restrictions, we note that an increase in UD is estimated to *reduce* productivity in firms never covered by an agreement but to increase productivity in firms that are always covered. Although the latter estimate is not significantly different from zero, the results are consistent with our prior findings. We further restrict our sample to firms that do not change coverage status and firms that do change coverage status, respectively, during our sample period. Once again, our results prove to be robust to these restrictions. Compared to the results in Model 2b, the estimated effect of implementing a collective agreement, when evaluated at average UD, is stronger when only firms that do change status are considered. This is consistent with the above finding that this effect mainly seems to be driven by new entrants to the market, as the propensity to change coverage is higher among entrant firms.

Finally, we explore the importance of the linearity assumption implicitly imposed in our estimations. In general, there is no reason why an increase in UD from 10 to 20 per cent should have the same effect on productivity as an increase from 80 to 90 per cent. In Table A5 in the Appendix, we show the results of estimating Model 2b with UD measured as a categorical variable split into five equal intervals. Each UD interval is included in the estimation, as well as the interaction between each interval and the presence of a collective agreement. This exercise reveals that UD has a nonlinear effect on productivity. The estimated effects of going from a UD below 20 per cent to a UD between 20 and 40 per cent, between 40 and 60 per cent, or between 60 and 80 per cent is in fact very similar. In other words, the negative productivity effect of unionization is estimated to

be the same whether the UD goes from 0 to 20–40 per cent or from 0 to 60–80 per cent. The linearity assumption seems more reasonable when we consider the evaluated effect of implementing a collective agreement conditional on different levels of UD, which is also illustrated in Figure A2 in the Appendix. Overall, taking nonlinearity into consideration does not alter our prior findings in any significant way. If anything, our results are strengthened.

6.4 | Endogenous unionization

We may worry that our above estimates are confounded by selection bias, as unionization may be endogenously determined by the performance of the firm. To overcome this issue, we apply an instrumental variable (IV) approach, instrumenting UD at the workplace with the UD among the workers' parents. In the next section, we explore this instrument further, before we continue with the firm-level analysis in Subsection 6.3.2. Importantly, however, and as discussed in Section 5, the possible correlation between productivity shocks and the decision to enter or exit a collective agreement, remains a caveat in our study, even after controlling for fixed effects and UD.

6.4.1 | Parental influence on individual propensity to join a union

It is widely recognized that the choices of the individual are affected by intergenerational transmission of preferences regarding political orientation (Jennings et al., 2009), education (Holmund et al., 2011) and receipt of welfare insurance (Dahl et al., 2014), to mention some. This is also the case for union membership. As demonstrated in Bryson and Davies (2018), the decision of young workers in Britain of whether or not to join a union is influenced by their parents' union membership. In particular, their study reveals that young workers are 29 per cent more likely to join a union if one of their parents is a union member, and 87 per cent more likely to join a union if both are union members, compared to individuals with no unionized parents (pp. 12–13).

In our sample, the probability that a given individual was a union member in 2018 was 26 per cent higher if at least one of their parents were union members, compared to an individual with no unionized parents.[13] Note that our sample of individuals with information on parents' union memberships averages approximately 500,000 individuals per year, compared to approximately 1.6 million individuals in our full sample. This mainly reflects the fact that parents are excluded from our data when they leave the labour force. In addition, individuals working with their parents are excluded from the analysis.

To gain a better understanding of how the unionization behaviour of individuals is influenced by their parents' union memberships, we estimate a simple linear probability model, where union membership is estimated as a function of parents' union membership. We then add a list of controls, including sex, age, occupation, the industry of their current occupation, education and immigration status, as well as year dummies. We also exclude individuals co-working with any of their parents.[14] The estimated partial effect of parental union memberships on an individual's unionization behaviour is reported in Model 3 of Table 5. [15] The result shows that the probability of being unionized is 6.7 percentage points higher for individuals with at least one unionized parent, compared to an individual with no unionized parents. Evaluated at UD among individuals with no unionized parents in 2018, this amounts to a 22.3 per cent increase in the probability of being unionized, which is same order of size as found among young British workers (Bryson & Davies, 2018).

TABLE 5 Linear probability model estimates of union density as a function of parents' union memberships

	Model 3
At least one parent unionized	0.068***
	(197.26)
N	7,969,901
R^2	0.134

Note: Endogenous variable: binary variable taking the value 1 if the individual is a union member and 0 if not. Included controls: sex, age, immigration status, occupation (1-digit ISCO-08), industry of current occupation (2-digit NACE), educational attainment level (1-digit ISCED 2011) and year dummies. Individuals working together with their parents are excluded. *t*-Statistics are in parentheses. Robust standard errors are clustered at firm level.
***$p < 0.001$.

Although a rigorous analysis of intergenerational transmission of union membership should be implemented using a more sophisticated identification strategy, our aim here is limited to documenting its relevance in the Norwegian labour market. The simple analysis presented shows a strongly significant and sizeable intergenerational relationship for unionization behaviour. Admittedly, we cannot rule out the possibility that this relationship works in the reverse direction, that is, that the unionization behaviour of children affects the parents' decision on whether or not to join a union. However, our result fits into a series of studies of how the decision of parents influence the preferences and choices made by their children.

6.4.2 | UD among parents as an instrument for workplace UD

Table 6 documents the estimation results when instrumenting workplace UD with the contemporary UD among the workers' parents. Although the effect of intergenerational transmission of union memberships naturally becomes weaker when moving from individual unionization decisions to UD at the firm level, it remains highly statistically significant and passes conventional tests for weak instruments by a good margin. In Model 4a, we re-estimate Model 1e from Table 1 using two-stage least squares (2SLS). Model 4b then adds linear industry trends and allows for heterogeneous input elasticities, using the residuals from industry-specific production function GMM estimations as values for the endogenous variable (referred to as GMM-IV). Finally, Models 4c and 4d restrict the sample to firms with at least 5 and 10 employees, respectively.

Overall, the IV estimates confirm our main result: the presence of a collective agreement significantly alters what unions do to productivity. However, although the presence of an agreement moderates the negative effect of an increase in UD, the effect remains negative (though not statistically significant). Moreover, the effect of implementing a collective agreement, evaluated at average UD, is only significant (at the 10 per cent level) when we restrict the sample to firms with at least 10 employees in Model 4d. However, the estimated coefficient values in Models 4b, 4c and 4d are comparable to the above GMM estimates. It is also important to emphasize that the IV estimator identifies the local average treatment effect (LATE) of unionization among *compliers*, which in general is not equal to the average treatment effect (ATE). The results in Table 4 and 6 are thus not directly comparable, as differences may be ascribed to either selection bias or treatment heterogeneity, or a combination of the two.

TABLE 6 IV estimates of the effects of union density and collective agreements on total factor productivity

	Model 4a	Model 4b	Model 4c	Model 4d
	2SLS	GMM-IV	GMM-IV	GMM-IV
Union density (UD)	0.0985	−0.764***	−0.695***	−0.982**
	(0.69)	(−5.16)	(−3.45)	(−2.72)
Collective agreement (CA)	−0.131	−0.079	−0.090	−0.159
	(−1.68)	(−0.99)	(−1.09)	(−1.69)
UD × CA	0.559**	0.661**	0.658**	0.928**
	(2.67)	(3.10)	(2.84)	(3.11)
Marginal effects:				
UD for $CA = 0$	0.0985	−0.764***	−0.695***	−0.982**
	(0.69)	(−5.16)	(−3.45)	(−2.72)
UD for $CA = 1$	0.657	−0.103	−0.037	−0.054
	(3.23)	(−0.50)	(−0.17)	(−0.19)
CA for $\overline{UD}$	−0.029	0.041	0.048	0.084
	(−0.67)	(0.92)	(1.13)	(1.73)
Test (p-value): $\hat{\gamma}_1 + \hat{\gamma}_3 = 0$[a]	0.001	0.620	0.869	0.851
Year dummies	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Occupation and demographics	Yes	Yes	Yes	Yes
Industry trends		Yes	Yes	Yes
Heterogeneous input elasticities		Yes	Yes	Yes
Minimum number of employees			5	10
N	704,314	704,314	490,776	275,139
Firms	118,441	118,441	78,740	43,840
Average observations per firm	5.9	5.9	6.2	6.3
Test for weak instruments (F-statistics):				
Kleibergen–Paap Wald	268.2	277.9	170.9	70.6
Cragg–Donald Wald	669.4	698.0	387.6	157.8

Note: Union density measured as a rate between 0 and 1. Collective agreement measured as a dummy variable. Union density is instrumented by the contemporary union density among the workers' parents. The interaction term is instrumented with the interaction between the collective agreement dummy and the instrument. Industries are divided into 19 groups. Demographics include age intervals, sex and country of origin. Union density instrumented by union density among parents in IV estimation.

[a]The reported test refers to the p-value of an F-test of the sum of the coefficients on UD and UD × CA. t-Statistics are in parentheses. Robust standard errors are clustered at firm level.

**$p < 0.01$,

***$p < 0.001$.

7 | DISCUSSION AND CONCLUSIONS

Overall, our results show that the qualitative interpretation of what unions do to total factor productivity depends on whether or not the firm is covered by a collective agreement. In the absence of an agreement, increases in UD among the workers in a firm are estimated to reduce productivity. However, the implementation of a collective agreement is estimated to moderate this negative

impact. Moreover, when evaluated at average UD, the implementation of a collective agreement is estimated to increase productivity in most model specifications. Our findings thus give some support to the conclusions in Barth et al. (2020), but demonstrate the importance of taking account of the industrial relations climate when evaluating the impact of unionization on firm performance.

In general, there are good reasons to believe that the institutional framework encompassed in the collective agreements contributes to improving industrial relations in a firm. In the Norwegian context in particular, the agreements formally acknowledge the importance of the workers' voice and their contributions to productivity growth by establishing a system of collaboration, communication and participation. Furthermore, they regulate issues such as the right to information and consultation, procedures for electing employee representatives and rules for taking industrial action. Collective agreements thus represent an institutionalization of a particular way of managing industrial relations. In the absence of this institution, union activity may be more poorly organized and less predictable. Similarly, it may be difficult to utilize the productivity-enhancing potential of collective agreements in the absence of union activity. Based on our findings, UD and the presence of a collective agreement represent two necessary but insufficient conditions per se for releasing the productivity-enhancing effects of unionization. However, our results indicate that a sufficiently high UD and a collective agreement combined have a positive impact on firm-level productivity.

Despite the vast body of empirical literature investigating whether unions promote or impede productivity, the evidence is mixed and inconclusive. In this article, we have demonstrated the importance of recognizing institutional contexts when answering this question. In particular, we have argued that the presence of unions can be measured along two dimensions: the density of union members among employees, and the presence of a collective agreement. Such agreements act as a formal recognition of the policy put forward by the union and constitute an important organizational institution through which unions may alter industrial relations. However, little attention has been devoted to the study of collective agreements and their influence on what unions do to productivity.

Using matched employer–employee panel data, comprising almost 21 million individual-year and almost 1.2 million firm-year observations in the period 2002–2018, we have estimated how unions alter productivity at the firm level and how this effect is influenced by the presence of a collective agreement. Our main finding, which is robust across model specifications, is that the presence of a collective agreement significantly and positively alters what unions do to productivity. In most specifications, collective agreements are estimated to increase productivity. Moreover, across all specifications, collective agreements moderate the negative impact on productivity of increases in UD found in the absence of such agreements. However, care should be taken in interpreting our results, as the possible endogenous decision to enter or exit a collective agreement may bias our findings, even when controlling for firm fixed effects and endogenous unionization.

Our findings may reflect an interdependence between UD and collective agreements with respect to how they affect productivity. Although they may have a negative or insignificant impact on productivity in isolation, our results indicate that the combination of a sufficiently high UD and a collective agreement has a positive impact on firm-level productivity. Future research should investigate this interdependence further. In particular, it would be interesting to see an explicit attempt to model this complex relationship, especially within a dynamic framework.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from Statistics Norway. Restrictions apply to the availability of these data, which were used under license for this study. Researchers affiliated with an approved research institution, or a public authority can apply to data from Statistics Norway (https://www.ssb.no/en/data-til-forskning/utlan-av-data-til-forskere).

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ENDNOTES

[1] However, union density is low compared to the other Nordic countries, where trade unions have traditionally administered the unemployment benefit funds, and thus have had better recruitment opportunities.

[2] This is the case in Austria, Belgium, Finland, France, Germany, the Netherlands and Portugal (García-Serrano, 2009). A comprehensive overview of the prevalence and functioning of collective agreements in the OECD, including differences in the practice of *ergo omnes* clauses and extensions are found in the OECD report 'Negotiating Our Way Up' (2019).

[3] There is an important exception. In industries where inflows of migrant workers have led to 'social dumping', general application of collective agreements is practised. However, such extensions are 'narrow' in the sense that they only include minimum wage rates and some basic supplements. The provisions in the basic agreements about co-determination (including the election of employee representatives), do not extend to all firms in an industry unless they have a local agreement in place.

[4] Some firms in the sample are covered by collective agreements, without being members of the AFP scheme. This mainly applies to enterprises in shipping and the oil industry and privately run health and social services. The firms in question are manually coded as covered if union density exceeds 50 per cent and the number of employees is at least 25.

[5] There are only small differences between firms in the initial and the final sample in union density, collective agreement coverage, average age and distribution across sex, education levels, occupations and industries. Overall, the final sample appears to be representative of the population of private sector employees.

[6] The premise of a threshold in the union membership rate is institutionalized in the Basic Agreement between the Confederation of Norwegian Enterprise (NHO) and the Norwegian Confederation of Trade Unions (LO) (Hovedavtalen § 3-7, nr. 2). This states that employees cannot require that the enterprise become part of a collective agreement without at least 10 per cent of the employees within the particular bargaining area being members of a union.

[7] Low-skilled labour comprises workers who do not complete upper secondary school, while medium-skilled corresponds to workers who have completed upper secondary school. High-skilled labour includes workers with a degree from up to 4 years of higher education and workers with at least 120 credits without a degree. Finally, top-skilled labour includes workers who have completed more than 4 years of tertiary education.

[8] Input elasticities are omitted from Table 3 for the sake of readability and reported in Table A2 in the Appendix. The drop in the estimated coefficients of capital and labour inputs when moving from the OLS estimator to the FE estimator reflects the common issue of estimating panel data production functions using micro data (Griliches & Mairesse 1999).

[9] Table A3 in the Appendix shows the results of estimating various models using labour productivity, measured as value added per hours worked, as endogenous variable. All models are estimated with firm fixed effects, year dummy variables and controls on individual worker characteristics. Note that the hours worked by employees with different skill levels are now included as shares among the controls, in contrast to the models presented in Tables 1, 2 and 4. The model is estimated with and without controls for hours worked and capital intensity. Theoretically, the model should include the total number of hours worked, as the assumption of constant returns to scale is rejected in our models. Overall, we find that our results are robust to the choice of productivity measure.

[10] The estimator is implemented using the -prodest- command in Stata with the Wooldridge (wrdg) estimator and the gmm option specified (Rovigatti & Mollisi, 2018). The estimator proposed by Levinsohn & Petrin (2003) produces almost identical results (not reported).

[11] Specifically, we add interactions between yearly time dummies and 19 main groups of industries.

[12] Results for all 19 main groups of industries are available upon request.

[13] Figure A3 in the Appendix compares the sample's union density among workers with and without unionized parents in a given year during our sample period.

[14] This restriction barely changes the result.

[15] Full estimation results are available upon request.

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APPENDIX

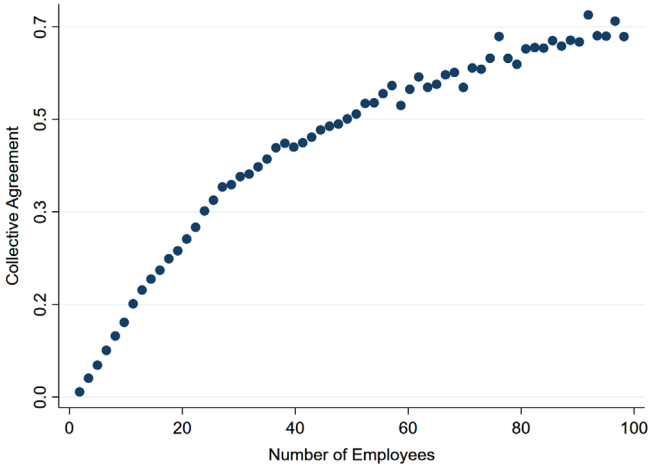

FIGURE A1 Binscatter illustrating mean collective agreement coverage as a function of the number of employees in the firm [Colour figure can be viewed at wileyonlinelibrary.com]

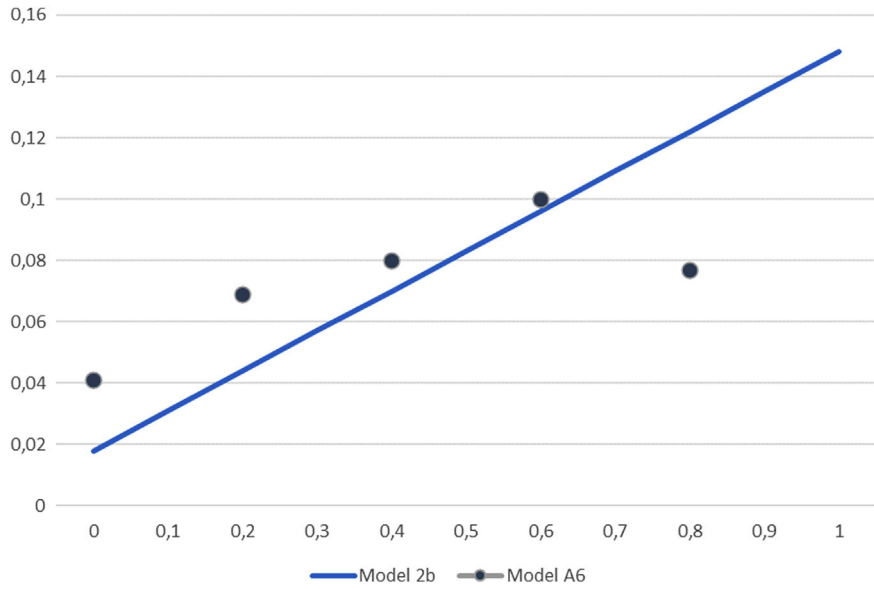

FIGURE A2 The effect of implementing a collective agreement, evaluated for different union density values [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE A1 Descriptive statistics

	Observations	Firms	Average years	Min	Max	Mean	SD overall	SD within	SD between
Log value added	1,170,670	178,438	6.6	0	25.83	14.82	1.45	0.52	1.39
Log capital	1,170,670	178,438	6.6	0	25.6	12.91	2.20	0.94	2.02
Log hours, low-skilled	1,170,670	178,438	6.6	−3.98	12.33	2.58	2.30	1.02	2.05
Log hours, medium-skilled	1,170,670	178,438	6.6	−4.20	12.95	3.98	2.03	0.78	2.00
Log hours, high-skilled	1,170,670	178,438	6.6	−3.28	12.03	2.08	2.26	0.95	1.98
Log hours, top-skilled	1,170,670	178,438	6.6	−0.98	12.45	0.82	1.72	0.74	1.46
Union density (UD)	1,170,670	178,438	6.6	0	1	0.17	0.26	0.13	0.25
Collective agreement (CA)	1,170,670	178,438	6.6	0	1	0.13	0.33	0.12	0.26
Occupational share 0 and 9[a]	1,109,842	173,247	6.5	0	1	0.06	0.18	0.10	0.18
Occupational share 1–3	1,109,842	173,247	6.5	0	1	0.37	0.38	0.15	0.38
Occupational share 4–5	1,109,842	173,247	6.5	0	1	0.29	0.35	0.14	0.35
Occupational share 6–8	1,109,842	173,247	6.5	0	1	0.27	0.37	0.11	0.36
Low-skilled worker share[b]	1,161,166	176,243	6.4	0	1	0.23	0.26	0.12	0.27
Medium-skilled worker share	1,161,166	176,243	6.4	0	1	0.53	0.32	0.14	0.33
High-skilled worker share	1,161,166	176,243	6.4	0	1	0.18	0.26	0.11	0.28
Top-skilled worker share	1,161,166	176,243	6.4	0	1	0.06	0.18	0.06	0.20
Share Norwegians	1,170,670	178,438	6.6	0	1	0.80	0.28	0.12	0.30
Share immigrants from Nordic countries	1,170,670	178,438	6.6	0	1	0.04	0.12	0.06	0.13
Share immigrants from EU countries in Eastern Europe	1,170,670	178,438	6.6	0	1	0.04	0.13	0.06	0.15

(Continues)

TABLE A1 (Continued)

	Observations	Firms	Average years	Min	Max	Mean	SD overall	SD within	SD between
Share immigrants from other EU countries	1,170,670	178,438	6.6	0	1	0.03	0.10	0.05	0.11
Share immigrants from the rest of the world	1,170,670	178,438	6.6	0	1	0.08	0.19	0.08	0.22
Share low-age	1,170,670	178,438	6.6	0	1	0.10	0.18	0.11	0.18
Share medium-age	1,170,670	178,438	6.6	0	1	0.71	0.29	0.17	0.28
Share high-age	1,170,670	178,438	6.6	0	1	0.18	0.27	0.15	0.25
Share top-age	1,170,670	178,438	6.6	0	1	0.01	0.05	0.05	0.0

[a]Occupational shares are calculated at 1-digit (ISCO 08) level,
[b]2-digit NUS2000 codes, translatable to ISCED97.

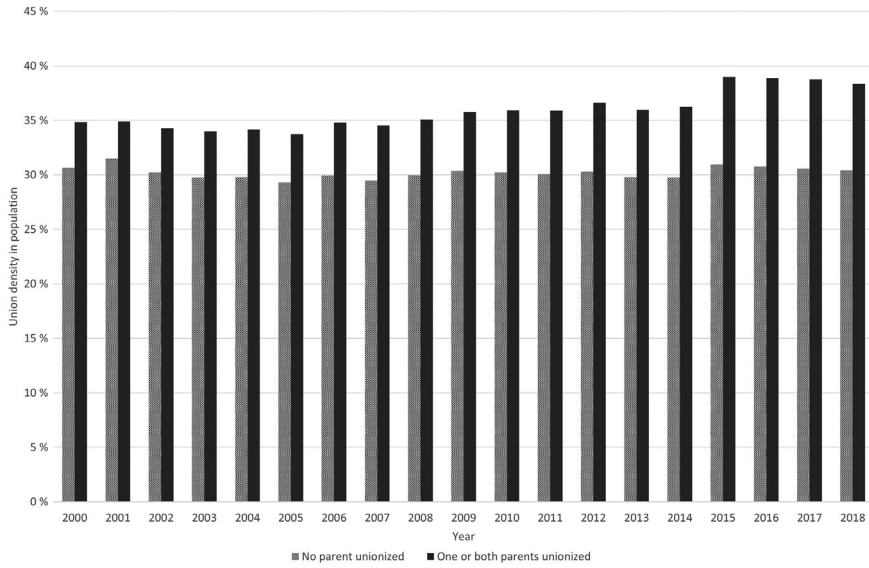

FIGURE A3 Union density in the sample and parental union membership ($N = 500{,}000$ individuals per year)

TABLE A2 Input elasticities corresponding to Table 3

	Model 1a	Model 1b	Model 1c	Model 1d	Model 1e	Model 1f	Model 1g
	FE	FE	FE	FE	LPW-GMM	LPW-GMM	LPW-GMM
Log capital	0.077***	0.077***	0.077***	0.075***	0.087***	0.087***	0.087***
	(82.64)	(82.55)	(82.55)	(81.99)	(104.54)	(104.54)	(104.54)
Log hours, low-skilled	0.080***	0.080***	0.080***	0.078***	0.108***	0.108***	0.108***
	(109.74)	(109.24)	(109.28)	(106.57)	(269.95)	(269.95)	(269.95)
Log hours, medium-skilled	0.147***	0.146***	0.146***	0.144***	0.242***	0.242***	0.242***
	(126.96)	(126.55)	(126.53)	(125.46)	(391.60)	(391.60)	(391.60)
Log hours, high-skilled	0.071***	0.070***	0.071***	0.069***	0.142***	0.142***	0.142***
	(93.64)	(93.37)	(93.47)	(91.25)	(359.91)	(359.91)	(359.91)
Log hours, top-skilled	0.059***	0.059***	0.059***	0.056***	0.160***	0.160***	0.160***
	(60.34)	(59.97)	(60.08)	(57.19)	(294.38)	(294.38)	(294.38)

Note: Union density measured as a rate between 0 and 1. Collective agreement measured as a dummy variable. All estimations include year dummies. Demographics include age intervals, sex and country of origin. *t*-Statistics are in parentheses. Models 1e–1g use as regressand the residuals from an LPW-GMM estimation of value added on capital and labour inputs only. Robust standard errors are clustered at firm level.

***$p < 0.001$.

TABLE A3 Estimation results using labour productivity (value added per hour worked) as endogenous variable

	Model A3a	Model A3b	Model A3c	Model A3d	Model A3e
$\log(C/HW)$			0.0636***	0.0633***	0.143***
			(73.86)	(74.08)	(14.72)
$\log(HW)$		−0.410***	−0.398***	−0.403***	−0.425***
		(−158.70)	(−145.18)	(−147.13)	(−23.41)
Union density (UD)	−0.0689***	−0.0386***	−0.0427***	−0.0429***	−0.0468***
	(−11.18)	(−7.02)	(−7.21)	(−7.26)	(−8.00)
Collective agreement (CA)	−0.00833	0.111***	0.0926***	0.0921***	0.0928***
	(−1.04)	(14.84)	(12.74)	(12.74)	(12.90)
UD × CA	0.0336*	0.0621***	0.0697***	0.0580***	0.0437***
	(2.19)	(4.53)	(5.17)	(4.34)	(3.32)
Marginal effects of:					
UD for $CA = 0$	−0.0689***	−0.0386***	−0.0427***	−0.0429***	−0.0468***
	(−11.18)	(−7.015)	(−7.211)	(−7.256)	(−7.997)
UD for $CA = 1$	−0.0353**	0.0235	0.0270*	0.0150	−0.00311
	(−2.410)	(1.811)	(2.137)	(1.201)	(−0.253)
CA for $\overline{UD}$	−0.00247	0.122***	0.105***	0.102***	0.100***
	(−0.381)	(19.77)	(17.58)	(17.24)	(17.01)
Test (p-value): $\hat{\gamma}_1 + \hat{\gamma}_3 = 0$[a]	0.0160	0.0702	0.0326	0.230	0.800
Industry by time dummies	No	No	No	Yes	Yes
Heterogeneous input elasticities	No	No	No	No	Yes
R^2 (within)	0.0695	0.169	0.215	0.220	0.228
R^2 (between)	0.0614	0.00941	0.0450	0.0387	0.0483
R^2 (overall)	0.0704	0.0173	0.0558	0.0504	0.0623
N	1,342,530	1,342,530	1,100,463	1,100,262	1,100,262
Firms	205,427	205,427	170,937	170,894	170,894
Average observations per firm	6.5	6.5	6.4	6.4	6.4

Note: Union density measured as a rate between 0 and 1. Collective agreement measured as a dummy variable. C and HW denote capital and hours worked, respectively. All estimations include year dummies, firm fixed effects and the following controls on individual workers' characteristics (measured as shares): education, occupation, age, sex and country of origin. t-Statistics are in parentheses.

[a]The reported test refers to the p-value of an F-test of the sum of the coefficients on UD and UD × CA.

*$p < 0.05$,

**$p < 0.01$,

***$p < 0.001$.

TABLE A4 LPW-GMM estimates of union density and collective agreements on total factor productivity with various sample restrictions

	Model 2b	Model A4a	Model A4b	Model A4c	Model A4d	Model A4e	Model A4f	Model A4g
Union density (UD)	−0.103***	−0.0730***	−0.120***	−0.100***	0.0293	−0.108***	−0.107***	−0.0737***
	(−15.44)	(−5.37)	(−14.02)	(−10.63)	(1.32)	(−15.21)	(−15.02)	(−3.61)
Collective agreement (CA)	0.0180*	−0.0152	0.0109	0.0150	–	–	–	0.0362***
	(2.25)	(−1.31)	(0.79)	(1.01)	(.)	(.)	(.)	(3.88)
UD × CA	0.130***	0.127***	0.154***	0.139***	–	–	0.156***	0.0863***
	(8.70)	(5.46)	(6.23)	(5.37)	(.)	(.)	(6.76)	(3.70)
Marginal effects of:								
UD for $CA = 0$	−0.1035***	−0.0730***	−0.120***	−0.100***				−0.0737***
	(−15.44)	(−5.37)	(−14.02)	(−10.63)				(−3.61)
UD for $CA = 1$	0.0267	0.0537	0.0344	0.0384				0.0125
	(1.91)	(0.01)	(0.15)	(0.12)				(0.66)
CA for $\overline{UD}$	0.0399***	0.00921	0.0353**	0.0375**				0.0640***
	(6.02)	(0.94)	(3.14)	(3.07)				(9.76)
Test (p-value): $\hat{\gamma}_1 + \hat{\gamma}_3 = 0$[a]		0.00658	0.153	0.123			0.0248	0.509
Firm presence restriction		Present all years	Enters	Enters and stays				
CA restriction					Always	Never	Always or never	Change status
N	941,969	244,407	505,937	379,206	77,173	770,598	847,771	94,198
Firms	152,651	17,614	105,200	62,052	8392	134,504	142,896	9755
Average observations per firm	6.2	13.9	4.8	6.1	9.2	5.7	5.9	9.7

Note: All models use as regressand the residuals from LPW-GMM estimation of value added on capital and labour inputs only, with heterogeneous input elasticities across 19 groups of industries. Union density measured as a rate between 0 and 1. Collective agreement measured as a dummy variable. All models include year dummies, industry by year dummies, firm fixed effects and controls on worker characteristics (occupation, age intervals, sex and country of origin). In Model 2b (our reference model), there are no restrictions on the sample. Model A4a restricts the sample to firms that were in operation throughout our entire sample period. Model A4b only includes firms that enter the market during our sample period, while Model A4c only includes those that enter the market during our sample period and stay in the market. In Models A4d and A4e, we restrict the sample of firms to those who always and those who never, respectively, have a collective agreement, while Model A4f includes all firms that do not change status during our sample period. Finally, Model A4g only includes firms that change status during our sample period (i.e. either enter or exit agreements, or both).

[a]The reported test refers to the p-value of an F-test of the sum of the coefficients on UD and UD × CA. Standard errors of marginal effects are calculated using the delta method. t-Statistics are in parentheses. Robust standard errors are clustered at firm level.

*$p < 0.05$,

**$p < 0.01$,

***$p < 0.001$.

TABLE A5 Nonlinear effects of unionization on total factor productivity

	Model 2b	Model A5
Collective agreement (CA)	0.018*	0.041***
	(2.25)	(5.25)
Union density (UD)	−0.103***	–
	(−15.44)	
UD × CA	0.130***	–
	(8.70)	
UD = 20–40% (UD2)		−0.052***
		(−21.55)
UD = 40–60% (UD3)		−0.056***
		(−13.70)
UD = 60–80% (UD4)		−0.061***
		(−9.12)
UD = 80–100% (UD5)		−0.001
		(−0.13)
UD2 × CA		0.028***
		(4.19)
UD3 × CA		0.039***
		(4.85)
UD4 × CA		0.060***
		(5.71)
UD5 × CA		0.036**
		(2.67)
Marginal effects of:		
CA for $\overline{UD}$	0.040***	
	(6.02)	
CA for $UD1 = 1$		0.041***
		(5.25)
CA for $UD2 = 1$		0.069***
		(9.99)
CA for $UD3 = 1$		0.080***
		(10.93)
CA for $UD4 = 1$		0.100***
		(10.54)
CA for $UD5 = 1$		0.077***
		(6.06)
N	941,969	941,969
Firms	152,651	152,651
Average observations per firm	6.2	6.2

(Continues)

TABLE A5 (Continued)

Note: Both models use as regressand the residuals from LPW-GMM estimation of value added on capital and labour inputs only, with heterogeneous input elasticities across 19 groups of industries. All models include year dummies, industry by year dummies, firm fixed effects and controls on worker characteristics (occupation, age intervals, sex and country of origin). In Model 2b, union density is measured as a rate between 0 and 1. In Model A6, union density is measured as a categorical variable taking the values {1, 2, 3, 4, 5} if the union density is within the corresponding intervals {0–0.2, 0.2–0.4, 0.4–0.6, 0.6–0.8, 0.8–1}. The first interval is used as reference category. Collective agreement measured as a dummy variable. Standard errors of marginal effects are calculated using the delta method. *t*-Statistics are in parentheses. Robust standard errors are clustered at firm level.

*$p < 0.05$,

**$p < 0.01$,

***$p < 0.001$.