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Productivity and wage effects of firm-level collective agreements: Evidence from Belgian linked panel data

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Working paper: Productivity and wage effects of firm-level collective agreements: Evidence from Belgian linked panel data

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Abstract

How do firm-level collective agreements affect firm performance in a multi-level bargaining system? Using detailed Belgian linked employer-employee panel data, our findings show that firm agreements increase both wage costs and labour productivity (with respect to sector-level agreements). Relying on a recent approach developed by Bartolucci (2014), they also indicate that firm agreements exert a stronger impact on wages than on productivity, so that on average profitability is hampered. However, this rent-sharing effect only holds in sectors where firms are more concentrated. Firm agreements are thus mainly found to raise wages beyond labour productivity when the rents to be shared between workers and firms are relatively big. Overall, this suggests that firm-level agreements benefit both employers and employees – through higher productivity and wages – without being detrimental to firms' gross profits.

Résumé

Quel est l'effet des conventions collectives de travail conclues au niveau des entreprises sur la performance de ces dernières dans un système de négociation à plusieurs niveaux? En utilisant des données appariées employeurs-employés pour la Belgique, nos résultats montrent que les accords d'entreprise augmentent les coûts salariaux et la productivité du travail (en comparaison avec les accords sectoriels). En s'appuyant sur une approche récente développée par Bartolucci (2014), nos résultats indiquent également que les accords d'entreprise ont un impact plus fort sur les salaires que sur la productivité, ce qui en moyenne nuit aux bénéfices bruts des entreprises. Toutefois, cet effet de partage de la rente n'est observé que dans les secteurs où les entreprises sont plus concentrées. Les accords d'entreprise ont donc principalement pour effet d'augmenter les salaires au-delà de la productivité du travail lorsque les rentes à partager entre les travailleurs et les entreprises sont relativement importantes. En somme, nos résultats suggèrent que les accords d'entreprise bénéficient à la fois aux employeurs et aux employés - grâce à une productivité et des salaires accrus - sans être trop dommageable à la compétitivité-coût des entreprises.

Table of contents

Acknowledgements **3**

Abstract **4**

Résumé **5**

Productivity and wage effects of firm-level collective agreements: Evidence from Belgian linked panel data **7**

Introduction 7
Background 8
Data and descriptive statistics 12
Methodology 15
Results 16
Conclusion 21

References **23**

Appendix **28**

Tables

Table 1. Descriptive statistics at the firm level, overall and by level of collective bargaining 14
Table 2. The impact of firm-level collective agreements on labour costs 19
Table 3. Estimates according to the degree of product market competition 20

Productivity and wage effects of firm-level collective agreements: Evidence from Belgian linked panel data

Introduction

Despite significant interest by academics and policy-makers, the role of unions and collective bargaining systems in firm productivity and profitability remains a largely open debate. Most reforms to decentralise collective bargaining have been undertaken with the explicit goal of fostering productivity growth. However, since the seminal works of Freeman (1976) and Freeman and Medoff (1984), we know that the theoretical effect of unions and collective bargaining on productivity is twofold: on the one hand, unions can behave as "rent-seekers", raise wages, restrict employment flexibility, affect labour supply by standardising wages across regions and industries (Addison and Belfield, 2004) and as a result, negatively affect firms' performance. On the other hand, by giving a "voice" to workers, unions can provide an institutionalised mechanism by which labour and management can communicate and bargain (Gomez et al., 2008). Unions and collective bargaining institutions thus enable workers to voice their concerns and requests, reduce "exit" and, in turn, improve efficiency notably through job and organisational changes. In sum, the effect of unions and collective bargaining arrangements for firm productivity and profitability[1] remains an empirical issue, and will depend on their impact on wage costs and labour productivity. If the wage premium determined by unions or collective bargaining originates from higher productivity, then both workers and firms can benefit. However, "*if raised wages come at the expense of normal profits, this can damage the prospects of firms and employment growth - to the long term detriment of all*" (Bryson, 2014: 1).

While in the United States, collective agreements between unions and employers can be negotiated exclusively at the firm level, wages are determined by multi-employer collective agreements (at the national, industry or regional levels) in many European countries. They are often complemented by single-employer agreements (at the firm or establishment level). The existing literature has shown that firm-level agreements generally yield higher wages and foster rent-sharing, i.e. strengthen the wage-profit elasticity (Gürtzgen, 2010; Rycx and Rusinek, 2013; OECD, 2018). This is an expected outcome, since in many countries firm-level agreements can only improve wages and working conditions. In contrast, very little is known regarding the consequences of firm-level agreements on labour productivity (Doucouliagos et al., 2017; Gürtzgen, 2010; Magda et al., 2012). This is somehow surprising since the decentralisation of collective bargaining was mainly promoted in order to better align wages with productivity and to enhance productivity by promoting incentive schemes that can be better implemented at the firm level, such as performance-related pay schemes (OECD, 2018).

Our paper provides one of the first attempts at measuring the impact of firm-level collective agreements on both wages and productivity in the context of a two-tier bargaining system, which is typical of continental European countries. More precisely, we rely on detailed matched employer-employee panel data for Belgium, covering all years from 1999 to 2010, to investigate the consequences of firm-level collective agreements (with respect to multi-

[1] In this paper, profitability refers to gross operating profits (value added minus the wage bill).

employer agreements) on wage costs and productivity-wage gaps, i.e. profits. Our data offers several advantages. The panel covers a large part of the private sector, provides accurate information on average productivity and wages within firms, and allows us to control for a wide range of worker, job and firm characteristics. It also enables us to address important econometric issues that are often not accounted for in this literature, such as firm-level fixed effects and endogeneity. While each national bargaining system has its own specificities, the Belgian bargaining system shares many features with the systems in Finland, France, Iceland, Italy, Portugal, Slovenia, Spain and Switzerland (see OECD, 2017 for a detailed discussion), where multi-employer bargaining is complemented by firm-level bargaining. Debates on the (re-)introduction of some forms of sector-level bargaining or regulations are also present in the United States, United Kingdom and New Zealand. Therefore, while keeping the institutional differences in mind, the conclusions of this analysis for Belgium can be of interest for several other countries.

To estimate the impact of firm-level collective agreements on wages and productivity-wage gaps, we rely on an approach developed by Bartolucci (2014) which can be summarised as estimating a wage equation at the firm level and controlling for a large set of covariates, including firm-level labour productivity. If the results show that firm-level agreements have a significant positive effect on wage costs, conditional on labour productivity and other covariates, then firm-level agreements are mainly a tool for rent-sharing (i.e. their impact on wages is stronger than on productivity, so that profits are hampered). In contrast, if the presence of firm-level agreements is found *ceteris paribus* to depress wage costs, then firm-level agreements foster profitability. Finally, if wage costs are not found to depend significantly on firm-level agreements, then firms' profitability is not affected by firm-level agreements (i.e. the latter's impact is alike on productivity and wage costs).

Economic theory suggests that trade unions' ability to bargain higher wages depends on the size of the rents that are to be shared between workers and firms (Boeri and van Ours, 2014; Bryson, 2007). We also contribute to the existing literature by testing the accuracy of this prediction. To do so, we investigate whether the consequences of firm-level collective agreements on wages and productivity-wage gaps depend on the degree of competition that firms face in their market. More rent-sharing is anticipated among firms operating in less competitive environments, where the size of the rents to be shared is typically larger and where unions are strong enough to negotiate and sign an agreement.

The remainder of this paper is organised as follows. The next section provides a brief review of the literature regarding the impact of collective bargaining on wages and productivity. Section 3 summarises the main features of collective bargaining in the Belgian private sector. The dataset and descriptive statistics are presented in Section 4. Our methodology and empirical results are shown in Sections 5 and 6. The last section concludes.

Background

In all English-speaking countries, most wage bargaining occurs at the firm or establishment level, and only in the presence of a union. In these systems, union membership is a reasonable proxy of bargaining coverage. Therefore, most of the literature based on the United States or the United Kingdom traditionally refers to the consequences of union membership (Bryson, 2007) but their results cannot be generalised to the majority of European countries, where sector-level bargaining still plays a significant role.

In Western Continental Europe, the vast majority of workers are covered by collective agreements, whether they are union members or not (OECD, 2017). Due to the existence of *erga omnes* clauses and extension mechanisms[2], the coverage rate in those countries is indeed generally much higher than the trade union density. The extreme case is that of France, where membership in trade unions is around 8%, while practically all employees are covered by a collective agreement. A similar pattern can be found in all countries with sector-level bargaining. In Belgium, for instance, 54% of employees are member of a union, but 96% of them are covered by a collective agreement.

Therefore, in continental European countries, the interest is rather in the type of bargaining system and the level at which bargaining takes place, a debate which is at least three decades old.

In the 1980s, the corporatist (Cameron, 1984) view suggested that centralised bargaining at the national level delivers the best macroeconomic and labour market outcomes, allowing negotiators to internalise the macroeconomic effects of their decisions. However, opponents retorted that this model clashed with the good performance seen in countries without centralised bargaining, such as the United States or the United Kingdom after Thatcher. To reconcile these opposing views, Calmfors and Driffill (1988) suggested that, in fact, both centralised and decentralised systems perform well, while intermediate systems, i.e. sector-level bargaining, lead to poorer outcomes as they are "*strong enough to cause major disruptions, but not sufficiently encompassing to bear any significant fraction of the costs for society of their actions in their own interests*" (Calmfors and Driffill, 1988). This hypothesis was at the root of the critical stance on sector-level bargaining of the OECD Jobs Strategy (OECD, 1994). It was also the intellectual basis behind the reforms which either shifted the dominant bargaining level from sector to firm (like those passed in Australia, New Zealand or the United Kingdom), or increased the scope of firm-level bargaining (as in practically all European countries). Later empirical studies did not provide much backing for the Calmfors and Driffill (1988) hypothesis, and led to a reconsideration of the OECD stance on sector-level bargaining in the 2006 and, even more, in the 2018 Job Strategy, particularly in light of the role that collective bargaining plays in reducing inequalities. However, the debate on the role of different bargaining systems on productivity and profitability remains very much an open question.

Collective bargaining and wages

The available empirical evidence tends to show that workers covered by a firm-level agreement generally earn higher wages than those solely covered by sectorial agreements. On the one hand, this is not surprising as firm-level bargaining can often only raise wages relative to sector-level agreements. However, the wage premium related to firm-level bargaining is also explained by other factors (Dahl et al., 2013), in particular: i) decentralised bargaining enables better rewarding of individual performance (Lucifora and Origo, 2015); ii) it can foster rent-sharing (Gürtzgen, 2010; Rusinek and Rycx, 2013); and iii) it can lead to higher wages due to efficiency wage considerations (Cahuc, Carcillo and Zylberberg, 2014) or iv) because trade unions and employers are less likely to fully internalize the macroeconomic consequences of their agreements (Calmfors, 1993).

[2] *Erga omnes* clauses extend an agreement to all workers in a signatory company. Administrative extensions extend the terms of a collective agreement at sector level also to workers in firms which have not signed the agreement or are not affiliated to an employer organisation which signed the agreement.

Dell'Aringa and Lucifora (1994) are among the first to show a wage premium of firm-level bargaining in the Western European context. Their results, based on Italian data, show that firm-level bargaining leads to a significant wage gain for both white- and blue-collar workers. Since then, the existence of a positive wage premium associated with firm-level collective agreements has been confirmed for other countries (OECD, 2018), including Belgium (Rycx, 2003), Denmark (Plasman et al., 2007), France (Leclair et Petit, 2004), Greece (Daouli et al., 2013), Ireland (McGuinness et al., 2010), Portugal (Cardoso and Portugal, 2005), Spain (Card and de la Rica, 2006; Dell'Aringa and Pagani, 2007) and Sweden (Granqvist and Regner, 2008). The wage premium associated with firm-level collective agreements (with respect to higher-level agreements) is generally estimated at between 3 and 7%. However, some studies find a more limited effect: it is around 0.5% in the Netherlands (Hartog et al., 2002) and close to zero in Germany (Antonczyck, 2011).

Whereas the aforementioned papers are mainly based on cross-sectional data, more recent studies rely on longitudinal datasets. Gürtzgen (2016), for instance, shows with German linked panel data that transitioning from no coverage to firm-level bargaining leads to a wage premium, while transitioning from sector- to firm-level bargaining yields a wage penalty. The former outcome could result from the fact that the introduction of a firm-level agreement, where there was no coverage, has been associated with the presence of strong unions. In contrast, the decentralisation of wage bargaining has been mainly initiated by employers, therefore unions were often no longer in a position to secure a wage premium, especially given that sector- and firm-level bargaining are mutually exclusive in Germany. In Sweden, bargaining occurs at the firm level (decentralised system), at the sector level (centralised system) or at both levels (two-tier system). Relying on longitudinal data for this country and using a fixed effects model, Andreasson (2014) finds a wage gain of 6% for firm bargaining and of 1.7% for a two-tier system compared with a centralised one. Using similar longitudinal data for Denmark, Dahl et al. (2013) also focus on the wage effects of bargaining changes and, more precisely, of bargaining decentralisation. Their results reveal a wage premium of 4.7% for firm bargaining relative to sector bargaining (and no significant effect associated with two-tier bargaining) using a job-spell-fixed effects model.

Collective bargaining and productivity

Several studies have analysed the effect of unions on productivity and productivity-wage gaps (i.e. profitability) in English-speaking countries. The meta-analyses by Doucouliagos and Laroche (2003), Doucouliagos et al. (2017) and Doucouliagos et al. (2018) suggest that union effects on productivity are quite small on average[3] but show significant variation across countries, periods, industries and product market structures. However, very few studies have focused on Western Europe and on the role that bargaining systems, over and above labour unions, play in these countries. From a theoretical perspective, firm-level bargaining may enable firms to better reward individual skills and to adopt more appropriate incentive practices than sector-level bargaining, notably for performing a mix of tasks (Lindbeck and Sower, 2001). According to efficiency wage arguments, this could in turn improve workers' motivation and productivity. However, firm-level bargaining can also increase firms' transaction costs. Moreover, by raising wage demands after contract negotiation, it can seize returns on capital, slow investments in physical capital and R&D, and hence impede firms' performance (Acemoglu and Pischke, 1999; Cardullo, Conti and Sulis, 2015; Haucap and Wey, 2004). In contrast, by compressing the wage structure, a

[3] In contrast, meta-studies show a clear negative relationship between unions and investments.

more centralised bargaining system can force unproductive companies to exit the market faster (Braun, 2011). All in all, the effect of the level of bargaining on productivity remains an empirical question.

However, the empirical evidence for Western Continental Europe remains very scarce, and existing studies essentially focus on the consequences of union membership (instead of bargaining levels) on productivity. A recent study by Barth et al. (2017), for instance, investigates this relationship using longitudinal firm-level data for Norway. Accounting for the endogeneity of unionisation, they find that increases in union density have a sizeable positive effect on both productivity and wages. When adding productivity as an additional covariate in their wage regression, they also show that the impact of union density on earnings decreases by a third. This outcome is consistent with a rent-sharing explanation, i.e. that the wage-profit elasticity gets larger as union density increases. The study by Hibbs and Locking (2000) is the only one so far to investigate in depth the effect of collective bargaining decentralisation on productivity. Their estimates for Sweden show that the possibility of renegotiating sector-level agreements at the company level hampers aggregate productivity growth by slowing down the exit of inefficient firms. By contrast, Andreasson (2014) provides some preliminary descriptive results suggesting that firm-level agreements are associated with higher productivity in Sweden. Similarly, OECD (2018), using data for Austria, Denmark, Finland, France, Germany, the Netherlands and Spain, finds that centralisation is linked with lower productivity growth, both for total factor and labour productivity.

Our paper is one of the first to propose a comprehensive analysis of the effect of firm-level agreements on both wages and productivity in a two-tier bargaining context, similar to the one that can be found in several continental European countries. To do so we rely on detailed matched employer-employee panel data for Belgium, covering more than a decade, to investigate the consequences of firm-level collective agreements (in addition to industry and national agreements) on wage costs and productivity-wage gaps. Put differently, we investigate whether firm-level agreements have a similar effect on wages and productivity. Last but not least, we investigate the role of an important moderating factor, namely the degree of product market competition.

Wage bargaining in the Belgian private sector

Wage bargaining in Belgium occurs at three levels: the national (interprofessional) level, the sectoral level and the company level. Negotiations generally occur every two years on a pyramidal basis. In principle, they are inaugurated by a national collective agreement defining minimum wages and a margin for wage increases that may be bargained at lower levels.[4] Next, this national agreement is improved within every sector of activity. Sector-

[4] Every year the Central Economic Council produces a technical report on the maximum available nominal wage cost increase margin that is compatible with the objectives of the July 1996 legislation on the promotion of employment and the competitiveness of the Belgian economy. This margin depends essentially on forecast pay trends in the three reference countries (France, Germany and the Netherlands). It is used by the social partners every two years when bargaining the interprofessional (i.e. national) collective agreement and fixing the 'wage norm', i.e. the theoretical maximum margin for wage cost growth. The objective of the wage norm is to make sure that all parties to the negotiations take on board the need for wage restraint in an open economy with a high unemployment rate. The wage norm has thus been implemented to guarantee a sufficiently high degree of coordination among the social partners and to avoid excessive wage increases.

level agreements are concluded within Joint Committees that bring together employer and union representatives. They set sector-wide standards for all workers covered by the Joint Committee. Finally, firm-level agreements can further renegotiate wages and working-time when a union delegation is present.[5] However, firm-level bargaining cannot give rise to a collective agreement which would run counter to the sectoral agreement. In other words, the wage bargained at the firm level can only be greater or equal to the wage set at the sectoral level (i.e. the so-called "favourability principle").

Belgium is characterised by a coverage rate of 96% (OECD, 2017).[6] Almost all non-unionised workers and the employers who are not members of an employers' organisation are also covered by a collective labour agreement. Article 19 of the law dated 5 December 1968 specifies that a collective agreement is automatically binding upon the signatory organisations, employers who are members of those organisations or who have personally concluded the agreement, employers joining those organisations after the date of the conclusion of the agreement, and finally, all workers, whether unionised or not, who are employed by an employer so bound. Moreover, almost all sectoral collective agreements are rendered obligatory by royal decree. This means that they apply compulsorily to all companies in the sector and to their workers, whether or not they are members of the signatory organisations (employers' organisations or unions). This extension mechanism, which also exists in several other European countries (OECD, 2017), aims to reduce differences in working conditions among workers within sectors, and more generally to foster social cohesion. However, they may also have an adverse effect on employment and firms' performance.

Firm-level agreements complement sector-level agreements, and define wages and working time, as well as work organisation and other aspects of working life. However, agreements at firm level can only improve the terms of employment for workers (applying the so-called "favourability principle"). In case of diverging standards in different agreements covering the same workers, the most favourable conditions to employees apply.

Data and descriptive statistics

Our empirical analysis is based on a combination of two large data sets covering the period 1999-2010. The first, carried out by Statistics Belgium, is the 'Structure of Earnings Survey' (SES). SES is a representative sample of all firms operating in Belgium which employ at least 10 workers and with economic activities within sections C to K of the NACE Rev.1 nomenclature. The survey contains a wealth of information provided by the management of firms, both on the characteristics of the latter (e.g. level of collective wage bargaining, sector of activity, number of employees, region where the firm is located) and their workers (e.g. age, education, sex, tenure, gross earnings, working hours, occupations). The SES provides no financial information. It has therefore been merged by Statistics Belgium with a firm-level survey, the 'Structure of Business Survey' (SBS). The SBS, also conducted by Statistics Belgium, provides information on financial variables such as investments, value added and gross output for all Belgian companies. The coverage of the

[5] A union delegation is compulsory in companies with more than 50 employees if unions request to create it.

[6] Only self-employed workers may not be covered by a collective agreement. These workers are not included in our sample.

SBS differs from that of the SES in that it does not cover the whole financial sector (NACE J) but only Other Financial Intermediation (NACE 652) and Activities Auxiliary to Financial Intermediation (NACE 67).

The computation of our explanatory variables (especially, those reflecting the composition of the labour force) requires a sufficient number of individual observations per firm. We therefore eliminate (a very small number of) firms with less than 10 observations in a given year. We also exclude workers and/or firms for which data are missing or inaccurate.[7] Next, the estimation of capital stock through the 'perpetual inventory method' (OECD, 2009) requires information on investments for a minimum of two successive periods. This restricts our sample to firms that have been observed in at least two consecutive years. It leads to the over-representation of medium-sized and larger firms, since sampling percentages of firms in our sample increase with the size of the latter. Finally, we restricted our sample to single-establishment firms (SEF). The rationale for doing this is that information on dependent variables (taken from the SBS) is at the level of the firm, while explanatory variables (taken from the SES) are measured at the establishment level. Put differently, the dependent variable takes the same value for all establishments belonging to the same multi-establishment firm. To avoid this aggregation bias, we focus on SEF only.[8] Our final sample consists of an unbalanced panel of 7,419 firm-year observations from 2,439 firms. It is representative of all medium-sized and large firms employing at least 10 employees in the Belgian private sector, with the exception of large parts of the financial sector (NACE J) and the electricity, gas and water supply industry (NACE E), so about two-thirds of total private employment in Belgium.

[7] For instance, we eliminate a (very small) number of firms for which the recorded value added was negative.

[8] This restriction reduces the number of establishments by approximately 24% (from 3,225 to 2,439 establishments). However, this is unlikely to generate significant selection bias. Descriptive statistics for SEF are indeed very similar to those obtained for our initial sample (including both single- and multi-establishment firms). The average values for hourly productivity and wage costs are for instance almost the same in both samples. SEF are however found to be somewhat smaller and more concentrated in the manufacturing and construction industries. As a result, the share of blue-collar workers is also found to be slightly bigger in SEF.

Table 1. Descriptive statistics at the firm level, overall and by level of collective bargaining

	All		Firm-level agreement		No firm-level agreement[a]	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Value-added per hour (ln)[b]	3.79	0.54	3.90	0.50	3.72	0.57
Wage cost per hour (ln)[b]	3.39	0.35	3.48	0.31	3.32	0.37
Gross profit per hour (ln)[c]	2.34	1.19	2.48	1.15	2.23	1.21
Share of workers with primary or lower secondary education	0.33	0.31	0.31	0.28	0.34	0.33
Share of workers with higher secondary education	0.42	0.29	0.43	0.26	0.42	0.30
Share of workers with tertiary education	0.25	0.26	0.27	0.40	0.24	0.27
Share of workers with 10 years of tenure or more	0.38	0.23	0.44	0.23	0.33	0.22
Share of workers < 30 years	0.21	0.14	0.20	0.12	0.22	0.15
Share of workers > 49 years	0.17	0.12	0.17	0.12	0.17	0.13
Share of women	0.24	0.22	0.23	0.20	0.25	0.23
Share of part-time workers (less than 30 hours per week)	0.10	0.13	0.10	0.12	0.11	0.15
Share of blue-collar workers	0.58	0.33	0.59	0.31	0.58	0.34
Share of workers with fixed-term contacts	0.03	0.08	0.03	0.08	0.03	0.08
Share of apprentices	0.00	0.01	0.00	0.00	0.00	0.01
Share of temporary agency workers	0.00	0.04	0.00	0.05	0.00	0.03
Industry						
Mining and quarrying (C)	0.01	0.08	0.01	0.10	0.00	0.06
Manufacturing (D)	0.58	0.49	0.70	0.46	0.48	0.50
Electricity, gas and water supply (E)	0.00	0.03	0.00	0.02	0.00	0.03
Construction (F)	0.12	0.32	0.04	0.21	0.17	0.38
Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)	0.11	0.31	0.08	0.28	0.13	0.34
Hotels and restaurant (H)	0.01	0.11	0.01	0.08	0.02	0.14
Transport, storage and communication (I)	0.06	0.23	0.06	0.24	0.06	0.23
Financial intermediation (J)	0.02	0.12	0.02	0.14	0.01	0.11
Real estate, renting and business activities (K)	0.10	0.30	0.07	0.26	0.12	0.33
Employment (ln)	4.81	1.07	5.35	0.93	4.38	0.97
Capital stock per worker (ln)	10.78	1.53	10.96	1.50	10.54	1.54
Herfindahl-Hirschman index[d]	0.04	0.07	0.06	0.07	0.04	0.06
Number of firm-year observations	7,419		3,267		4,152	
Number of firms	2,439		700		1,739	

a) "No firm-level agreement" identifies firms that are solely covered by national and sectoral-level collective agreements.
b) All variables measured in monetary terms have been deflated to constant prices of 2004 by the consumer price index taken from Statistics Belgium.
c) Measured as follows: ln(value added per hour – wage cost per hour).
d) Based on NACE 3 digit Herfindahl-Hirschman indices (HHI) provided by Statistics Belgium for each year from 1999 to 2010 (Statistics Belgium, 2016). Descriptive statistics based on 7,370 firm-year observations and 2,424 firms.
Source: Authors' calculations.

As shown in Table 1, around 28 percent of firms in our final sample (i.e. 700 out of 2,439) are covered by a firm-level collective agreement.[9] We note a clear-cut difference between the characteristics of firms covered by a company collective agreement and those not so covered. The point is that firms within which wages are collectively renegotiated are more

[9] This is in line with previous evidence on this issue (see e.g. du Caju et al., 2012).

capital intensive, productive and profitable (though wage costs are also higher here), larger[10] and more concentrated in manufacturing. They also employ workers that are somewhat more educated, with more years of seniority. Conversely, the shares of women and part-timers are slightly lower among those firms. As regards firms solely covered by national and sectoral collective agreements, they are more often found in construction, wholesale and retail trade, and real estate, renting and business activities. Finally, descriptive statistics show that the degree of product market competition is somewhat stronger among firms that are not covered by a firm-level collective agreement. Indeed, the mean Herfindahl-Hirschman index is found to be lower among those firms (0.04 vs 0.06).[11]

Methodology

Our empirical approach is based on the wage-setting equation proposed by Bartolucci (2014). It is similar to the wage equation in Hellerstein et al. (1999) but directly estimates a parameter for the logarithm of average firm-level productivity. Accordingly, the three following equations have been estimated:

$$\log\left(\frac{Wage\ Cost}{Hours}\right)_{j,t} = \alpha_j + \beta\, Firm\ Agreement_{j,t} + \sum_{t=1}^{T-1} \rho_t YEAR_t + \varepsilon_{j,t} \tag{1}$$

$$\log\left(\frac{Wage\ Cost}{Hours}\right)_{j,t} = \alpha_j^* + \beta^*\, Firm\ Agreement_{j,t} + \sum_{t=1}^{T-1} \rho_t^* YEAR_t + \lambda^* X_{j,t} + \varepsilon_{j,t}^* \tag{2}$$

$$\log\left(\frac{Wage\ Cost}{Hours}\right)_{j,t} = \alpha_j^{**} + \beta^{**}\, Firm\ Agreement_{j,t} + \sum_{t=1}^{T-1} \rho_t^{**} YEAR_t + \lambda^{**} X_{j,t} + \delta^{**} \log\left(\frac{Value\ Added}{Hours}\right)_{j,t} + \varepsilon_{j,t}^{**} \tag{3}$$

The dependent variable in equations (1) to (3) is the average real wage bill (including payroll taxes and variable pay components, such as wage premia for overtime, weekend or night work, performance bonuses and other premia) in firm j at time t. It is obtained by dividing the firm's total wage cost by the total number of hours worked. The main explanatory variable ($Firm\ Agreement_{j,t}$) in all three equations is a dummy, taking the value 1 if the firm is covered by a firm-level collective agreement, and 0 otherwise (i.e. if the firm is solely covered by a national and sectoral collective agreement).

Equation (1) only controls for year dummies. The parameter β thus captures the raw wage differential between firms solely covered by a national and sector-level collective agreement and those in which working conditions are collectively renegotiated in-house, after controlling for annual changes in the business cycle. Equation (2) also includes $X_{j,t}$,

[10] The presence of union delegations (negotiating firm-level agreements) in firms with more than 50 employees partly explains the structure of our sample.

[11] To compute these estimates, we relied on NACE 3 digit Herfindahl-Hirschman indices provided by Statistics Belgium for each year from 1999 to 2010 (Statistics Belgium, 2016).

i.e. a vector containing a set of variables controlling for observable worker, job and firm characteristics. More precisely, it comprises the share of the workforce in firm *j* at time *t* that: (i) has at most a degree from lower secondary education and tertiary education, respectively; (ii) is younger than 30 and older than 49 years, respectively; (iii) has at least 10 years of tenure; (iv) is female; (v) works part-time; (vi) occupies blue-collar jobs; (vii) has a fixed-term contract; and (viii) is an apprentice or under contract with a temporary employment agency. $X_{j,t}$ also includes 8 industry dummies, the logarithm of firm size, 2 dummies for the region in which the firm is located, and the logarithm of the capital stock per worker in firm *j* at time *t*. Hence, the parameter β^* measures the average wage effect of being covered by a firm-level collective agreement after controlling for a large set of covariates. Equation (2) corresponds to the traditional wage-setting regression run in the literature to estimate the impact of a firm-level collective agreement on workers' wages. However, it is aggregated at the level of the firm. Indeed, most previous studies use the individual worker as a statistical unit. The time-varying firm information enables us to control for firm time-invariant unobserved characteristics, and to test for potential endogeneity (see below). It also makes it possible to follow Bartolucci's (2014) approach, i.e. to include firm-level average labour productivity as an additional control variable. This is done in equation (3). The parameter β^{**} in this equation measures the impact *ceteris paribus* of a firm-level collective agreement on the gap between wage costs and labour productivity. The interpretation of β^{**} is as follows: if the estimate of β^{**} is found to be significantly positive (negative), it implies that firm-level agreements are harmful (beneficial) for gross operating profits, i.e. they are more (less) beneficial for workers' wages than for firms' value added. However, if the estimate of β^{**} is found to be insignificant, it implies that firm-level agreements leave firms' profitability unaffected, i.e. their impact is alike on wage costs and productivity. Despite the difficulties highlighted by Bartolucci (2014) in estimating a production function accurately, we complement our analysis by directly estimating the impact of firm-level collective agreements on firms' productivity. To do so, we rely on equation (2), using the hourly productivity of a firm (instead of the hourly wage cost) as a dependent variable.

Results

Benchmark estimates

We first estimated equation (1) with pooled OLS. The results, presented in column (1) of Table 2, show the impact of being covered by a firm-level agreement on firms' average hourly wage bill, while controlling solely for year dummies. The regression coefficient associated with the firm-level agreement dummy is highly significant, and equal to 0.141. It means that the hourly wage cost is on average 14% higher among firms in which wages are collectively renegotiated in-house, after controlling for annual business cycle effects. If we include additional covariates for worker, job and firm characteristics (as specified in equation (2), this wage cost differential drops to around 5%, but remains significant at the 1% probability level (see column (2)). Interestingly, the magnitude of this premium is coherent with previous estimates obtained for Belgium using cross-sectional data at the worker level. It is also in the range of estimates reported for other Western European countries with multi-tier bargaining regimes, such as France, Italy and Spain.

Endogeneity

Firms in the Belgian private sector cannot choose by which sector-level agreement they will be covered. Indeed, it is the Ministry of Employment, Labour and Social Dialogue that

decides to which Joint Committee (JC) a firm belongs. The decision of the Ministry is based on the principal economic activity of the firm. Within JCs, firms can choose whether or not they want to renegotiate wages collectively 'in-house'. This choice could lead to an endogeneity problem, especially if the latter is not independent of firms' average labour productivity and wage cost. However, as highlighted by Rusinek and Rycx (2013), the probability that a firm opts for an 'in-house' agreement is contingent on the JC to which it belongs, as, since several decades, some sectors have a more established tradition of firm-level bargaining than others . An additional feature likely to mitigate endogeneity is that the level of wage bargaining is highly persistent over time. Firms covered by an 'in-house' collective agreement are indeed very unlikely to change bargaining status, i.e. to become solely covered by a sector-level agreement (and vice-versa). Accordingly, within-firm changes in wages/productivity are expected to have little impact on a company's likelihood to renegotiate wages collectively 'in house'.

To examine whether our results are affected by a potential endogeneity issue, we re-estimated equation (2) using two-stage least-squares (2SLS). We use as an instrument for firm agreement the incidence of firm-level collective agreements by industry and firm size cells at each period. More precisely, for each firm *i*, we computed the percentage of firms (excluding firm *i*) belonging to the same industry-size cell covered by a firm-level collective agreement.[12] The rationale for using this IV is that the mean hourly wage cost within a firm is unlikely to be correlated with whether or not many firms in the same industry and size class are covered by a firm agreement. Moreover, we expect the likelihood of a firm to be covered by a firm-level collective agreement to be higher when a larger share of firms belonging to the same industry/size cell renegotiates wages collectively in-house. First-stage estimates (reported in Table A1 in Appendix) suggest that a 10 percentage point increase in the industry-size coverage raises a firm's probability of being covered by a firm-level agreement by 5 percent on average. These estimates suggest that our IV is not weak, which is also corroborated by the Cragg-Donald Wald F statistic for weak identification. The latter is indeed much bigger than 10.[13] Moreover, we can reject the null hypothesis that our first-stage equation is under-identified. The Kleibergen-Paap rk LM statistic is indeed found to be highly significant. As regards the endogeneity test[14], the p-value associated with the Chi-squared statistic is equal to 0.60. This outcome suggests that the null hypothesis of no endogeneity should not be rejected.[15] Estimates thus indicate that our main explanatory variable, i.e. firm agreement, is not endogenous, and that OLS estimates (reported in Table 2) should be preferred over those obtained by 2SLS.

[12] We considered five sectors (i.e. NACE categories C&D, F, G&H, I&J, and K) and four size classes (i.e. 10 - 58, 59 - 129, 130 - 253, and 254 workers or more).

[13] We rely on the standard 'rule of thumb' that weak identification is problematic for F statistics smaller than 10 (as suggested by van Ours and Stoeldraijer, 2011).

[14] The test is based on the difference of two Sargan-Hansen statistics: one for the equation in which the firm-level collective agreement variable is treated as endogenous, and one in which it is treated as exogenous. If the null hypothesis of this test cannot be rejected, then instrumentation is actually not necessary.

[15] Finding an appropriate instrumental variable for firm agreements remains a difficult task. Given potential remaining concerns on the endogeneity of the instrument and the power of diagnostics tests, our results should be interpreted with caution.

Firm fixed unobserved heterogeneity

Another potential issue that has not been tested so far is the presence of firm fixed effects. Indeed, pooled OLS estimates might suffer from a potential heterogeneity bias because wages can be related to firm-specific, time-invariant characteristics (such as the quality of management, the culture of the firm, the ownership of a patent or other firm idiosyncrasies) that are not measured in micro-level surveys. To examine whether we should address this issue, we applied a Breusch-Pagan LM test. The latter clearly supports the existence of firm fixed effects.

The traditional way to control for this is by estimating a fixed effects (FE) model. This boils down to estimate a within differentiated model, i.e. a model where the mean of each variable has been subtracted from the initial values. Given that our variable of interest, i.e. firm agreement, is (almost) time-invariant, this approach cannot be applied. Hence, we re-estimated equation (2) with the system generalised method of moments (SYS-GMM), proposed by Arellano and Bover (1995) and Blundell and Bond (1998). This estimator is widely used in the literature to obtain consistent estimates of time-invariant regressors while controlling for firm fixed effects (Roodman, 2009). It implies to simultaneously estimating a system of two equations (one in level and one in first differences) and to use 'internal instruments' to control for endogenous regressors. All explanatory variables, except the level of collective wage bargaining, the region where the firm is located, the sectoral affiliation and time, have been considered as endogenous in our SYS-GMM regressions. Put differently, variables showing very little or no variability over time have not been instrumented, so as to avoid inconsistent estimates due to weak instrumenting. SYS-GMM estimates thus control for firm fixed effects as well as for the endogeneity of time-varying explanatory variables (in addition to a large set of covariates).

SYS-GMM estimates associated with equation (2) are reported in column (4) of Table 2. To examine their reliability, we applied the Hansen's (1982) and Arellano-Bond's (1991) tests. The first is a test of over-identification which allows to test the validity of the instruments. The second is a test for autocorrelation, where the null hypothesis assumes no second order autocorrelation in the first differenced errors. On the basis of these tests, we do not reject respectively the null hypotheses of valid instruments and of no second order auto-correlation in first differenced errors. SYS-GMM estimates thus appear to be reliable. The regression coefficient obtained by SYS-GMM for our main explanatory variable (see column (4)) is slightly smaller than that estimated by OLS (see column (2)), which means that part of previous estimated wage cost gaps were due to firm-level fixed unobserved heterogeneity. Yet, the wage premium in companies covered by a firm-level collective agreement still stands at 4.6%.

The impact on productivity-wage gaps

To examine whether firm-level collective agreements have a stronger impact on wages than on productivity, we first followed the methodology developed by Hellerstein et al. (1999). Thus, we estimated equation (2) by SYS-GMM using as dependent variable firm-level average hourly labour productivity (instead of the firm-level average hourly wage cost). Results are reported in Table A2 in Appendix. They show that firm-level agreements foster productivity. More precisely, the productivity premium in companies covered by a firm-level collective agreement is estimated at 2.1%. This productivity premium appears to be smaller than the corresponding wage cost differential (estimated at 4.6%) reported in column (4) of Table 2. Hence, estimates suggest that firm-level agreements are detrimental to gross operating profits. However, to test the robustness of this conclusion, we adopted

the more reliable approach suggested by Bartolucci (2014). To do so, we estimated equation (3) using SYS-GMM. Put differently, we added firm-level labour productivity among regressors of the wage-setting equation (2). Results are reported in the last column of Table 2. Estimates show that productivity is strongly and positively related to wage costs. They also indicate that a wage premium of 3.7% is still recorded in companies covered by a firm-level collective agreement, after controlling for productivity. This result suggests that firm-level agreements generate some rent-sharing, i.e. they lead to higher wages at a given level of productivity. [16] More precisely, given that the coefficient associated with firm-level agreements is larger in column (4) than in column (5) of Table 2, estimates support the conclusion that firm-level agreements are more beneficial for workers' wages than for firms' productivity[17]. In sum, SYS-GMM estimates suggest that, on average, firm-level agreements are *ceteris paribus* detrimental to profitability.[18]

Table 2. The impact of firm-level collective agreements on labour costs

Dependent variable: log average hourly wage cost[a]	OLS	OLS	OLS	SYS-GMM	SYS-GMM
Log labour productivity[a]			0.397***		0.280***
			(0.031)		(0.050)
Firm-level collective agreement[b]	0.141***	0.051***	0.025***	0.046***	0.037***
	(0.008)	(0.007)	(0.005)	(0.011)	(0.009)
Year dummies	Yes	Yes	Yes	Yes	Yes
Individual and job characteristics[c]	No	Yes	Yes	Yes	Yes
Firm characteristics[d]	No	Yes	Yes	Yes	Yes
Arellano-Bond test for AR(2), p-value[e]				0.67	0.51
Hansen over-identification test, p-value				0.48	0.54
R-squared (adjusted)	0.04	0.45	0.68		
Number of firm-year observations	7,419	7,419	7,419	7,419	7,419

Note: ***: statistically significant at the 1% level. Robust standard errors in parentheses. GMM-SYS specifications include first and second lags of explanatory variables (except time dummies) as instruments.
a) Variable at firm-level expressed in natural logarithm.
b) Dummy equal to one if the firm is covered by a firm-level collective agreement.

[16] Note that we also estimated equation (3) by OLS. Results, reported in column (3) of Table 2, support the conclusion that firm agreements have a stronger positive effect on wage costs than on productivity.

[17] We ran additional regressions to check that our results are not dependent on the inclusion of capital per worker in the regression. This estimation (Table A3 in Appendix) confirms our results.

[18] A simple comparison of the two coefficients (firm agreement on wages and firm agreement on productivity) may be insufficient to conclude that firm agreements hamper profitability. However, if we apply the coefficients to the mean values of wages and productivity in our sample, they also show that the increase in wage cost is on average larger than the increase in productivity. Moreover, as a robustness test, we ran a regression using the log of value added/wage cost as dependent variable. SYS-GMM estimates show that firm agreements have a negative impact on the log of this ratio. This is coherent with our benchmark estimates. However, caution is required as they do not pass all diagnosis tests. Accordingly, we prefer to rely on the approach suggested by Bartolucci (2014) which has also been shown to be somewhat more flexible and robust than that of Hellerstein and Neumark (1995) notably because it does not impose that the elasticity of wages with respect to productivity is equal to 1. Moreover, it avoids the estimation of a production function and hence the choice of an appropriate functional form for the latter.

c) Individual and job characteristics include the: % workers with at most a degree from lower secondary education and tertiary education, respectively; % workers with 10 years of tenure or more; % workers younger than 30 and older than 49 years, respectively; % women; % part-time workers; % blue-collar workers; % workers with fixed term employments contracts; % apprentices; and % temporary agency workers.
d) Firm characteristics include: 8 industry dummies; the natural logarithm of firm size; 2 dummies for the region where the firm is located; the natural logarithm of capital stock per worker.
e) AR(2) refers to second-order autocorrelation in first-differenced errors.
Source: Authors' calculations.

The role of product market competition

Bargaining models suggest that trade unions' ability to negotiate higher wages depends on their strength but also on the size of the rents that are to be split between workers and firms. Economic theory thus predicts that the wage premium associated with firm-level collective agreements should be higher when the price-elasticity of demand for products or services in the sector is lower, i.e. in the case of monopolistic or oligopolistic competition. The argument goes that employers in less competitive environments can more easily pass wage increases on to consumers, without fear of being undercut by other producers, or meet additional costs from above-normal profits (Boeri and van Ours, 2014). To investigate the accurateness of this prediction, we relied on NACE 3 digit Herfindahl-Hirschman indices of product market concentration computed by Statistics Belgium. More precisely, for each year, we split firms according to whether or not they were operating in an industry (at the NACE 3 digit level) with a product market competition index below the median sample value of that year, i.e. with a Herfindahl-Hirschman index above the median value. We thus created a dummy variable, set equal to one, for firms operating in less competitive environments. This dummy has been included in our benchmark equations as an additional control variable and in interaction with our main variable of interest ('firm-level agreement').

Table 3. Estimates according to the degree of product market competition

Dependent variable: log average hourly wage cost[a]	OLS	OLS	OLS	SYS-GMM	SYS-GMM
Log average labour productivity[a]			0.390***		0.281***
			(0.031)		(0.050)
Firm-level collective agreement[b] and strong competition[c]	0.106***	0.038***	0.012**	0.032***	0.025***
	(0.010)	(0.008)	(0.006)	(0.011)	(0.009)
Firm-level collective agreement[b] and weak competition[c]	0.164***	0.077***	0.038***	0.065***	0.051***
	(0.015)	(0.013)	(0.009)	(0.016)	(0.012)
Weak competition[c]	0.086***	0.035***	0.009	0.065***	0.041***
	(0.012)	(0.009)	(0.008)	(0.016)	(0.013)
Year dummies	Yes	Yes	Yes	Yes	Yes
Individual and job characteristics[d]	No	Yes	Yes	Yes	Yes
Firm characteristics[e]	No	Yes	Yes	Yes	Yes
Arellano-Bond test for AR(2), p-value				0.784	0.494
Hansen over-identification test, p-value				0.528	0.428
R-squared (adjusted)	0.06	0.44	0.68		
Number of firm-year observations	7,370	7,370	7,370	7,370	7,370

Note: ***, **: statistically significant at the 1 and 5% level, respectively. Robust standard errors in parentheses.
a) Variable at firm-level expressed in natural logarithm.
b) Dummy equals to one if the firm is covered by a firm-level collective agreement.

c) Dummy equals to one if the firm at time t belongs to an industry (at the NACE 3 digit level) with a degree of product market competition index above the median sample value, i.e. with Herfindhal-Hirschman index below (strong competition) or above (weak competition) the median sample value.
d) See note d) of Table 2.
e) See note e) of Table 2.
Source: Authors' calculations.

As expected, SYS-GMM estimates reported in columns (4) and (5) of Table 3 first show that mean hourly wage costs are significantly higher in less competitive environments. The wage differential stands at between 6.5% and 4%, depending on whether or not firm-level productivity is controlled for. Interestingly, results also show that the wage premium associated with firm-level collective agreements is systematically higher when product market competition is weaker.[19] Our results are line with French results showing an increasing wage premium of union recognition in firms with high market share (Breda, 2017). More precisely, GMM-SYS estimates (reported in column (4)) suggest that the wage premium in companies covered by a firm-level collective agreement is *ceteris paribus* twice as big when competition is lower (6.5% instead of 3.2%). After controlling for productivity, these wage premia drop respectively to 5.1% and 2.5% in more and less competitive environments (see column (5))[20]. These findings suggest that firm-level agreements are mainly a tool for rent-sharing in both types of environments (i.e. their impact on wages is stronger than on productivity, so that gross profits are hampered). However, results also support the prediction that firm-level agreements lead to significantly less rent-sharing when product market competition is fiercer, i.e. when the rents to be split between workers and firms are smaller. OLS estimates reported in columns (1) to (3) lead to the same conclusion.

Conclusion

This article contributes to the literature on the wage and productivity effects of different collective bargaining regimes. Our analysis is focused on Belgium, a country where, like in several other European countries, multi-employer bargaining (at the national and/or sector level) can be complemented with single-employer bargaining. Using matched employer-employee panel data covering the years 1999-2010, we distinguish firms solely covered by multi-employer agreements from the ones covered by an additional firm-level agreement. We rely on an approach developed by Bartolucci (2014) that enables us to estimate the wage differential associated to firm-level collective agreements, but also to test whether this wage differential is in line with the corresponding productivity differential. Our paper is one of the first to investigate this research question. We also add to the literature by investigating the role of product market competition, as this is likely to affect the size of the rents that are shared between workers and firms.

A large volume of literature, though essentially based on cross-sectional data, found that firm bargaining yields higher wages. Using the system generalized method of moments (SYS-GMM) estimator, we find a wage premium of between 4 and 5% after controlling for

[19] Differences in regression coefficients associated with firm-level collective agreements in low- and high-competitive environments are statistically significant at the 1% level in the OLS regressions (columns (1) to (3)) and at the 10% level in the GMM-SYS regressions (columns (4) and (5)).

[20] Regressions including the value of the Herfindhal-Hirschmann index confirm this result. Results available on request.

individual, job and firm characteristics. This effect is coherent with the Belgian bargaining system in which only upward flexibility is allowed at the firm level. However, we show that firm bargaining also fosters productivity. While a rather large amount of literature has focused on the impact of union membership on productivity in English-speaking countries, this paper is among the first to investigate the effect of firm-level agreements (beyond the mere presence of a union in the workplace) on productivity at firm level. Using the SYS-GMM estimator, we obtain a productivity premium associated with firm bargaining of around 2%. This result is confirmed using Bartolucci's approach, which adds firm-level productivity as an additional covariate in the wage equation. The wage and productivity estimates also indicate that firm agreements generate some rent-sharing, i.e. they lead to higher wages at a given level of productivity. Firm agreements are thus found to be more beneficial for workers' wages than for firms' productivity, so that on average profitability is hampered. Yet, our findings show that firm-level agreements lead to significantly more rent-sharing when competition in the firms' product market is weaker. Put differently, firm agreements are mainly found to raise wages beyond productivity when the rents to be shared between workers and firms are higher. This finding, in line with theoretical predictions, has so far never been shown in the European context.

Overall, what are the implications of our estimates for firm performance? On the one hand, findings show that on average firm agreements are detrimental to profitability. Referring to the 'two faces of unionism' (Freeman and Medoff, 1984), one might conclude that the 'rent-seeking behaviour of unions' dominates their 'voice effect'. However, our findings also show that firm bargaining is mainly a tool for rent-sharing when competition is low. This suggests that firm agreements are probably not detrimental for firm performance in the Belgian context. In the presence of weaker competition, firms can indeed meet additional costs from above-normal profits. And when competition is fiercer, results show that the wage premium associated with firm bargaining primarily originates from higher productivity, so that – as highlighted by Bryson (2014) – both workers and firms can actually benefit.

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Appendix

Table A 1. First and second-stage estimates of 2SLS regression

First-stage regression Dependent variable: being covered by a firm-level collective agreement[a]	
Instrumental variable: Coverage rate by industry-size cell[b]	0.499*** (0.067)
Other covariates[c]	Yes
Sanderson-Windmeijer F-test of excluded instruments	54.91***
Number of firm-year observations	7,419
Second-stage regression Dependent variable: log average hourly wage cost[d]	
Firm-level collective agreement[e]	0.102 (0.090)
Year dummies	Yes
Individual and job characteristics[f]	Yes
Firm characteristics[g]	Yes
Under-identification (p-value of Kleibergen-Paap rk LM statistic)[h]	0.00
Weak identification (Cragg-Donald Wald F statistic)[i]	54.91
Endogeneity (p-value associated to Chi-squared statistic)[j]	0.60
R-squared (adjusted)	0.43
Number of firm-year observations	7,419

Note: ***: statistically significant at the 1% level. Robust standard errors in parentheses.
a) The dependent variable is a dummy equal to one of the firm is covered by a firm-level agreement and zero otherwise.
b) Incidence of firm-level collective agreements by industry and firm size cells at each period. More precisely, for each firm i, we computed the percentage firms (excluding firm i) belonging to the same industry-size cell at each period covered by a firm-level collective agreement. We considered five sectors (i.e. NACE categories C&D, F, G&H, I&J, and K) and four size classes (i.e. [0, 58], [59, 129], [130-253] and 254 workers and more).
c) Other covariates include all explanatory variables of equation (3), except firm agreement.
d) The dependent variable is the natural logarithm of the firm-level average hourly wage cost.
e) Dummy equal to one if the firm is covered by a firm-level collective agreement, and zero otherwise.
f) See note d) of Table 2.
g) See note e) of table 2.
h) The Kleibergen-Paap rk LM statistic for under-identification tests whether the equation is identified, i.e. whether the excluded instruments are all relevant. The null hypothesis in this test is that the equation is under-identified.
i) The Cragg-Donald statistic for weak identification is a Wald F statistic testing whether the excluded instruments are sufficiently correlated with the endogenous regressor. The null hypothesis is that the instruments are weak. According to the standard 'rule of thumb', weak identification is problematic for F statistics smaller than 10 (as suggested by van ours and Stoeldraijer, 2011).
j) The endogeneity test is based on the difference of two Sargan-Hansen statistics: one for the equation in which firm-level collective agreement is treated as endogenous, and one in which it is treated as exogenous. If the null hypothesis of this test cannot be rejected, then instrumentation is actually not necessary, i.e. 'being covered by a firm-level collective agreement' can actually be considered as exogenous.
Source: Authors' calculations.

Table A 2. The impact of firm-level collective agreements on productivity

Dependent variable: log average hourly productivity[a]	SYS-GMM
Firm-level collective agreement[b]	0.021**
	(0.011)
Year dummies	Yes
Individual and job characteristics[c]	Yes
Firm characteristics[d]	Yes
Arellano-Bond test for AR(2), p-value[e]	0.191
Hansen over-identification test, p-value	0.584
Number of firm-year observations	7,419

Note: **: statistically significant at the 5% level. Robust standard errors in parentheses. SYS-GMM specifications include first and second lags of explanatory variables (except time dummies) as instruments.
a) The dependent variable is the natural logarithm of the firm-level average hourly value added at factor costs.
b) Dummy equal to one if the firm is covered by a firm-level collective agreement.
c) See note d) of Table 2.
d) Including variables listed in note e) of Table 2 and the lagged dependent variable.
e) AR(2) refers to second-order autocorrelation in first-differenced errors.
Source: Authors' calculations.

Table A 3. The impact of firm-level collective agreements on labour costs (without capital stock)

Dependent variable: log average hourly wage cost[a]	OLS	OLS	OLS	SYS-GMM	SYS-GMM
Log average labour productivity[b]			0.369***		0.303***
			(0.029)		(0.064)
Firm-level collective agreement[c]	0.141***	0.055***	0.024***	0.046***	0.036***
	(0.008)	(0.007)	(0.005)	(0.011)	(0.009)
Year dummies	Yes	Yes	Yes	Yes	Yes
Individual and job characteristics[d]	No	Yes	Yes	Yes	Yes
Firm characteristics[e]	No	Yes	Yes	Yes	Yes
Arellano-Bond test for AR(2), p-value[f]				0.66	0.69
Hansen over-identification test, p-value				0.57	0.56
R-squared (adjusted)	0.04	0.44	0.67		
Number of firm-year observations	7.419	7.419	7.419	7.419	7.419

Note: ***: statistically significant at the 1% level. Robust standard errors in parentheses. SYS-GMM specifications include first and second lags of explanatory variables (except time dummies) as instruments.
a) The dependent variable is the natural logarithm of the firm-level average hourly wage cost.
b) The natural logarithm of the firm-level average hourly labour productivity.
c) Dummy equal to one if the firm is covered by a firm-level collective agreement.
d) See note d) of Table 2.
e) See note e) of Table 2.
f) AR(2) refers to second-order autocorrelation in first-differenced errors.
Source: Authors' calculations.