Organised Labour, Labour Market Imperfections, and Employer Wage Premia*

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Abstract: This paper investigates the interplay between organised labour, labour market imperfections, and employer wage premia. Based on representative German plant data for the years 1999–2016, we document that employer monopsony involving below competitive wages is far more prevalent than the contrary worker monopoly. We further find a smaller prevalence and intensity of employer monopsony when unions or works councils are present and the opposite for worker monopoly. Finally, the presence and intensity of employer monopsony are associated with a lower level and larger dispersion of employer wage premia, whereas more intense worker monopoly is accompanied by a higher level only.

JEL-Classification: J42, J50, J31, D22.

Keywords: employer monopsony, worker monopoly, collective wage agreements, works councils, employer wage premia.

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1 Introduction

It has not been long since most labour economists abandoned the textbook model of perfect competition and embraced the idea that workers and employers possess some market power in the wage formation process. In the broadest sense, imperfect competition in the labour market can be seen as a situation where substantial employment rents accrue to workers and employers (Manning, 2011). This vision immediately raises the question of how these rents are split among workers and employers or, in other words, what wage emerges under a bilateral monopoly in which both parties possess some market power.

Booth (2014) approaches this question by considering two polar cases of wage formation under imperfect competition: employer wage setting, where employers possess monopsony power, and union wage setting, where workers exercise monopoly power when negotiating wages. Compared to a competitive labour market, labour market imperfections may thus manifest themselves either in below competitive wages because of employer monopsony or in above competitive wages on account of worker monopoly.

Against this backdrop, our contribution is to investigate for Germany the extent of labour market imperfections, how industrial relations shape labour market imperfections, and how labour market imperfections relate to employer wage premia. To that end, we follow the approach by Dobbelaere and Mairesse (2013) that uses production function estimates to measure how imperfect labour markets are. Specifically, we exploit their result that labour market imperfections drive a wedge between the output elasticities of labour and intermediate inputs and their revenue shares that is informative on the power imbalance between employers and workers (i.e. employer monopsony vs. worker monopoly) and the intensity of employers' and workers' labour market power when considering the market for intermediate inputs as competitive benchmark. Importantly, this permits us to control for product market imperfections that manifest themselves in price-cost mark-ups and thus to account for a possible interdependency between labour and product market imperfections that would otherwise contaminate estimates of labour market imperfections (for a discussion in the case of price-cost mark-ups, see De Loecker *et al.*, 2016).

Building on this production-based approach and a representative sample of about

9,000 plants for the years 1999–2016, this paper is the first to document the prevalence and intensity of both employer monopsony and worker monopoly in the labour market for Germany. We find that employer monopsony is much more prevalent than worker monopoly and that substantial labour market imperfections are the norm rather than the exception in Germany. They should thus figure much more prominently in both science and politics, not the least since the (lack of) competition in the labour market promises important insights into recent labour market trends like the falling labour share in income and rising wage inequality.

Our core result is that collective bargaining and works councils matter for both the prevalence and the intensity of labour market imperfections. We find that the existence of any of these labour market institutions is associated with a lower probability of employer monopsony (as opposed to worker monopoly). On top of these findings at the extensive margin, we also show that both forms of organised labour are accompanied with lower employer monopsony and higher worker monopoly power at the intensive margin, that is given an outcome involving below or above competitive wages. These results suggest that organised labour benefits workers in shifting market power from employers to workers where effect sizes are generally larger for works councils, the German counterpart of the workplace union in other countries, than for collective bargaining, which is typically conducted at the sectoral level.

Moreover, we see that employer monopsony is more persistent than worker monopoly and find some evidence that the existence of collective bargaining or works councils is negatively related to the probability of switching from worker monopoly to employer monopsony. These findings lend further credence to the hypothesis that industrial relations shape labour market imperfections, and they also suggest that the erosion of organised labour during our period of observation has contributed to shifting the power imbalance between employers and workers in favour of employers.

Finally, we document that employer wage premia, that is wage differences that are left after differences in workers' human capital and unobservable skills have been rewarded, are closely related to labour market imperfections. To measure employer wage premia, we

follow Card *et al.* (2018) and Hirsch and Mueller (2020) and rely on the employer wage effect from an AKM decomposition of individual workers' log wages (Abowd *et al.*, 1999). Holding constant plant surplus, the mean employer wage premium is lower under employer monopsony, and it is also negatively related to the intensity of employer monopsony and positively to the intensity of worker monopoly. Moreover, the presence and intensity of employer monopsony are accompanied by more dispersed wage premia, so that employer monopsony not only depresses workers' wage outcomes, but also aggravates inequality. Our results thus establish a close link between both types of labour market imperfections and the employer wage component from an AKM decomposition.

In summary, our evidence strongly suggests that organised labour matters for labour market imperfections that, in turn, matter for employer wage premia. The remainder of this paper is organised as follows. Section 2 details on our contribution to the literature and provides hypotheses for the relationship between industrial relations and labour market imperfections in the German context and beyond. Section 3 lays the theoretical foundations of our estimation approach, Section 4 describes its econometric implementation and Section 5 our data. Sections 6 and 7 present and discuss our results for the link between industrial relations and labour market imperfections and between labour market imperfections and employer wage premia, respectively, and Section 8 concludes.

2 Contribution and hypotheses

Whereas wage outcomes above competitive wages and their theoretical foundation in union wage-setting models form the starting point of the broad empirical rent-sharing literature (surveyed by Card *et al.*, 2018, and Dobbelaere and Mairesse, 2018), below competitive wages are at the heart of a recent literature on the prevalence and causes of monopsony in the labour market (for overviews, see Manning, 2011, 2021). Until recently, though, both strands of the literature evolved separately. What is more, in quantifying labour market imperfections they have largely neglected possible links between labour

and product market imperfections that may contaminate findings.[1]

This started to change following a series of papers initiated by Dobbelaere and Mairesse (2013) who were the first to propose an estimation approach encompassing labour market imperfections rooted in either employer monopsony or worker monopoly while also allowing for product market imperfections.[2] In their empirical analysis, Dobbelaere and Mairesse (2013) document substantial labour and product market imperfections for France as do other studies using their approach for Japan and the Netherlands (Dobbelaere *et al.*, 2015), for Chile (Dobbelaere *et al.*, 2016), and for Portugal (Félix and Portugal, 2016).[3]

What is lacking, though, is evidence on how industrial relations, such as collective bargaining through unions and workplace co-determination through works councils, shape labour market imperfections. To be sure, there exists a large body of evidence that industrial relations affect the wages paid by employers including some recent papers identifying wage effects from quasi-experimental variation in industrial relations (e.g. Jäger *et al.*, 2021; 2022). Yet, in analysing reduced-form effects of industrial relations on wages these contributions just consider end-points rather than the structural parameters we consider that, in turn, permit direct measurement of the presence and intensity of labour market imperfections. What is more, evidence resting on quasi-experiments tends to look at specific instances rather than broad-based populations of employers and workers that we are able to consider. For these reasons, we see our contribution as complementary to this quasi-experimental evidence although, admittedly, we cannot rest identification on that kind of exogenous variation in industrial relations.

By examining how industrial relations shape labour market imperfections, this paper not only contributes to the literature on the determinants of employer monopsony and

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1 Of course, this is not to imply that there are no papers acknowledging that the joint existence of labour market and product market imperfections shapes, for instance, the wage and employment effects of migration (e.g. Spitz-Oener and Prantl, 2020) and changes in trade policy (e.g. Goldberg and Pavcnik, 2016).

2 Recently, Tortarolo and Zarate (2020) and Yeh *et al.* (2021) proposed similar approaches that restrict to below competitive wages on the labour market and price-cost mark-ups on the product market. In consequence, both approaches rule out above competitive wages and thus neglect worker monopoly as another source of labour market imperfections.

3 Dobbelaere and Kiyota (2018) further show for Japan that exporters are more likely to operate in imperfect product markets and to share rents with their workers by paying above competitive wages, whereas the opposite patterns emerge for multinationals. Other papers investigating the relationship between trade openness and market imperfections include Caselli *et al.* (2021) and Damoah (2021).

worker monopoly power in rent splitting, but it also adds to the literatures on the falling labour share in income (e.g. Grossman and Oberfield, 2022) and rising wage inequality (for a survey, see Acemoglu and Autor, 2011, and for the German case, see Dustmann *et al.*, 2009). For example, Card *et al.* (2013) document that increasing dispersion in employer wage premia, that is in the wages paid by different employers to equally productive workers, during the 1990s and 2000s contributed to the rise in wage inequality in West Germany. And Hirsch and Mueller (2020), in turn, observe that the fall in collective bargaining coverage during that period contributed to the rise in the dispersion of employer wage premia. If organised labour matters for the prevalence and intensity of labour market imperfections in that it shifts market power from employers to workers, then the erosion of organised labour documented for Germany as for other countries may be one common source of the trends of a decreasing labour share in income and increasing wage inequality.

Turning to the system of industrial relations in Germany, the principle of bargaining autonomy grants unions and employers the right to regulate wages and working conditions absent state interference. Collective agreements are legally binding, are predominantly concluded as multi-employer agreements between a union and an employers' association at the sectoral level, and almost always apply to all of the covered employers' workers irrespectively of workers' union status. Although sectoral negotiations mostly take place in regional bargaining units, officials of the two bargaining parties closely coordinate the regional negotiations within one sector, so that variations between them are small. There even exists some cross-sectoral coordination by both parties, giving rise to some uniformity in collective bargaining policy across sectors (for details, see Hirsch and Schnabel, 2014).

Collective bargaining in Germany predominantly concerns wages, but also determines job classifications, working time, and working conditions. Norms stipulated in the collective agreement are generally minimum terms, so that employers bound by the agreement cannot undercut, but only improve upon these terms and conditions. Exceptions to this general rule are in some cases laid down in so-called opening clauses that allow re-negotiating collective bargaining issues, mostly wages and working time, at the plant level, typically under conditions of economic hardship.

Whereas many employers pay higher wages than stipulated in the collective agreements (Jung and Schnabel, 2011) and opening clauses have gained ground, for most workers the wages set in the agreements are crucial for the level and development of their actual wages. At the end of our observational window in 2016, 58% (47%) of workers in West (East) Germany held jobs in the 32% (21%) of plants covered by a collective agreement (Ellguth and Kohaut, 2017). Compared to the start of our observation period, we see a marked fall in collective bargaining coverage. In 2000, 70% (55%) of workers in West (East) Germany were employed by the 48% (28%) of covered plants (Kohaut and Schnabel, 2003).

On average, plants covered by a collective agreement pay higher wages than uncovered plants (Guertzgen, 2009; Fitzenberger *et al.*, 2013). In a recent study, Hirsch and Mueller (2020) further show that higher average wages in covered plants reflect higher employer wage premia, holding constant plant surplus. They interpret their finding as evidence that collective bargaining increases workers' bargaining power. This interpretation is in line with evidence from the empirical rent-sharing literature and with a host of theoretical contributions arguing that collective bargaining enables workers to push through above competitive wages. Hence, we expect a higher prevalence and intensity of worker monopoly in covered than in uncovered plants. We further suspect the opposite to hold for employer monopsony, although we lack direct empirical evidence on this received wisdom seized by the Council of Economic Advisors (2016), which argues that declining unionisation in the US has raised employer monopsony power and has, in consequence, led to lower wage growth and increased wage inequality. In this paper, we will put these hypotheses to a rigorous test.

On top of collective bargaining typically conducted at the sectoral level, the second backbone of Germany's dual system of industrial relations is given by workplace co-determination through works councils, the German counterpart of the workplace union in other countries. Works councils are mandatory but not automatic in all plants with at least five permanent workers, for setting up a works council requires three workers or a union representative to initiate an election procedure in the plant.

At the end of our observation period in 2016, 43% (34%) of workers in West (East)

Germany were employed by the 9% (9%) of plants with a works council (Ellguth and Kohaut, 2017). Like collective bargaining coverage, workplace co-determination dropped compared to the start of our observational window. In 2000, 50% (41%) of workers in West (East) Germany held jobs in the 12% (12%) of plants with a works council (Ellguth and Kohaut, 2018). Together, shrinking collective bargaining coverage and works council prevalence point at an erosion of the traditional model of industrial relations in Germany.

Works councils have far-reaching co-determination rights, in particular on what are termed 'social matters', which comprise remuneration arrangements, the commencement and termination of working hours, the regulation of overtime and reduced working hours, as well as health and safety measures (for details, see Addison, 2009). Unlike unions, though, works councils may not call a strike and they are excluded from reaching agreement with the employer on wages and working conditions that are settled or normally settled by collective agreements between unions and employers' associations at the sectoral level. One exception to this general rule is that collective agreements contain opening clauses (mentioned before) that explicitly authorise works councils to do so.

However, even if opening clauses are absent, works councils' extensive co-determination rights on many other issues mean that works council existence is likely to improve workers' bargaining power and thus to spur rent-seeking activities (Freeman and Lazear, 1995). In line with this conjecture, extant studies have documented that works council presence is accompanied by higher average wages (Addison *et al.*, 2001, 2010). Furthermore, Hirsch and Mueller (2020) show that the higher average wages in plants with a works council mirror higher employer wage premia, holding constant plant surplus, and interpret their finding as evidence that workplace co-determination increases workers' bargaining power. Although we lack direct empirical evidence on how works council presence shapes labour market imperfections, we follow the received wisdom that it shifts market power from employers to workers and thus expect a lower prevalence and intensity of employer monopsony when works councils are present and the opposite for worker monopoly. As with collective bargaining, we will put these hypotheses to a rigorous test.

3 Theoretical framework

To determine a plant's labour and product market imperfections, we follow the approach introduced by Dobbelaere and Mairesse (2013) that allows to infer both types of imperfections from production function estimates.[4] In this section, we will summarise the assumptions and the outcomes of this approach, along with underlying intuitions, whereas we relegate derivations to Appendix A. Consider plant i at time t that produces a good Q_{it} from its labour input N_{it}, its intermediate inputs M_{it}, and its capital input K_{it}, subject to the strictly increasing (in all its arguments) and concave production function:

$$Q_{it} = Q(N_{it}, M_{it}, K_{it}) \tag{1}$$

In terms of the plant's input choices, we assume (i) that labour and intermediate inputs are free of adjustments costs and are thus choice variables in the short run, (ii) that capital is predetermined and thus no choice variable in the short run, and (iii) that the plant takes the price of its intermediate inputs as given.[5] We further assume that all plants in the market maximise short-run profits. Then, the plant's optimisation problem involves maximising short-run profits with respect to output Q_{it}, labour N_{it}, and intermediate inputs M_{it}, and the corresponding first-order conditions allow us to infer the existing product and labour market imperfections.

Turning to the plant's product market first, we obtain the standard result that the plant's price is a mark-up over its marginal cost of production, where we denote the price-cost mark-up in the following by μ_{it}. Turning to the plant's choice of intermediate inputs

[4] In our data, we observe plants rather than firms and will thus refer to plants throughout the paper.

[5] Given recent evidence on imperfections in intermediate inputs markets by Morlacco (2020) and Kikkawa *et al.* (2022), this latter assumption of price taking for intermediate inputs might be perceived as being restrictive. This evidence notwithstanding, we stick to the assumption for two reasons. The first is a data reason. Like Morlacco (2020), we could easily model imperfections in intermediate inputs markets as an additional unit cost that drives a wedge between the marginal cost of production and the marginal products of plants' inputs. Data constraints, however, prevent us from putting this approach to work. The second reason is that we want to focus our empirical analysis on the relationship between industrial relations and labour market imperfections faced by plants, abstaining from non-competitive buyer behaviour in the market for intermediate inputs.

next, we find that the price-cost mark-up is given as

$$\mu_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} \tag{2}$$

where $(\varepsilon_M^Q)_{it} = (\partial Q_{it}/\partial M_{it})(M_{it}/Q_{it})$ denotes the output elasticity of intermediate inputs, $\alpha_{Mit} = J_{it}M_{it}/R_{it}$ their revenue share, J_{it} their price, and $R_{it} = P_{it}Q_{it}$ the plant's revenues. The intuition behind this result is that the plant will make economic profits when the output elasticity of intermediate inputs exceeds their revenue share and that these profits must stem from product market imperfections because the plant takes the price of intermediate inputs as given. Consequently, the gap of the output elasticity of intermediate inputs and their revenue share is informative on the price-cost mark-up.

Turning to the plant's labour market, wage formation depends on possible labour market imperfections, and we can infer the presence and intensity of labour market imperfections from the wedge

$$\psi_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} - \frac{(\varepsilon_N^Q)_{it}}{\alpha_{Nit}} \tag{3}$$

between the output elasticities of intermediate inputs and labour and their respective revenue shares where $(\varepsilon_N^Q)_{it} = (\partial Q_{it}/\partial N_{it})(N_{it}/Q_{it})$ denotes the output elasticity of labour, $\alpha_{Nit} = W_{it}N_{it}/R_{it}$ its revenue share, and W_{it} the wage. We refer to ψ_{it} as the plant's joint market imperfections parameter, the reason of which will become clear shortly.

If there is perfect competition in the labour market, the plant's demand for labour will be akin to its demand for intermediate inputs, so there will be no such wedge and $\psi_{it} = 0$. Things, however, are different when labour market imperfections are present. Imperfections may either stem from employer monopsony power that enables employers to set below competitive wages or from worker monopoly power that allows workers to impose above competitive wages on plants.

Under employer monopsony, the plant makes additional economic profits due to its wage-setting power. Consequently, the economic profits derived from the plant's labour input dominate those from its intermediate inputs and ψ_{it} turns negative. Plants' wage-

setting power may originate from concentration or collusion, but may also be pervasive in labour markets with many competing employers due to search frictions, mobility costs, or job differentiation (Manning, 2011, 2021). All these possible channels impede workers' responsiveness to wages, so that the labour supply curve faced by a single employer is upward-sloping rather than horizontal as it would be under perfect competition. This curve's wage elasticity $(\varepsilon_W^N)_{it}$, in turn, is a direct measure of employer monopsony power and we can infer this structural parameter from the joint market imperfections parameter because under monopsony:

$$\psi_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} - \frac{(\varepsilon_N^Q)_{it}}{\alpha_{Nit}} = -\frac{\mu_{it}}{(\varepsilon_W^N)_{it}} < 0 \tag{4}$$

Hence, a negative ψ_{it} indicates employer monopsony, and the more negative ψ_{it} gets, the more pronounced are the combined labour and product market imperfections, which is the reason why we refer to ψ_{it} as the joint market imperfections parameter.

In contrast, labour market imperfections may also originate from worker monopoly power enabling workers to impose above competitive wages on plants. As an underlying structural model, we consider efficient bargaining (McDonald and Solow, 1981) between a risk-neutral plant and its risk-neutral workforce, though other structural models are possible as well.[6] Under worker monopoly, the economic profits derived from the plant's intermediate inputs dominate those from its labour input and ψ_{it} turns positive. Moreover, we can infer workers' relative bargaining power under efficient bargaining γ_{it}^{EB} as the structural parameter of worker monopoly power from the joint market imperfections parameter because under efficient bargaining:

$$\psi_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} - \frac{(\varepsilon_N^Q)_{it}}{\alpha_{Nit}} = \mu_{it}\gamma_{it}^{EB}\left[\frac{1-\alpha_{Nit}-\alpha_{Mit}}{\alpha_{Nit}}\right] > 0 \tag{5}$$

One drawback of measuring worker monopoly power by γ_{it}^{EB} is that efficient bargaining assumes that the plant and its workers bargain over wages and employment. This may be hard to justify in some institutional settings, in particular in the German case where

[6] For instance, Stole and Zwiebel (1996) considers wage bargaining between individual workers and their employer when incomplete labour contracts provide incumbent workers with hold-up power.

collective bargaining is typically at the sectoral level. In such an environment, right-to-manage bargaining (Nickell and Andrews, 1983), in which the parties bargain over the wage only and the plant is then free to choose employment at the bargained wage, may be a more convincing underlying structural model (see also Hirsch and Schnabel, 2014).

As is shown by Manning (1987), efficient and right-to-manage bargaining are nested as two polar cases in a more general sequential bargaining model with subsequent wage and employment negotiations. Under efficient bargaining, workers' bargaining power is the same in the wage and employment negotiations, whereas it is nil in the employment negotiations under right-to-manage bargaining. Given this close connection between the two models, we show in Appendix A how to convert workers' relative bargaining power under efficient bargaining γ_{it}^{EB} into its right-to-manage counterpart γ_{it}^{RTM}. This conversion allows us to measure worker monopoly power without invoking the assumption that the plant and its workers bargain over both wages and employment.

Specifically, we arrive at the conversion formula:

$$\gamma_{it}^{RTM} = \frac{1}{(\eta_W^N)_{it}\left(\frac{W_{it}-\overline{W}_{it}}{W_{it}}\right)+1}\,\gamma_{it}^{EB} \tag{6}$$

where $(\eta_W^N)_{it}$ denotes the (negative) wage elasticity of the plant's labour demand and $\overline{W}_{it}$ the alternative wage. Hence, for any bargain above the alternative wage, i.e. $W_{it} > \overline{W}_{it}$, workers' relative bargaining power under right-to-manage bargaining exceeds their bargaining power under efficient bargaining. The intuition is that, unlike efficient bargaining where employment is a separate bargaining issue, the plant's labour demand drops with rising wages under right-to-manage bargaining, thereby restraining workers' wage demands. Therefore, achieving the same wage under efficient and right-to-manage bargaining implies more bargaining power for workers under right-to-manage bargaining. The conversion rate depends negatively on the labour demand elasticity, which captures the size of the employment response to rising wages. In the polar case that employment is unresponsive to wages, i.e. $(\eta_W^N)_{it} = 0$, workers' relative bargaining power is the same in both models, which makes sense as in this case rising wages do not harm employment

under right-to-manage bargaining, akin to efficient bargaining where wage-employment outcomes lie on a vertical contract curve.

4 Econometric implementation

To measure labour and product market imperfections based on the price-cost mark-up μ_{it} and the joint market imperfections parameter ψ_{it}, we have to estimate the output elasticities of intermediate inputs $(\varepsilon_M^Q)_{it}$ and labour $(\varepsilon_N^Q)_{it}$ as well as their revenue shares α_{Mit} and α_{Nit}. Our econometric implementation is based on a production function

$$q_{it} = f(n_{it}, m_{it}, k_{it}; \boldsymbol{\beta}) + \omega_{it} \tag{7}$$

with lower-case letters denoting logs of variables, e.g. $q_{it} = \ln Q_{it}$, a vector of common (within two-digit sectors) technology parameters $\boldsymbol{\beta}$, and a Hicks-neutral productivity shock ω_{it} observed by the plant, but unobserved by us. Identifying $\boldsymbol{\beta}$ crucially depends on controlling for the productivity shock ω_{it} because it will be correlated with the plant's input choices and ignoring it could thus induce omitted variable bias. To control for it, we follow the estimation approach by Ackerberg *et al.* (2015) that builds on the insight that plants' optimal input choices hold information about unobserved productivity.[7] We provide the details in Appendix B.

In our empirical specification, we approximate the unknown regression function $f(\cdot)$ by means of a second-order Taylor polynomial and estimate the coefficients of a translog production function at the two-digit sector level (including a full set of region dummies and a linear time trend, which we will omit in the following for notational ease). Specifically,

[7] Note that some recent papers have shown that factor adjustment costs and non-neutral productivity shocks could also drive a wedge between the output elasticities of labour and intermediate inputs and their respective revenue shares (e.g. Doraszelski and Jaumandreu, 2018; Raval, 2020; Bond *et al.*, 2021). However, these papers ignore labour market imperfections and assume competitive labour markets instead. To the best of our knowledge, there exists no comprehensive approach that would allow us to incorporate their insights into our investigation of labour market imperfections.

we estimate:

$$\begin{aligned} y_{it} = {} & \beta_0 + \beta_n n_{it} + \beta_m m_{it} + \beta_k k_{it} + \beta_{nn} n_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{kk} k_{it}^2 \\ & + \beta_{nm} n_{it} m_{it} + \beta_{nk} n_{it} k_{it} + \beta_{mk} m_{it} k_{it} + \omega_{it} + \epsilon_{it} \end{aligned} \tag{8}$$

where the regression constant β_0 measures the mean efficiency level across plants and ϵ_{it} is an idiosyncratic error term that comprises unpredictable output shocks and potential measurement error in output and inputs and is assumed to be mean independent of current and past input choices.

We arrive at estimates of the output elasticities $(\varepsilon_M^Q)_{it}$ and $(\varepsilon_N^Q)_{it}$ by combining the estimated $\widehat{\boldsymbol{\beta}}$ with data on plants' input choices:

$$(\widehat{\varepsilon}_N^Q)_{it} = \widehat{\beta}_n + 2\widehat{\beta}_{nn} n_{it} + \widehat{\beta}_{nm} m_{it} + \widehat{\beta}_{nk} k_{it} \tag{9}$$

$$(\widehat{\varepsilon}_M^Q)_{it} = \widehat{\beta}_m + 2\widehat{\beta}_{mm} m_{it} + \widehat{\beta}_{mn} n_{it} + \widehat{\beta}_{mk} k_{it} \tag{10}$$

Hence, both output elasticities vary across plants and over time.[8] Since the observed output $Y_{it} = Q_{it} \exp \epsilon_{it}$ includes idiosyncratic factors that are orthogonal to input use and productivity, we cannot take revenue shares from our data without correcting for these factors. We do so by recovering an estimate of ϵ_{it} from the production function estimation and calculate adjusted revenue shares as:

$$\widehat{\alpha}_{Nit} = \frac{W_{it} N_{it}}{P_{it} Y_{it} / \exp \widehat{\epsilon}_{it}} \tag{11}$$

$$\widehat{\alpha}_{Mit} = \frac{J_{it} M_{it}}{P_{it} Y_{it} / \exp \widehat{\epsilon}_{it}} \tag{12}$$

Combining the estimated output elasticities (9) and (10) and the adjusted revenue shares (11) and (12), we arrive at estimates of the price-cost mark-up and the joint market

[8] Note that with a Cobb-Douglas production technology, output elasticities would simplify to $(\widehat{\varepsilon}_N^Q)_{it} = \widehat{\beta}_n$ and $(\widehat{\varepsilon}_M^Q)_{it} = \widehat{\beta}_m$ and thus vary neither across plants (within two-digit sectors) nor over time.

imperfections parameter:

$$\widehat{\mu}_{it} = \frac{(\widehat{\varepsilon}^{Q}_{M})_{it}}{\widehat{\alpha}_{Mit}} \tag{13}$$

$$\widehat{\psi}_{it} = \frac{(\widehat{\varepsilon}^{Q}_{M})_{it}}{\widehat{\alpha}_{Mit}} - \frac{(\widehat{\varepsilon}^{Q}_{N})_{it}}{\widehat{\alpha}_{Nit}} \tag{14}$$

While the sign of the estimated ψ_{it} informs us on the power imbalance between employers and workers as either employer monopsony (negative ψ_{it}) or worker monopoly (positive ψ_{it}), we further use the estimated μ_{it} and ψ_{it} to obtain the structural parameters capturing employer monopsony or worker monopoly power and thus the intensity of labour market imperfections. Using (4) or (5), respectively, we recover the plant-level labour supply elasticity or workers' relative bargaining power under efficient bargaining as:

$$(\widehat{\varepsilon}^{N}_{W})_{it} = -\frac{\widehat{\mu}_{it}}{\widehat{\psi}_{it}} \tag{15}$$

$$\widehat{\gamma}^{EB}_{it} = \frac{\widehat{\psi}_{it}}{\widehat{\mu}_{it}} \left[\frac{\widehat{\alpha}_{Nit}}{1 - \widehat{\alpha}_{Nit} - \widehat{\alpha}_{Mit}} \right] \tag{16}$$

Finally, to convert workers' relative bargaining power under efficient bargaining to its right-to-manage counterpart, we apply the conversion formula (6):

$$\widehat{\gamma}^{RTM}_{it} = \frac{1}{(\eta^{N}_{W})_{it} \left(\frac{W_{it} - \overline{W}_{it}}{W_{it}} \right) + 1} \widehat{\gamma}^{EB}_{it} \tag{17}$$

To put this conversion into work, we need estimates of the plant's labour demand elasticity and the percentage gap between the plant and the alternative wage. For the labour demand elasticity, we turn to the literature and use the average estimate of this elasticity for Germany of –0.36 (taken from the meta-analysis by Lichter *et al.*, 2015, based on 79 estimates for Germany that comprise all sectors and types of workers). For the plant wage, we rely on the plant wage effect from an AKM decomposition. In the AKM framework, which provides a suitable approximation of the German wage structure (Card *et al.*, 2013), the plant wage effect measures the wage premium enjoyed by all workers in a plant's workforce adjusted for observed and unobserved worker quality (details are in

Appendix C). To arrive at the percentage gap between the plant and the alternative wage, we consider the gap of the plant wage effect and the 25th percentile of the plant wage effects of plants in the same two-digit sector at the same point in time.

5 Data

Our data come from the IAB Establishment Panel described by Ellguth *et al.* (2014). Starting in 1993 (1996), the IAB Establishment Panel has surveyed West (East) German plants (not firms) that employ at least one worker covered by the social security system on 30th June of the survey year, and is representative of the population of these plants.

Crucial for our purpose, it contains information on plants' revenues and intermediate inputs, employment, wage bill, and industrial relations (i.e. collective bargaining coverage and works council existence). To arrive at plants' total labour costs, we use information from the Federal Statistical Office on the non-wage labour costs at the two-digit sector level and add it to the wage bill. We further deflate all nominal values using two-digit price deflators and apply the procedure by Eberle *et al.* (2011) to construct a time-consistent sector classification. Although the IAB Establishment Panel has no direct information on plants' capital stock, it can readily be computed from the included investment data using a modified perpetual inventory approach put forward by Mueller (2008). Since our estimation approach uses lagged information on plants and since the survey information on plants' revenues and intermediate inputs is for the previous year, plants only enter the sample if we observe them in at least three consecutive years. Using information from the survey waves for 1998–2017, we are thus able to build a panel for the years 1999–2016.[9]

In our analysis, we focus on the manufacturing and service sectors and discard the financial and insurance sectors, for which output measures are not comparable to the other sectors in our sample. We further exclude plants producing tobacco products (i.e. 89 plant-year observations belonging to this highly regulated industry) and disregard plants with less than five workers, which are not at risk of having a works council. Before estimating

[9] We cannot use earlier waves because of a change in the questionnaire regarding plants' industrial relations and because we do not want to constrain our analysis to West Germany.

production functions for each two-digit sector, we drop observations with revenue shares of labour and intermediate inputs outside the unit interval and, to remove outliers, only keep observations within the sector-specific 1% trimmed range of value added per worker and capital intensity. Our final regression sample comprises 40,146 observations of 8,936 plants belonging to 38 two-digit sectors (for descriptive statistics, see Table 1; the included sectors are visible from Table 2).[10]

6 Do industrial relations matter for labour market imperfections?

6.1 Descriptive analysis

Using our panel of German plants for 1999–2016, we now apply the estimation approach described in Section 4. In a first step, we estimate translog production functions for each two-digit sector based on the control function approach by Ackerberg *et al.* (2015) that allows us to control for unobserved productivity shocks. In a second step, we use the estimated coefficients together with information on plants' input use to infer whether they operate in a labour market involving employer monopsony or worker monopoly and to quantify the intensity of labour market imperfections.

Table 2 presents means (overall and by two-digit sector) of the estimated output elasticities of labour, intermediate inputs, and capital as well as the resulting returns to scale, i.e. the sum of the three output elasticities. For our whole sample, average output elasticities are 0.44 for labour, 0.56 for intermediate inputs, and 0.10 for capital, with returns to scale amounting to 1.10 and thus slightly above constant returns. We also see marked differences in production technologies across sectors.

We now use plants' estimated output elasticities and revenue shares to infer their joint market imperfections parameter whose sign informs us on plants' time-varying

[10] Note that we drop the small number of observations with a negative estimate of the price-cost mark-up (236 plant-year observations) and an estimated parameter of workers' absolute bargaining power under efficient bargaining, i.e. $\phi_{it}^{EB} = \gamma_{it}^{EB}/(1+\gamma_{it}^{EB})$, outside the unit interval (1,855 plant-year observations). Note also that including these observations would not change any of our conclusions.

labour market setting (i.e. employer monopsony vs. worker monopoly). Throughout, our descriptive evidence will come from population weighted samples, thereby allowing us to draw conclusions on the population of manufacturing and service plants in Germany.[11] As is clear from Table 3, 70% of (plant-year) observations involve employer monopsony and just 30% worker monopoly. We note in passing that we obtain an average price-cost mark-up of 1.24 that is much larger under worker monopoly than employer monopsony (1.49 vs. 1.13), which is reassuring as worker monopoly arguably presupposes substantial rents to be split between employers and workers and is thus only sustainable when product market imperfections shield employers from competition.[12]

Turning to plants' industrial relations, we observe big differences in the prevalence of employer monopsony and worker monopoly across plants with and without a works council and small differences across plants covered by collective agreements and uncovered plants. Employer monopsony is 9.1pp less frequent where works councils exist and 0.8pp where collective bargaining is present. These findings make sense against the background that collective bargaining is typically conducted at the sectoral level and is, for this reason, less likely to limit the power imbalance between individual employers and workers than worker co-determination at the workplace. They further square up with the result of Hirsch and Mueller (2020) that works council existence has a stronger association with the mean employer wage premium than collective bargaining coverage.

The found associations suggest that both forms of organised labour benefit workers in that they limit employer monopsony and bolster worker monopoly. Yet, they are also consistent with a causal link in the opposite direction with workers unionising or setting up a works council to foster rent extraction when confronted with a rather weak employer who is forced to pay above competitive wages from the outset. Since our interest lies in how

[11] We also repeated our descriptive analysis weighting plants with their number of workers, which did not change any of our insights.

[12] Note that the average price-cost mark-up across plants is rather modest in size compared to existing estimates in the literature. Yet, one has to bear in mind that previous studies typically ignore labour market imperfections in that they assume competitive wage formation and thus, given that employer monopsony is much more prevalent than worker monopoly in our data, are prone to overstating the wedge between prices and marginal costs (as discussed in detail by De Loecker *et al.*, 2016). And, reassuringly, our numbers are similar in size to recent estimates that allow for labour market imperfections (e.g. Dobbelaere *et al.*, 2015; Soares, 2020).

industrial relations shape labour market imperfections, we will later regress imperfections on industrial relations and further control variables to substantiate a possible causal link running from industrial relations to labour market imperfections.

To assess the intensity of labour market imperfections, we use our estimates of the joint market imperfections parameter and the price-cost mark-up to recover the plant-level labour supply elasticity $(\varepsilon_W^N)_{it}$ and workers' relative bargaining power under efficient bargaining γ_{it}^{EB} as the structural parameters capturing employer monopsony and worker monopoly power, respectively. In other words, we look at our outcomes through the lens of monopsony or efficient bargaining as two models of imperfect labour markets. Moreover, we use the conversion formula (17) to infer workers' relative bargaining power under right-to-manage bargaining γ_{it}^{RTM} because the right-to-manage model may be a more appropriate representation of German labour market institutions.[13] Table 4 reports medians of the (unbounded from above) market power measures for all plants and by industrial relations.

For the 70% of observations involving employer monopsony, we find that the median plant-level labour supply elasticity amounts to 1.10, which points at marked monopsony power for employers. This number is not too different from the median of 1,320 elasticity estimates of 1.68 reported in Sokolova and Sorensen (2021) and almost identical to the average elasticity estimate for US firms of 1.08 in Webber (2015), which is one of the rare studies that provides elasticity estimates at the individual employer level as we do, though based on a different methodology. Note, however, that our median elasticity estimate for plants with employer monopsony as labour market setting is also consistent with previous studies obtaining larger estimates because the average elasticity for all plants estimated by earlier studies is a weighted average of the elasticity in plants with significant monopsony power and the elasticity in those with none. The latter are plants paying above competitive

[13] Note that we do not observe AKM plant wage effects, which we need for the conversion, for 895 out of the 13,251 plant-year observations involving worker monopoly. We decided to impute these missing AKM plant wage effects by the predicted values of a linear regression of the observed AKM plant wage effects on dummies for two-digit sector, plant size (ten categories), and their interaction, time dummies, dummies for a single-plant company, plant age (four categories), and exporting activity, as well as the share of skilled workers, apprentices, part-time workers, and female workers in the plant's workforce, and the plant's log wage bill per worker. That said, our results hardly change when restricting to those plant-year observations with non-missing AKM plant wage effects.

wages, and thus plants facing very large elasticities.

For the 30% of observations involving worker monopoly, we observe a median relative bargaining power of workers of 0.49 under efficient bargaining and 0.53 under right-to-manage bargaining. This means that in the median plant workers' absolute bargaining power is roughly half of employers' bargaining power. In general, worker monopoly power is very similar under efficient and right-to-manage bargaining. The average conversion rate in the conversion formula (17) is 1.06 with a standard deviation of 0.09.

At the extensive margin, we find that the presence of works councils or collective bargaining is associated with a lower prevalence of employer monopsony and a higher prevalence of worker monopoly. Now that we look at the intensity of labour market imperfections, the picture emerging is less clear. Both types of organised labour are associated with a larger plant-level labour supply elasticity and thus less employer monopsony power, and as with the extensive margin the difference is much bigger for works councils than for collective bargaining. On the other hand, under worker monopoly workers' relative bargaining power is even lower if collective bargaining is present and shows no difference between plants with and without works councils. These inconsistent correlation patterns for worker monopoly power, however, may simply reflect confounding factors, such as plant size and sector affiliation. Therefore, we now turn to partial correlations from regressions.

6.2 Regression analysis

Obviously, the descriptive correlations considered so far cannot establish a causal link running from industrial relations to labour market imperfections. To come a bit closer to causal statements, we now run several regressions for the prevalence and the intensity of labour market imperfections. In terms of the extensive margin, we investigate which factors including industrial relations captured by dummies for collective bargaining coverage and the existence of a works council influence the probability of employer monopsony (as opposed to worker monopoly). Table 5 reports average marginal effects for the probability of employer monopsony from successively richer probit regressions. All models include as

controls a full set of region, year, and two-digit sector dummies as well as a dummy for a single-plant company. We then successively include plant size, i.e. log employment, and dummies for plant age (model 2); information on workforce composition, i.e. the share of skilled workers, apprentices, part-time workers, and female workers (model 3); and a dummy for exporting activity (model 4).

Once we add plant size, plant age, and workforce composition to the probit regression (models 3–4), we find that the presence of collective bargaining or a works council is associated with a non-negligible reduction in the conditional probability of employer monopsony. In our richest specification (model 4), collective bargaining is accompanied by an average drop in the probability of 1.8pp and works council existence even by a drop of 5.6pp, both of which are statistically significant at the 5% and 1% level, respectively. These findings support the view that organised labour matters for the prevalence of labour market imperfections in that it seems to reduce the likelihood that employers can impose below competitive wages on workers. And in line with our descriptive evidence, works council existence appears to matter more than collective bargaining coverage.

We further observe some interesting patterns for the control variables. Plant size shows a positive association with the probability of employer monopsony, whereas we find the opposite for exporting plants (in line with previous evidence by Dobbelaere and Kiyota, 2018, for Japan). Hence, larger and non-exporting plants seem to be more powerful in the labour market. Finally, the composition of the workforce appears to matter. The probability of employer monopsony is lower the more skilled workers are employed, whereas it is larger the more apprentices, part-timers, and females are among the workers, suggesting a more pronounced power imbalance for the latter groups.

Turning to the intensive margin of labour market imperfections, we examine how industrial relations and the other plant characteristics included in our preferred specification of the probit regression (i.e. the richest model 4) influence the magnitude of employer monopsony or worker monopoly power. Yet, meaningful measures of employer monopsony or worker monopoly power are only available if we have either $\psi_{it} < 0$ and thus employer monopsony or $\psi_{it} \geqslant 0$ and thus worker monopoly, so we restrict the estimation

samples accordingly.[14] Table 6 presents the results of OLS regressions and underscores that what we found at the extensive margin, with few exceptions, also shows up at the intensive margin. Since all dependent variables are in logs, estimated coefficients are interpretable as (approximate) percentage changes and thus directly inform us on the economic significance of the respective variables.

Given employer monopsony, we find that the existence of collective bargaining or a works council reduces employer monopsony power significantly, which is in line with some suggestive earlier evidence presented by Bachmann and Frings (2017). The plant-level labour supply elasticity is on average 8.3% larger in covered than in uncovered plants and 14.7% larger in plants with a works council than in plants without, where both associations are statistically significant at the 1% level. We further find the same patterns for the control variables that we obtained at the extensive margin. Employer monopsony power shows a positive association with plant size and a negative with exporting activity. Moreover, it is significantly related to workforce composition. It is smaller the more skilled workers are employed and larger the more apprentices, part-timers, and females are in the workforce. Particularly the latter finding for females is in line with existing evidence that employers possess more monopsony power over female as opposed to male workers (see the recent survey by Hirsch, 2016, and Hirsch *et al.*, 2010, for Germany).

Given worker monopoly, we find that the existence of collective bargaining is associated with a rise in workers' relative bargaining power under efficient bargaining of 7.6% and the presence of a works council even with a rise of 13.9%, though only the latter association is statistically significant (at the 5% level). Under right-to-manage bargaining, the associated rise of workers' relative bargaining power is somewhat bigger and amounts to 9.5% and 16.4%, respectively, which are both statistically significant at the 5% or 1% level. For the control variables, we obtain, with the sole exception of plant age, the same correlation patterns as for the plant-level labour supply elasticity. Reassuringly, this

[14] Rather than running OLS regressions on these restricted samples, we could correct for the truncation of employer monopsony and worker monopoly power by fitting type II Tobit models, in which the first-stage probit participation equation for $\psi_{it} < 0$ or $\psi_{it} \geqslant 0$, and the second-stage outcome equation for the respective market power parameter include the same regressors, but these are allowed to have different coefficients in the two equations (e.g. Cameron and Trivedi, 2005). We did so in a check of robustness and obtained very similar results (which are available upon request).

finding implies mirror-inverted associations of the controls with worker monopoly power *vis-à-vis* employer monopsony power.

6.3 Analysis of switches in plants' labour market setting

Exploiting the time-varying nature of our estimates of the joint market imperfections parameter and the resulting assignment of plants' labour market setting as either employer monopsony or worker monopoly, we next investigate how switches in plants' labour market setting over time are related to the presence of collective bargaining or a works council. In doing so, we hope to further back up the claim that industrial relations shape labour market imperfections (rather than the other way round). Besides, such an analysis promises suggestive evidence on whether the deterioration of organised labour during our period of observation shifted the power imbalance between employers and workers in favour of employers and thus plausibly contributed to the long-term trends of a falling labour share and rising wage inequality.

Table 7 provides transition matrices for plants' labour market setting. What emerges is that employer monopsony is more persistent than worker monopoly (panel A). For 91% of the plants with employer monopsony we also find employer monopsony in the subsequent observation while 9% of these plants switch to worker monopoly. In contrast, just 76% of the plants with worker monopoly stay in this setting in the subsequent observation while 24% of these plants change to employer monopsony. These findings strongly suggest that employer monopsony is gaining ground against worker monopoly.[15]

Separate transition matrices by industrial relations show that worker monopoly is more persistent where organised labour is present, whereas the persistence of employer monopsony is similar across plants. Plants covered by a collective agreement are 2pp less likely to switch from worker monopoly to employer monopsony than uncovered plants (panel B), and plants with a works council even have a 5pp lower switching probability

[15] We also checked whether plants entering or exiting our sample differ in terms of their labour market settings from those plants staying in our sample, which contribute to the reported transition matrix. Notably, exit probabilities are very similar across employer monopsony and worker monopoly, and also the prevalence of the respective labour market settings for plants entering our sample does not differ much from the prevalence of settings for incumbent plants. Hence, the picture would not change when accounting for compositional changes following plant entry and plant exit.

than plants without (panel C). These findings suggest that the presence of organised labour protects workers from employer monopsony, and in line with our previous results workplace co-determination seems to matter more than collective bargaining.

These patterns also show up when running probit regressions for switches from worker monopoly to employer monopsony or the other way round that include the same control variables as our previous regression models. As we see from Table 8, collective bargaining coverage is on average associated with a 1.7pp lower conditional probability of switching from worker monopoly to employer monopsony, which yet is not statistically significant at conventional levels. Works council existence is on average associated with a drop in the switching probability by 5.1pp, which is statistically significant at the 1% level. Given the pronounced persistence of worker monopoly, both numbers represent sizeable changes. In line with the descriptive evidence from transition matrices, we see only little differences in the conditional switching probability from employer monopsony to worker monopoly where organised labour is present.

In summary, we find that organised labour seems to protect workers in that it reduces the probability of an unfavourable switch from worker monopoly to employer monopsony. We thus have further evidence suggesting that industrial relations shape labour market imperfections. And, reassuringly, these findings are unlikely to suffer from reversed causality running from labour market imperfections to industrial relations and therefore strengthen our results from regressions of labour market imperfections on industrial relations where issues of reversed causality are more of a concern.

7 Do labour market imperfections matter for employer wage premia?

Our findings so far strongly suggest that industrial relations matter for labour market imperfections. But do labour market imperfections, in turn, matter for the wage premium paid by employers to their workers? In other words, what is the impact of labour market imperfections on the level and dispersion of wages after accounting for sorting of workers

with different abilities into plants that differ in labour market imperfections and in the size of rents to be split between employers and workers? Answering this question is not only crucial for our research question and against the background that rising dispersion in employer wage premia is an important driver of increasing wage inequality in Germany and other countries (Akerman *et al.*, 2013; Barth *et al.*, 2016; Card *et al.*, 2013), but also provides a most welcome opportunity of cross-validating our measures of labour market imperfections, that is examining their predictive power for actual employer wage premia.

Up to now, there is scant evidence on this issue, though some recent contributions surveyed by Manning (2021) find that labour market imperfections are associated with wages.[16] This evidence, however, is about individual wages and not about employer wage premia, so worker sorting may contaminate findings. To obtain a measure of employer wage premia that does not suffer from worker sorting, we follow Card *et al.* (2018) and Hirsch and Mueller (2020) and rely on the AKM plant wage effects estimated for our data by Bellmann *et al.* (2020). Since we are interested in how labour market imperfections shape wage outcomes for a given plant surplus, we further follow Hirsch and Mueller (2020) in controlling for the quasi rent per worker as the proper measure of this surplus. We provide details on our measures of employer wage premia and plant surplus in Appendix C.

To investigate the link between employer wage premia and labour market imperfections, we regress the standardised AKM plant wage effect on our measures of labour market imperfections, the quasi rent per worker to control for the plant surplus, and all the control variables included in the regressions before.[17] To capture the extensive margin of labour market imperfections, we include a dummy variable for the presence

[16] For instance, Hirsch *et al.* (2022) show that smaller employer monopsony power in denser local labour markets accounts for about half of the urban wage premium in Germany. For the US, Azar *et al.* (2022) observe lower posted wages in more concentrated local labour markets and Benmelech *et al.* (2022) find a negative association between labour market concentration and wages that is rising over time and more pronounced where unionisation rates are low. Furthermore, Brooks *et al.* (2021) show that wage mark-downs substantially depress the labour share in China and India whereas Berger *et al.* (2019) find that labour market concentration, while substantial, has not contributed to the falling US labour share. Finally, Rinz (2022) documents for the US that higher labour market concentration is accompanied by higher wage inequality while Webber (2015) finds that a larger labour supply elasticity to the employer reduces the dispersion of wages because its wage-lifting effect is most pronounced at the lower end of the wage distribution.

[17] As before, we do not observe AKM plant wage effects for all plants and decided to impute missing AKM plant wage effects following the procedure outlined in footnote 13. Note that we obtain almost the same results when restricting to the sample of plants with non-missing AKM plant wage effects.

of employer monopsony. To capture their intensive margin, we include, in the restricted samples of plants involving either employer monopsony or worker monopoly, the plant-level labour supply elasticity, workers' relative bargaining power under efficient bargaining, or their relative bargaining power under right-to-manage bargaining as measures of employer monopsony or worker monopoly power. For each of these four measures, we estimate four regression models: an OLS regression for the mean employer wage premium, which provides the impact of labour market imperfections on the level of wage premia, and re-centred influence function (RIF) regressions (Firpo *et al.*, 2009) for the variance, the first decile, and the ninth decile of the unconditional wage premium distribution, which inform us on their influence on the dispersion of wage premia.

Table 9 presents the core findings from these 16 regressions, and detailed results are reported in Appendix D. Holding constant plant surplus and the other control variables, employer monopsony is accompanied by a 0.16 standard deviations lower mean wage premium (where a standard deviation in wage premia amounts to about 25 log points in our sample).[18] Whereas the level of wage premia is thus lower under employer monopsony, the opposite holds for the dispersion of wage premia. Employer monopsony is associated with a 8% larger variance (of standardised wage premia), which reflects that employer monopsony is associated with a 0.16 standard deviations lower first decile and a 0.08 standard deviations lower ninth decile of wage premia and thus widens the wage premium distribution. All these partial correlations are statistically significant at the 1% level.

These findings at the extensive margin also show up at the intensive margin of employer monopsony. When employer monopsony is present, which is the case for 26,895 observations, a one standard deviation larger log plant-level labour supply elasticity, which amounts to 1.35 in our sample, is associated with a 0.09 ($= 1.35 \times 0.066$) standard deviations higher mean employer wage premium, which is statistically significant at the 1% level. Furthermore, such an increase in employer monopsony power is accompanied by a statistically significant drop in the variance of premia by 11.1%, which reflects the

[18] We note in passing that we obtain an R^2 of 0.53 in the OLS regression which means that the included regressors can account for the majority of the variation in wage premia, and we further note that the results for the control variables show little surprises so that we leave them uncommented.

associated rise of the first decile of the premium distribution by 0.12 standard deviations and the almost unaltered ninth decile. Our findings thus not only suggest that the presence and intensity of employer monopsony harm workers by reducing the level of employer wage premia for a given surplus, but also that they aggravate inequality as those working for low-premium employers suffer most.

Turning to the intensity of worker monopoly, which is present for 13,251 observations, we find that a one standard deviation larger log relative bargaining power of workers under efficient bargaining, which amounts to 1.54 in our sample, is associated with a 0.06 ($= 1.54 \times 0.036$) standard deviations higher mean employer wage premium and a 0.07 (0.06) standard deviations higher first (ninth) decile of the premium distribution and thus little change in the variance of employer wage premia. All these partial correlations are statistically significant at the 1% level. Under right-to-manage bargaining, standardised effect sizes are very similar, so we omit the details. Hence, given worker monopoly, more worker monopoly power benefits workers uniformly across the wage premium distribution, though to a more modest extent compared to employer monopsony power.

In summary, our findings suggest that labour market imperfections matter for employer wage premia, and in the way predicted by theory thereby cross-validating our measures of imperfections in the labour market. In consequence, both the presence and the intensity of labour market imperfections seem to influence the level and the dispersion of employer wage premia while they themselves seem to be shaped by industrial relations.

8 Conclusions

This paper has investigated the interplay between industrial relations, labour market imperfections, and employer wage premia in Germany and posed two questions. Do industrial relations matter for labour market imperfections? And do labour market imperfections, in turn, matter for employer wage premia? We addressed these two questions using the production function approach of Dobbelaere and Mairesse (2013) that allows to infer the presence and intensity of labour market imperfections from production

function estimates. Based on representative plant-level data from the IAB Establishment Panel encompassing the years 1999–2016, we answered both questions in the affirmative.

At the descriptive level, we found that employer monopsony is far more prevalent than worker monopoly (70% vs. 30% of plant-year observations), so that the vast majority of German employers pay below competitive wages. In regressions, we found that employer monopsony is less frequent when collective bargaining or, even more so, a works council is present. These findings at the extensive margin are complemented by results at the intensive margin where we observe that employer monopsony (worker monopoly) power is less (more) pronounced when a works council or collective bargaining exists. We also saw that their existence is associated with a lower probability of switching from worker monopoly to employer monopsony, suggesting that organised labour protects workers from employer monopsony and lending further credence to a causal link running from industrial relations to labour market imperfections. Finally, we found that employer wage premia are lower and more dispersed under employer monopsony and for larger monopsony power as workers with low-premium employers suffer most from monopsony. In contrast, we saw that more worker monopoly power is accompanied by higher wage premia but leaves their dispersion unaltered as it benefits workers uniformly across the premium distribution.

In short, our results document that labour market imperfections in Germany predominantly give rise to employer monopsony and they strongly suggest that labour market imperfections are shaped by industrial relations, with collective bargaining and worker co-determination protecting workers from employer monopsony and shifting market power from employers to workers. Hence, they point at organised labour's erosion as one possible contributor to the falling labour share and rising wage inequality. While our regression results, in particular those for switches in labour market settings, go some way in substantiating causal links running from industrial relations to labour market imperfections and from labour market imperfections to employer wage premia, our data did not permit us to further. Establishing causality in a rigorous way using exogenous variation in industrial relations remains a promising avenue for future research.

Tables

Table 1: Descriptive statistics

	Mean	SD	p25	p50	p75
Real plant output growth rate (Δq_{it})	0.002	0.226	–0.086	0.000	0.092
Labour growth rate (Δn_{it})	0.014	0.154	–0.027	0.000	0.074
Intermediate inputs growth rate (Δm_{it})	0.004	0.422	–0.169	0.000	0.171
Capital growth rate (Δk_{it})	0.006	0.127	–0.054	–0.028	0.026
Revenue share of intermediate inputs (α_{Mit})	0.471	0.196	0.322	0.474	0.620
Revenue share of labour (α_{Nit})	0.273	0.169	0.140	0.246	0.371
$1 - \alpha_{Nit} - \alpha_{Mit}$	0.209	0.213	0.066	0.189	0.351
$\ln(\text{wagebill}_{it})$	5.709	1.228	4.852	5.542	6.408
$\ln(\text{employment}_{it})$	2.621	0.906	1.946	2.398	3.045
$\ln(\text{capital}_{it})$	13.105	1.533	12.121	13.009	13.988
$\ln(\text{material}_{it})$	13.278	1.606	12.175	13.135	14.296
$\ln(\text{output}_{it})$	14.100	1.334	13.122	13.873	14.913
Capital intensity $(\ln(\frac{K}{N})_{it})$	10.464	1.129	9.764	10.522	11.206
Value added per worker $(\ln(\frac{Q-M}{N})_{it})$	10.609	0.820	10.155	10.615	11.078
Solow residual (SR_{it})	–0.026	0.201	–0.094	–0.005	0.067
Works council (dummy)	0.093	0.291	0.000	0.000	0.000
Collective bargaining (dummy)	0.365	0.482	0.000	0.000	1.000
Single-plant company (dummy)	0.851	0.356	1.000	1.000	1.000
Plant age $\leqslant$ 4 years (dummy)	0.051	0.220	0.000	0.000	0.000
Plant age 5–9 years (dummy)	0.121	0.327	0.000	0.000	0.000
Plant age 10–14 years (dummy)	0.102	0.303	0.000	0.000	0.000
Plant age 15–19 years (dummy)	0.075	0.264	0.000	0.000	0.000
Plant age $\geqslant$ 20 years (dummy)	0.651	0.477	0.000	1.000	1.000
Share of skilled workers	0.646	0.250	0.500	0.714	0.833
Share of apprentices	0.048	0.078	0.000	0.000	0.083
Share of part-time workers	0.267	0.249	0.067	0.192	0.400
Share of female workers	0.423	0.289	0.167	0.357	0.673
Exporting activity (dummy)	0.237	0.425	0.000	0.000	0.000
West Germany (dummy)	0.790	0.407	1.000	1.000	1.000
Observations			40,146		
Plants			8,936		

Notes: IAB Establishment Panel, 1999–2016, weighted using sample weights. The Solow residual is defined as $SR_{it} = \Delta q_{it} - \alpha_{Nit}\Delta n_{it} - \alpha_{Mit}\Delta m_{it} - (1 - \alpha_{Nit} - \alpha_{Mit})\Delta k_{it}$.

Table 2: Estimated output elasticities and returns to scale by two-digit sector (means)

Sector (NACE Rev.2)		Output elasticity of... labour	inter-mediate inputs	capi-tal	Returns to scale	Obs.	Plants
Food products	(10)	0.459	0.498	0.119	1.077	1,827	437
Beverages	(11)	0.392	0.599	0.192	1.182	258	45
Textiles	(13)	0.055	0.591	0.267	0.913	468	108
Wearing apparel, leather	(14–15)	0.306	0.825	0.084	1.215	187	43
Wood and wood products	(16)	0.287	0.714	0.076	1.076	883	179
Paper and paper products	(17)	0.386	0.570	0.013	0.969	371	75
Printing and recorded media	(18)	0.543	0.268	0.286	1.097	620	125
Chemicals and petroleum products	(19–20)	0.241	0.688	0.086	1.016	1,180	235
Basic pharmaceutical products	(21)	0.388	0.689	0.041	1.119	146	34
Rubber and plastic products	(22)	0.267	0.708	0.049	1.024	1,362	271
Non-metallic mineral products	(23)	0.391	0.579	0.106	1.076	1,396	277
Basic metals	(24)	0.526	0.469	0.060	1.054	1,404	267
Fabricated metal products	(25)	0.527	0.481	0.088	1.096	3,428	664
Computer and electronic products	(26)	0.568	0.631	0.174	1.373	1,006	244
Electrical equipment	(27)	0.316	0.574	0.106	0.996	1,039	216
Machinery and equipment	(28)	0.350	0.553	0.043	0.946	3,102	635
Motor vehicles and trailers	(29)	0.412	0.624	0.037	1.073	1,187	259
Other transport equipment	(30)	0.260	0.686	0.070	1.015	275	76
Furniture	(31)	0.519	0.504	0.025	1.048	653	128
Other manufacturing	(32)	0.579	0.471	0.063	1.114	1,022	209
Repair, installation of machinery	(33)	0.417	0.562	0.090	1.069	596	146
Wholesale trade (w/ vehicles)	(45)	0.231	0.636	0.129	0.996	1,992	432
Wholesale trade (w/o vehicles)	(46)	0.343	0.757	0.031	1.131	3,091	670
Retail trade (w/o vehicles)	(47)	0.382	0.672	0.026	1.079	4,050	922
Transport and warehousing	(49–53)	0.377	0.620	0.194	1.190	2,302	581
Publishing activities	(58–63)	0.402	0.413	0.201	1.016	1,027	289
Legal and accounting activities	(69)	0.834	0.259	0.099	1.191	1,272	283
Consultancy activities	(70)	0.502	0.569	0.191	1.261	295	85
Engineering activities	(71)	0.571	0.292	0.345	1.208	1,149	274
Scientific research	(72)	0.506	0.443	0.103	1.052	378	97
Advertising, market research	(73)	0.430	0.532	–0.049	0.912	204	56
Other professional activities	(74–75)	0.612	0.386	0.153	1.151	176	42
Rental and leasing activities	(77)	0.271	0.653	0.021	0.945	100	28
Employment activities	(78)	0.761	0.179	0.235	1.175	381	147
Travel agencies	(79)	0.379	0.593	0.109	1.081	131	37
Security activities	(80)	1.018	0.369	–0.152	1.235	98	30
Services to buildings and landscape	(81)	0.572	0.442	0.148	1.161	819	221
Office administration and support	(82)	0.058	0.698	0.028	0.784	271	69
All		0.441	0.555	0.103	1.098	40,146	8,936

Notes: IAB Establishment Panel, 1999–2016, weighted using sample weights.

Table 3: The prevalence of labour market imperfections (percentages)

Labour market setting	All plants	Collective bargaining		Works council	
		Yes	No	Yes	No
Employer monopsony ($\widehat{\psi}_{it} < 0$)	70.1	70.4	69.6	70.9	61.8
Worker monopoly ($\widehat{\psi}_{it} \geqslant 0$)	29.9	29.6	30.4	38.2	29.1

Notes: IAB Establishment Panel, 1999–2016, percentages of 40,146 plant-year observations, weighted using sample weights. Based on the estimates of the joint market imperfections parameter (equation 14).

Table 4: The intensity of labour market imperfections (medians)

Intensity of labour market imperfections	All plants	Collective bargaining		Works council	
		Yes	No	Yes	No
Given employer monopsony ($\widehat{\psi}_{it} < 0$) ...					
Plant-level labour supply elasticity ($(\widehat{\varepsilon}^{N}_{W})_{it}$)	1.10	1.15	1.07	1.48	1.07
Given worker monopoly ($\widehat{\psi}_{it} \geqslant 0$) ...					
Workers' relative bargaining power under efficient bargaining ($\widehat{\gamma}^{EB}_{it}$)	0.49	0.43	0.53	0.49	0.50
Workers' relative bargaining power under right-to-manage bargaining ($\widehat{\gamma}^{RTM}_{it}$)	0.53	0.48	0.54	0.50	0.50

Notes: IAB Establishment Panel, 1999–2016, 40,146 plant-year observations, weighted using sample weights. Based on the estimates of the joint market imperfections parameter (equation 14). Structural parameters of employer monopsony and worker monopoly power are recovered using equations (15) and (16) and the conversion formula of workers' relative bargaining power under efficient and right-to-manage bargaining (equation 17).

Table 5: Average marginal effects on the probability of employer monopsony from probit regressions

	(1)	(2)	(3)	(4)
Collective bargaining	–0.003	–0.010	–0.014*	–0.018**
	(0.009)	(0.009)	(0.008)	(0.008)
Works council	–0.022**	–0.076***	–0.058***	–0.056***
	(0.010)	(0.012)	(0.012)	(0.012)
Log employment		0.034***	0.035***	0.039***
		(0.004)	(0.004)	(0.004)
Plant age 5–9 years		0.010	0.008	0.008
		(0.014)	(0.014)	(0.014)
Plant age 10–14 years		0.007	0.005	0.005
		(0.015)	(0.015)	(0.015)
Plant age 15–19 years		0.011	0.011	0.010
		(0.016)	(0.016)	(0.016)
Plant age $\geqslant$ 20 years		0.016	0.015	0.014
		(0.014)	(0.014)	(0.013)
Share of skilled workers			–0.062***	–0.062***
			(0.017)	(0.017)
Share of apprentices			0.690***	0.675***
			(0.062)	(0.062)
Share of part-time workers			0.251***	0.238***
			(0.027)	(0.027)
Share of female workers			0.081***	0.085***
			(0.023)	(0.023)
Exporting activity				–0.041***
				(0.009)
Log likelihood	–20,428.65	–20,289.04	–19,808.96	–19,774.93
Number of observations			40,146	

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is a dummy variable for employer monopsony, i.e. a negative sign of the joint market imperfections parameter. Reported numbers are average marginal effects on the probability of employer monopsony with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Further covariates included in all specifications are region, year, and two-digit sector dummies as well as a dummy for a single-plant company.

Table 6: OLS regressions for the intensity of labour market imperfections

	Log of...		
	plant-level labour supply elasticity ($(\varepsilon_W^N)_{it}$)	workers' relative bargaining power under efficient bargaining (γ_{it}^{EB})	workers' relative bargaining power under right-to-manage bargaining (γ_{it}^{RTM})
Collective bargaining	0.083***	0.076	0.095**
	(0.027)	(0.047)	(0.047)
Works council	0.147***	0.139**	0.164***
	(0.037)	(0.056)	(0.056)
Log employment	–0.168***	–0.077***	–0.068***
	(0.015)	(0.022)	(0.023)
Plant age 5–9 years	0.056	–0.073	–0.076
	(0.046)	(0.083)	(0.083)
Plant age 10–14 years	0.104**	–0.079	–0.084
	(0.049)	(0.089)	(0.089)
Plant age 15–19 years	0.112**	–0.104	–0.102
	(0.051)	(0.094)	(0.094)
Plant age $\geqslant$ 20 years	0.128***	–0.043	–0.041
	(0.044)	(0.081)	(0.081)
Share of skilled workers	0.522***	0.376***	0.395***
	(0.053)	(0.084)	(0.085)
Share of apprentices	–1.088***	–1.629***	–1.645***
	(0.167)	(0.336)	(0.336)
Share of part-time workers	–1.034***	–0.287**	–0.294**
	(0.070)	(0.142)	(0.142)
Share of female workers	–0.256***	–0.181	–0.219*
	(0.069)	(0.127)	(0.127)
Exporting activity	0.109***	0.017	0.029
	(0.028)	(0.045)	(0.046)
R^2	0.291	0.124	0.123
Number of observations	26,895	13,251	13,251

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is the logarithm of the respective labour market imperfection measure. Reported numbers are coefficients from an OLS regression with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Further covariates included in all specifications are region, year, and two-digit sector dummies as well as a dummy for a single-plant company.

Table 7: Transition matrices for plants' labour market setting

Panel A: All plants

Labour market setting in t	Labour market setting in $t+1$	
	Employer monopsony	Worker monopoly
Employer monopsony ($\widehat{\psi}_{it} < 0$)	90.5	9.5
Worker monopoly ($\widehat{\psi}_{it} \geqslant 0$)	23.7	76.3

Panel B: Plants covered (uncovered) by collective agreements

Labour market setting in t	Labour market setting in $t+1$	
	Employer monopsony	Worker monopoly
Employer monopsony ($\widehat{\psi}_{it} < 0$)	90.9 (90.3)	9.1 (9.7)
Worker monopoly ($\widehat{\psi}_{it} \geqslant 0$)	22.4 (24.4)	77.6 (75.6)

Panel C: Plants with (without) a works council

Labour market setting in t	Labour market setting in $t+1$	
	Employer monopsony	Worker monopoly
Employer monopsony ($\widehat{\psi}_{it} < 0$)	89.6 (90.6)	10.4 (9.4)
Worker monopoly ($\widehat{\psi}_{it} \geqslant 0$)	19.3 (24.3)	80.7 (75.8)

Notes: IAB Establishment Panel, 1999–2016, percentages of 31,210 plant-year observations, weighted using sample weights in t. Based on the estimates of the joint market imperfections parameter (equation 14).

Table 8: Average marginal effects from probit regressions for a switch in the plant's labour market setting

	(1) Worker monopoly to employer monopsony	(2) Employer monopsony to worker monopoly
Collective bargaining	–0.017	0.009
	(0.011)	(0.006)
Works council	–0.051***	0.010
	(0.013)	(0.008)
Log employment	0.001	–0.022***
	(0.005)	(0.003)
Plant age 5–9 years	–0.025	–0.016
	(0.022)	(0.013)
Plant age 10–14 years	0.006	–0.012
	(0.023)	(0.013)
Plant age 15–19 years	–0.019	–0.016
	(0.023)	(0.013)
Plant age $\geqslant$ 20 years	–0.023	–0.023*
	(0.020)	(0.012)
Share of skilled workers	–0.027	0.058***
	(0.021)	(0.012)
Share of apprentices	0.346***	–0.178***
	(0.081)	(0.038)
Share of part-time workers	0.057	–0.125***
	(0.036)	(0.018)
Share of female workers	0.095***	–0.037**
	(0.029)	(0.015)
Exporting activity	–0.036***	0.003
	(0.011)	(0.006)
Log likelihood	–4697.4	–5973.8
Number of observations	10,251	20,959

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is a dummy variable that indicates a switch in the labour market setting in the respective direction for two consecutive observations of the same plant. Reported numbers are average marginal effects with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Further covariates included in all specifications are region, year, and two-digit sector dummies as well as a dummy for a single-plant company.

Table 9: Level and dispersion of employer wage premia and the presence and intensity of labour market imperfections (wage premium OLS and RIF regressions)

	(1) Mean	(2) Variance	(3) First decile	(4) Ninth decile
Employer monopsony (dummy)	–0.160***	0.083***	–0.164***	–0.082***
	(0.014)	(0.029)	(0.018)	(0.013)
Log of plant-level labour supply elasticity	0.066***	–0.082***	0.091***	0.011*
$((\varepsilon_W^N)_{it})$	(0.006)	(0.013)	(0.008)	(0.006)
Log of workers' relative bargaining power	0.036***	0.018	0.045***	0.038***
under efficient bargaining (γ_{it}^{EB})	(0.006)	(0.013)	(0.011)	(0.006)
Log of workers' relative bargaining power	0.052***	0.006	0.066***	0.048***
under right-to-manage bargaining (γ_{it}^{RTM})	(0.017)	(0.013)	(0.011)	(0.006)

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is the standardised AKM plant wage effect. Reported numbers are coefficients from separate OLS and RIF regressions with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Controls included are log employment, the shares of skilled workers, apprentices, part-time workers, and female workers, four plant-age dummies, a dummy for exporting activity, region, year, and two-digit sector dummies as well as a dummy for a single-plant company. Detailed results are reported in Appendix Tables D.1–D.4.

A Theoretical derivations

Plant i's short-run profits at time t are given by

$$\Pi_{it} = R_{it} - W_{it}N_{it} - J_{it}M_{it} \tag{A.1}$$

where $R_{it} = P_{it}Q_{it}$ denotes the plant's revenues, P_{it} the price of the good, and W_{it} and J_{it} the input prices of labour and intermediate inputs, respectively. Then, the plant's optimisation problem involves maximising short-run profits (A.1) with respect to output Q_{it}, labour N_{it}, and intermediate inputs M_{it}.

A.1 Product market imperfections

Turning to the plant's product market first, the first-order condition with respect to Q_{it} yields the plant's price-cost mark-up:

$$\mu_{it} = \frac{P_{it}}{(C_Q)_{it}} = \left(1 + \frac{s_{it}\kappa_{it}}{e_t}\right)^{-1} \tag{A.2}$$

where $(C_Q)_{it} = \partial C_{it}/\partial Q_{it}$ denotes the marginal cost of production, C_{it} the cost function, $s_{it} = Q_{it}/Q_t$ the market share of plant i in industry demand Q_t, $e_t = (\partial Q_t/\partial P_t)(P_t/Q_t)$ the own-price elasticity of industry demand, and $\kappa_{it} = \partial Q_t/\partial Q_{it}$ a conjectural variations parameter that captures competitors' quantity response to plant i's output choice.[19]

Turning to plant i's choice of intermediate inputs next, the first-order condition with respect to M_{it} yields $(Q_M)_{it} = \mu_{it}J_{it}/P_{it}$ where $(Q_M)_{it} = \partial Q_{it}/\partial M_{it}$ denotes the marginal product of intermediate inputs. Multiplying this expression by M_{it}/Q_{it} yields

$$(\varepsilon_M^Q)_{it} = \mu_{it}\alpha_{Mit} \tag{A.3}$$

[19] Specifically, under Cournot competition with plants producing a homogenous good and competing in quantities, $\kappa_{it} = \partial Q_t/\partial Q_{it} = 1$ with a single industry-wide output price in equilibrium $P_{it} = P_t$. Hence, in this case the price-cost mark-up is $\mu_{it} = P_t/(C_Q)_{it} = (1 + s_{it}/e_t)^{-1}$. Under Betrand competition with plants producing a horizontally differentiated good and competing in prices instead of quantities, $\partial P_t/\partial P_{it} = 1$ and thus $\kappa_{it} = \partial Q_t/\partial Q_{it} = e_t/(s_{it}e_{it})$ with $e_{it} = (\partial Q_{it}/\partial P_{it})(P_{it}/Q_{it})$ denoting plant i's own-price elasticity of residual demand. Hence, in this case the price-cost mark-up is $\mu_{it} = P_{it}/(C_Q)_{it} = (1 + s_{it}/e_{it})^{-1}$.

with the output elasticity of intermediate inputs $(\varepsilon_M^Q)_{it} = (\partial Q_{it}/\partial M_{it})(M_{it}/Q_{it})$ and their revenue share $\alpha_{Mit} = J_{it}M_{it}/R_{it}$. Hence, in the optimum the output elasticity of intermediate inputs equals the share of their expenditures in output evaluated at the marginal cost of production. Using equation (A.3), the price-cost mark-up is given as:

$$\mu_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} \tag{A.4}$$

A.2 Competitive labour market

Unlike the price of intermediate inputs that the plant takes as given, wage formation depends on possible labour market imperfections. If there is perfect competition in the labour market, the first-order condition with respect to N_{it} is analogous to intermediate inputs $(Q_N)_{it} = \mu_{it}W_{it}/P_{it}$ where $(Q_N)_{it} = \partial Q_{it}/\partial N_{it}$ denotes the marginal product of labour. Multiplying this expression by N_{it}/Q_{it} yields

$$(\varepsilon_N^Q)_{it} = \mu_{it}\alpha_{Nit} \tag{A.5}$$

with the output elasticity of labour $(\varepsilon_N^Q)_{it} = (\partial Q_{it}/\partial N_{it})(N_{it}/Q_{it})$ and its revenue share $\alpha_{Nit} = W_{it}N_{it}/R_{it}$. As with intermediate inputs, this condition means that in the optimum the output elasticity of labour equals the share of the plant's payroll in its output evaluated at the marginal cost of production.

Absent labour market imperfections, comparing equations (A.3) and (A.5) shows that there exists no wedge

$$\psi_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} - \frac{(\varepsilon_N^Q)_{it}}{\alpha_{Nit}} = 0 \tag{A.6}$$

between the output elasticities of intermediate inputs and labour and their respective revenue shares, where we refer to ψ_{it} as the joint market imperfections parameter.

A.3 Employer monopsony

Things look different when labour market imperfections are present. We first consider employer monopsony. In this case, plants' wage-setting power stems from the fact that the labour supply curve faced by a single employer is upward-sloping rather than horizontal as it would be under perfect competition. Let the labour supply faced by the plant paying W_{it} be $N_{it}^S(W_{it})$ and its inverse $W_{it}^S(N_{it})$. Plugging the latter into the plant's profits (A.1), maximising these with respect to N_{it} yields the first-order condition

$$(R_N)_{it} = (W_N^S)_{it} N_{it} + W_{it}^S(N_{it}) \tag{A.7}$$

where $(R_N)_{it} = \partial R_{it}/\partial N_{it}$ denotes the marginal revenue product of labour and $(W_N^S)_{it} = \partial W_{it}^S/\partial N_{it}$ is the slope of the labour supply curve to the plant.

Rewriting equation (A.7) gives

$$W_{it} = \frac{(\varepsilon_W^N)_{it}}{(\varepsilon_W^N)_{it} + 1}(R_N)_{it} \tag{A.8}$$

where $(\varepsilon_W^N)_{it} = (\partial N_{it}^S/\partial W_{it})(W_{it}/N_{it}^S)$ is the wage elasticity of plant-level labour supply. The latter informs us on how wage-driven workers are and thus on the plant's monopsony power. Under perfect competition, the plant-level labour supply curve is horizontal with $(\varepsilon_W^N)_{it} = \infty$ and workers obtain the marginal revenue product of labour. Under monopsony, workers respond imperfectly to wages, which provides the plant with wage-setting power that is inversely related to the elasticity of labour supply $(\varepsilon_W^N)_{it}$.

Rewriting equation (A.8) using $(R_N)_{it} = P_{it}(Q_N)_{it}/\mu_{it}$, we arrive at:

$$(\varepsilon_N^Q)_{it} = \mu_{it}\alpha_{Nit}\left[1 + \frac{1}{(\varepsilon_W^N)_{it}}\right] \tag{A.9}$$

Combining equations (A.9) and (A.4) yields the joint market imperfections parameter

$$\psi_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} - \frac{(\varepsilon_N^Q)_{it}}{\alpha_{Nit}} = -\frac{\mu_{it}}{(\varepsilon_W^N)_{it}} < 0 \tag{A.10}$$

that now has a negative sign. In words, the plant's monopsony power allows it to set below competitive wages that, in turn, drives a negative wedge between the output elasticities of intermediate inputs and labour and their respective revenue shares. Based on (A.10), we can further recover the plant-level labour supply elasticity $(\varepsilon_W^N)_{it}$ as the structural parameter that informs us on the intensity of employer monopsony.

A.4 Worker monopoly under efficient bargaining

In contrast, labour market imperfections may also originate from worker monopoly power enabling them to impose above competitive wages on plants. As an underlying structural model, we will consider efficient bargaining (McDonald and Solow, 1981) between a risk-neutral plant and its risk-neutral workforce. Under efficient bargaining, the negotiated wage-employment pair maximises both parties' joint surplus and follows from maximising the generalised Nash product

$$\Omega^{EB} = [N_{it}(W_{it} - \overline{W}_{it})]^{\phi_{it}^{EB}} [R_{it} - W_{it}N_{it} - J_{it}M_{it}]^{1-\phi_{it}^{EB}} \tag{A.11}$$

with respect to W_{it} and N_{it} where $\overline{W}_{it}$ denotes the alternative wage and $0 < \phi_{it}^{EB} < 1$ the part of the surplus accruing to workers, which measures workers' bargaining power. In the generalised Nash product (A.11), workers' net gain is the amount by which their payroll exceeds the alternative wage while the plant's net gain is its short-run profits.[20]

The first-order condition with respect to W_{it} or N_{it}, respectively, gives:

$$W_{it} = \overline{W}_{it} + \gamma_{it}^{EB} \left[\frac{R_{it} - W_{it}N_{it} - J_{it}M_{it}}{N_{it}} \right] \tag{A.12}$$

$$W_{it} = (R_N)_{it} + \phi_{it}^{EB} \left[\frac{R_{it} - (R_N)_{it}N_{it} - J_{it}M_{it}}{N_{it}} \right] \tag{A.13}$$

with workers' relative bargaining power $\gamma_{it}^{EB} = \phi_{it}^{EB}/(1 - \phi_{it}^{EB})$. Combining the first-order

[20] This formulation of efficient bargaining assumes that all employed union members immediately return to the external labour market when negotiations fail. Yet, results do not change when considering a sequence of bargaining sessions between the plant and a union of declining size whose members gradually lose jobs when disagreement continues (Dobbelaere and Luttens, 2016).

conditions (A.12) and (A.13) yields the so-called contract curve

$$(R_N)_{it} = \overline{W}_{it} \tag{A.14}$$

that characterises efficient wage-employment pairs.

In equilibrium, the price-cost mark-up satisfies $\mu_{it} = P_{it}/(C_Q)_{it} = P_{it}/(R_Q)_{it}$ with the marginal revenue $(R_Q)_{it} = \partial R_{it}/\partial Q_{it}$. Plugging equation (A.14) into equation (A.12), we thus arrive at:

$$(\varepsilon_N^Q)_{it} = \mu_{it}\alpha_{Nit} - \mu_{it}\gamma_{it}^{EB}(1 - \alpha_{Nit} - \alpha_{Mit}) \tag{A.15}$$

Combining equations (A.15) and (A.4) yields the joint market imperfections parameter

$$\psi_{it} = \frac{(\varepsilon_M^Q)_{it}}{\alpha_{Mit}} - \frac{(\varepsilon_N^Q)_{it}}{\alpha_{Nit}} = \mu_{it}\gamma_{it}^{EB}\left[\frac{1 - \alpha_{Nit} - \alpha_{Mit}}{\alpha_{Nit}}\right] > 0 \tag{A.16}$$

that now has a positive sign. In words, worker monopoly power allows workers to capture part of the rents by imposing above competitive wages on the plant that, in turn, drives a positive wedge between the output elasticities of intermediate inputs and labour and their respective revenue shares. Based on (A.16), we can further recover workers' relative bargaining power γ_{it}^{EB} as the structural parameter that informs us on the intensity of worker monopoly.

A.5 Worker monopoly under right-to-manage bargaining

As an alternative to efficient bargaining, consider right-to-manage bargaining (Nickell and Andrews, 1983) as the underlying structural model of worker monopoly. Under right-to-manage bargaining, the plant and its workers bargain over the wage only and the plant is then free to choose employment at this bargained wage, thereby yielding a solution on the plant's labour demand curve. Hence, the negotiated wage follows from maximising the

generalised Nash product

$$\Omega^{RTM} = [N_{it}(W_{it} - \overline{W}_{it})]^{\phi_{it}^{RTM}} [R_{it} - W_{it}N_{it} - J_{it}M_{it}]^{1-\phi_{it}^{RTM}} \tag{A.17}$$

with respect to W_{it} where employment follows from the plant's labour demand function $N_{it} = N_{it}^D(W_{it})$. Substituting the plant's labour demand function into (A.17), the first-order condition with respect to W_{it} yields

$$W_{it} = \overline{W}_{it} + \gamma_{it}^{RTM} \left[\frac{(N_W^D)_{it}(W_{it} - \overline{W}_{it}) + N_{it}}{N_{it}} \right] \left[\frac{R_{it} - W_{it}N_{it} - J_{it}M_{it}}{N_{it}} \right] \tag{A.18}$$

where $(N_W^D)_{it} = \partial N_{it}^D / \partial W_{it}$ is the slope of the plant's labour demand curve.

Now consider the first-order conditions with respect to W_{it} under efficient and right-to-manage bargaining (A.12) and (A.18) and solve both for workers' relative bargaining power to get:

$$\gamma_{it}^{EB} = \left(\frac{W_{it} - \overline{W}_{it}}{W_{it}} \right) \left[\frac{\alpha_{Nit}}{1 - \alpha_{Nit} - \alpha_{Mit}} \right] \tag{A.19}$$

$$\gamma_{it}^{RTM} = \left(\frac{W_{it} - \overline{W}_{it}}{W_{it}} \right) \left[\frac{\alpha_{Nit}}{1 - \alpha_{Nit} - \alpha_{Mit}} \right] \frac{1}{(\eta_W^N)_{it} \left(\frac{W_{it} - \overline{W}_{it}}{W_{it}} \right) + 1} \tag{A.20}$$

with the wage elasticity of the plant's labour demand $(\eta_W^N)_{it} = (\partial N_{it}^D / \partial W_{it})(W_{it}/N_{it}^D)$. Plugging (A.19) into (A.20), we obtain that for a given value of γ_{it}^{EB} the same plant's bargaining power under right-to-manage bargaining would be:

$$\gamma_{it}^{RTM} = \frac{1}{(\eta_W^N)_{it} \left(\frac{W_{it} - \overline{W}_{it}}{W_{it}} \right) + 1} \gamma_{it}^{EB} \tag{A.21}$$

Hence, the conversion rate between γ_{it}^{RTM} and γ_{it}^{EB} depends negatively on the (negative) labour demand elasticity, which captures the employment response to rising wages.

B Estimating plants' production function

Our estimation approach to plants' production function (7) follows Ackerberg *et al.* (2015) and rests on the following timing assumptions. We assume that plants decide on their capital input k_{it} one period ahead at time $t-1$, which reflects planning and installation lags and causes capital to be predetermined. Among the variable factors of production, we assume that labour n_{it} is less variable than intermediate inputs m_{it} in that it is determined by plants at time $t-b$ with $0 < b < 1$. Hence, plants choose labour after capital but prior to intermediate inputs, where the latter is in line with plants requiring time to train new workers, with significant firing or hiring costs, or with long-lasting labour contracts in internal labour markets or unionised plants.

With respect to unobservable productivity, we assume that ω_{it} evolves according to an endogenous first-order Markov process. In particular, we assume that the plant's decision to engage in exporting activity might endogenously affect future productivity, which is at the heart of the Melitz (2003) model and amply supported by existing evidence (e.g. Helpman, 2006; Bernard *et al.*, 2007, 2012). Consequently, we can decompose ω_{it} into its expectation conditional on the information I_{it-1} available to the plant in $t-1$ and a random innovation to productivity denoted by ξ_{it}:

$$\begin{aligned} \omega_{it} &= \mathrm{E}[\omega_{it}|I_{it-1}] + \xi_{it} \\ &= \mathrm{E}[\omega_{it}|\omega_{it-1}, EXP_{it-1}] + \xi_{it} \\ &= g(\omega_{it-1}, EXP_{it-1}) + \xi_{it} \end{aligned} \tag{B.1}$$

In (B.1), EXP_{it-1} denotes plant i's export status in $t-1$, $g(\cdot)$ denotes some function, and ξ_{it} is assumed to be mean independent of the plant's information set I_{it-1} in $t-1$.

Given these timing assumptions, plant i's demand for intermediate inputs in t directly depends on n_{it} as well as on the other state variables k_{it}, EXP_{it}, and ω_{it}:

$$m_{it} = m_t(n_{it}, k_{it}, EXP_{it}, \omega_{it}) \tag{B.2}$$

Crucially, productivity ω_{it} is the only unobservable entering the demand function $m_t(\cdot)$.[21] Provided strict monotonicity of the demand function with respect to ω_{it}, we can invert $m_t(\cdot)$ to infer ω_{it} from observables as:[22]

$$\omega_{it} = m_t^{-1}(m_{it}, n_{it}, k_{it}, EXP_{it}) \tag{B.3}$$

Enriching our empirical model by an idiosyncratic error term ϵ_{it} that comprises unpredictable output shocks as well as potential measurement error in output and inputs gives

$$y_{it} = f(n_{it}, m_{it}, k_{it}; \boldsymbol{\beta}) + \omega_{it} + \epsilon_{it} \tag{B.4}$$

with $y_{it} = q_{it} + \epsilon_{it} = f_{it} + \omega_{it} + \epsilon_{it}$ where we assume ϵ_{it} to be mean independent of current and past input choices.[23] In our empirical specification, we approximate the unknown regression function $f(\cdot)$ by means of a second-order Taylor polynomial and estimate the coefficients of a translog production function at the two-digit sector level (including a full set of region dummies and a linear time trend, which we will omit in the following for notational ease):

$$\begin{aligned} y_{it} = {} & \beta_0 + \beta_n n_{it} + \beta_m m_{it} + \beta_k k_{it} + \beta_{nn} n_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{kk} k_{it}^2 \\ & + \beta_{nm} n_{it} m_{it} + \beta_{nk} n_{it} k_{it} + \beta_{mk} m_{it} k_{it} + \omega_{it} + \epsilon_{it} \end{aligned} \tag{B.5}$$

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[21] Adding the plant's export status EXP_{it} as an observed shifter to the plant's demand for intermediate inputs m_{it} while excluding it from the production function addresses a fundamental identification problem for the output elasticity of intermediate inputs and thus permits us to use Ackerberg *et al.*'s (2015) control function approach in the estimation of a gross output production function. To provide intuition for this problem, note that absent such a shifter the plant's demand for intermediate inputs would be $m_{it} = m_t(n_{it}, k_{it}, \omega_{it})$. In this case, unobserved productivity ω_{it} would be the only demand shifter except for the other inputs in the production function n_{it} and k_{it}. Since the output elasticity of intermediate inputs is identified from the co-movement of output and intermediate inputs holding constant the other inputs n_{it} and k_{it}, the only source of variation in the demand for intermediate inputs left would be unobserved productivity ω_{it}. Unobserved productivity ω_{it}, though, shifts both output and the demand of intermediate inputs, rendering the output elasticity of intermediate inputs unidentified in this case.

[22] Levinsohn and Melitz (2006) show that strict monotonicity of $m_t(\cdot)$ with respect to ω_{it} holds as long as more productive plants do not set excessively higher price-cost mark-ups.

[23] Note that the output elasticities of labour and intermediate inputs are given by $(\varepsilon_N^Q)_{it} = \partial f(\cdot)/\partial n_{it}$ and $(\varepsilon_M^Q)_{it} = \partial f(\cdot)/\partial m_{it}$, respectively, and are thus independent of productivity shocks by definition.

Plugging equation (B.3) into (B.4) results in a first-stage regression equation

$$\begin{aligned} y_{it} &= f(n_{it}, m_{it}, k_{it}; \boldsymbol{\beta}) + m_t^{-1}(m_{it}, n_{it}, k_{it}, EXP_{it}) + \epsilon_{it} \\ &= \varphi_t(n_{it}, m_{it}, k_{it}, EXP_{it}) + \epsilon_{it} \end{aligned} \tag{B.6}$$

that we exploit to separate the productivity shock ω_{it} from the idiosyncratic ϵ_{it}, that is to eliminate the part of output y_{it} that is driven by unanticipated shocks, measurement error, or any other random noise. This first stage uses the regression equation (B.6) together with the moment condition $\mathrm{E}[\epsilon_{it}|I_{it}] = 0$ to obtain an estimate $\widehat{\varphi}_{it}$ of the composite term $\varphi_t(n_{it}, m_{it}, k_{it}, EXP_{it}) = f_{it} + \omega_{it}$ or, in other words, an estimate of the plant's output net of idiosyncratic factors $q_{it} = y_{it} - \epsilon_{it}$. For a given coefficient vector $\boldsymbol{\beta}$, we can then estimate ω_{it} (up to a constant) as:

$$\begin{aligned} \widehat{\omega}_{it}(\boldsymbol{\beta}) &= \widehat{m}_t^{-1}(m_{it}, n_{it}, k_{it}, EXP_{it}) \\ &= \widehat{\varphi}_{it} - \beta_n n_{it} - \beta_m m_{it} - \beta_k k_{it} - \beta_{nn} n_{it}^2 - \beta_{mm} m_{it}^2 - \beta_{kk} k_{it}^2 \\ &\quad - \beta_{nm} n_{it} m_{it} - \beta_{nk} n_{it} k_{it} - \beta_{mk} m_{it} k_{it} \end{aligned} \tag{B.7}$$

For the identification of the production function coefficients $\boldsymbol{\beta}$, the second stage then uses the timing assumptions of our framework to set up the moment conditions:

$$\mathrm{E}[\xi_{it}(\boldsymbol{\beta})(n_{it-1}, m_{it-1}, k_{it}, n_{it-1}^2, m_{it-1}^2, k_{it}^2, n_{it-1}m_{it-1}, n_{it-1}k_{it}, m_{it-1}k_{it})'] = \mathbf{0} \tag{B.8}$$

In order to exploit these moment conditions, we have to recover the innovations to plant productivity ξ_{it}. Based on equation (B.7), we arrive at a consistent non-parametric estimate of the conditional expectation $\mathrm{E}[\omega_{it}|\omega_{it-1}, EXP_{it-1}]$ by taking the predicted values of a non-parametric regression of $\widehat{\omega}_{it}(\boldsymbol{\beta})$ on $\widehat{\omega}_{it-1}(\boldsymbol{\beta})$ and EXP_{it-1}. The residuals from this regression, in turn, provide us with consistent estimates of ξ_{it}. Based on these and the moment conditions (B.8), we then estimate $\boldsymbol{\beta}$ by standard GMM and rely on the Delta method for the standard errors (e.g. Wooldridge, 2010).

C Measuring employer wage premia and surplus

To measure employer wage premia and plant surplus, we follow Card *et al.* (2018) and Hirsch and Mueller (2020). Our measure of wage premia builds on an AKM decomposition that splits up a worker's individual wage into a worker-specific and a plant-specific component. Specifically, the log wage of worker m in period t is decomposed as:

$$\ln W_{mt} = \zeta_m + \theta_{i(m,t)} + \mathbf{X}'_{mt}\boldsymbol{\beta} + \upsilon_{mt} \tag{C.1}$$

In (C.1), ζ_m is a permanent log wage component specific to worker m, $\theta_{i(m,t)}$ is a permanent log wage component specific to plant i employing worker m at time t, $\mathbf{X}'_{mt}\boldsymbol{\beta}$ is a time-varying log wage component stemming from time-varying worker characteristics $\mathbf{X}_{mt}$ that are rewarded equally across plants, and υ_{mt} is an idiosyncratic log wage component.

In the AKM framework, ζ_m reflects the worker's permanent human capital, such as education and ability, $\mathbf{X}'_{mt}\boldsymbol{\beta}$ mirrors the worker's time-varying human capital, such as experience, that affects the worker's productivity no matter where the job is held, and $\theta_{i(m,t)}$ is the percentage wage premium paid to every worker of plant i. The crucial assumption for this interpretation of the AKM decomposition to hold is that the idiosyncratic log wage component υ_{mt} is unrelated to the sequence of employers $\{i(m,t)\}_t$, for which Card *et al.* (2013) provide supporting evidence in their AKM wage decomposition for Germany. For a critical assessment of the validity of the AKM framework in the US context, we refer to Lamadon *et al.* (2022).

To measure the plant surplus to be split between employers and workers, we follow Abowd and Lemieux (1993) and use the quasi rent per worker, with the plant's quasi rent Υ_{it} being defined as:

$$\Upsilon_{it} = P_{it}Q_{it} - J_{it}M_{it} - \widetilde{R}_{it}K_{it} - X_{it}N_{it} \tag{C.2}$$

That is, the quasi rent Υ_{it} is revenues $P_{it}Q_{it}$ net of the value of intermediate inputs $J_{it}M_{it}$ and capital inputs $\widetilde{R}_{it}K_{it}$ where $\widetilde{R}_{it}$ denotes the competitive rental rate of capital and net

of the value of labour inputs $X_{it}N_{it}$ priced at workers' outside option X_{it}.[24]

When constructing workers' outside option X_{it} we follow the idea in Abowd and Allain (1996) and calculate workers' outside option as:

$$\ln X_{it} = \overline{\ln W}_{st} + (\bar{\zeta}_{it} - \bar{\zeta}_{st}) - (\bar{\theta}_{st} - \theta_{st}^{p25}) \tag{C.3}$$

In (C.3), $\overline{\ln W}_{st}$ is the average log wage (i.e. plant-level payroll per worker) in the respective two-digit sector s, $\bar{\zeta}_{it}$ is the average AKM worker wage effect in plant i, $\bar{\zeta}_{st}$ is the average AKM worker wage effect, $\bar{\theta}_{st}$ is the average AKM plant wage effect, and θ_{st}^{p25} its 25th percentile in the two-digit sector. The term $\bar{\zeta}_{it} - \bar{\zeta}_{st}$ captures the deviation in worker quality between plant i and the sector average and thus accounts for unobserved quality differences between plants' workforces. Moreover, subtracting the spread between the average AKM plant effect and its 25th percentile $\bar{\theta}_{st} - \theta_{st}^{p25}$ in the respective two-digit sector accounts for the influence of wage premia paid by future employers on workers' current outside option. Specifically, we assume that risk-averse workers expect to receive just a modest pay premium at the 25th percentile when switching employers.

As detailed in Hirsch and Mueller (2020), this way of constructing workers' outside option involves quite some decisions, and some of these may seem somewhat arbitrary. Yet, as also discussed there, in general different choices, such as using the 10th percentile of wage premia rather than the 25th percentile, make only little difference.

[24] Note that we compute the competitive rental rate of capital $\widetilde{R}_{it}$ from the plant's capital stock and in doing so distinguish between prices for debt and equity at the two-digit sector level because the IAB data do not contain such information at the plant level. Specifically, we use the information on the 'cost of equity and capital' for Europe issued by Aswath Damodaran on 5th January 2019 at `http://pages.stern.nyu.edu/~adamodaran` and the 10-year long-term treasury bond rate for Germany to calculate the average rental rate of capital at the two-digit sector. Our average rental rate of capital is 9.9% for the years 1998–2004, 9.0% for 2005–2010, and 6.9% for 2011–2016.

D Full results of employer wage premium regressions

Table D.1: Level and dispersion of employer wage premia and the presence of labour market imperfections (OLS and RIF regressions)

	(1) Mean	(2) Variance	(3) First decile	(4) Ninth decile
Employer monopsony	–0.160***	0.083***	–0.164***	–0.082***
(dummy)	(0.014)	(0.029)	(0.018)	(0.013)
Quasi rent per worker	0.002***	–0.001***	0.001***	0.001***
(in €100,000)	(0.000)	(0.000)	(0.000)	(0.000)
Log employment	0.192***	–0.061***	0.158***	0.159***
	(0.007)	(0.011)	(0.007)	(0.005)
Plant age 5–9 years	–0.049*	0.142**	–0.116**	–0.003
	(0.026)	(0.068)	(0.045)	(0.027)
Plant age 10–14 years	–0.081***	0.242***	–0.183***	0.009
	(0.030)	(0.068)	(0.047)	(0.026)
Plant age 15–19 years	–0.019	0.140**	–0.249***	0.043
	(0.031)	(0.070)	(0.050)	(0.027)
Plant age $\geqslant$ 20 years	0.011	0.038	–0.084**	–0.000
	(0.025)	(0.060)	(0.038)	(0.025)
Share of skilled workers	0.290***	–0.248***	0.520***	0.045**
	(0.031)	(0.056)	(0.041)	(0.024)
Share of apprentices	–0.406***	–0.475**	–0.074	–0.406***
	(0.103)	(0.195)	(0.157)	(0.065)
Share of part-time workers	0.155**	1.132***	–0.222***	0.488***
	(0.059)	(0.081)	(0.069)	(0.034)
Share of female workers	–0.338***	0.022	–0.544***	–0.215***
	(0.045)	(0.072)	(0.055)	(0.028)
Exporting activity	0.084***	–0.064***	0.083***	–0.022
	(0.015)	(0.030)	(0.017)	(0.012)
R^2	0.531	0.040	0.197	0.185
Number of observations	40,146			

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is the standardised AKM plant wage effect. Reported numbers are coefficients from OLS and RIF regressions with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Further covariates included in all specifications are region, year, and two-digit sector dummies as well as a dummy for a single-plant company.

Table D.2: Level and dispersion of employer wage premia and the plant-level labour supply elasticity (OLS and RIF regressions)

	(1) Mean	(2) Variance	(3) First decile	(4) Ninth decile
Log of plant-level labour	0.066***	–0.082***	0.091***	0.011*
supply elasticity ($(\varepsilon_W^N)_{it}$)	(0.006)	(0.013)	(0.008)	(0.006)
Quasi rent per worker	0.002***	-0.002***	0.001***	0.002***
(in €100,000)	(0.000)	(0.000)	(0.000)	(0.000)
Log employment	0.202***	–0.047***	0.154***	0.190***
	(0.008)	(0.014)	(0.008)	(0.007)
Plant age 5–9 years	–0.051	0.074	–0.021	–0.025
	(0.032)	(0.086)	(0.054)	(0.034)
Plant age 10–14 years	–0.079**	0.203**	–0.124**	0.023
	(0.038)	(0.085)	(0.056)	(0.033)
Plant age 15–19 years	–0.034	0.091	–0.209***	0.052
	(0.038)	(0.088)	(0.059)	(0.033)
Plant age $\geqslant$ 20 years	–0.001	–0.034	–0.040	–0.010
	(0.032)	(0.076)	(0.047)	(0.031)
Share of skilled workers	0.247***	–0.240***	0.480***	0.019
	(0.037)	(0.071)	(0.048)	(0.032)
Share of apprentices	–0.413***	–0.278	–0.150	–0.410***
	(0.114)	(0.235)	(0.175)	(0.079)
Share of part-time workers	0.311***	0.961***	0.027	0.536***
	(0.069)	(0.099)	(0.076)	(0.043)
Share of female workers	–0.228***	–0.079	–0.348***	–0.227***
	(0.053)	(0.090)	(0.063)	(0.037)
Exporting activity	0.063***	–0.015	0.033*	–0.028*
	(0.018)	(0.038)	(0.019)	(0.016)
R^2	0.543	0.046	0.204	0.207
Number of observations	26,895			

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is the standardised AKM plant wage effect. Reported numbers are coefficients from OLS and RIF regressions with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Further covariates included in all specifications are region, year, and two-digit sector dummies as well as a dummy for a single-plant company.

Table D.3: Level and dispersion of employer wage premia and workers' relative bargaining power under efficient bargaining (OLS and RIF regressions)

	(1) Mean	(2) Variance	(3) First decile	(4) Ninth decile
Log of workers' relative bargaining power (γ_{it}^{EB})	0.036***	0.018	0.045***	0.038***
	(0.006)	(0.013)	(0.011)	(0.006)
Quasi rent per worker (in €100,000)	0.001***	–0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Log employment	0.186***	–0.045**	0.172***	0.144***
	(0.011)	(0.017)	(0.014)	(0.009)
Plant age 5–9 years	–0.055	0.316***	–0.190**	0.102**
	(0.039)	(0.107)	(0.086)	(0.047)
Plant age 10–14 years	–0.093**	0.359***	–0.400***	0.030
	(0.040)	(0.105)	(0.090)	(0.043)
Plant age 15–19 years	0.013	0.279**	–0.396***	0.061
	(0.044)	(0.110)	(0.096)	(0.046)
Plant age $\geqslant$ 20 years	0.024	0.232**	–0.190***	0.025
	(0.036)	(0.093)	(0.071)	(0.041)
Share of skilled workers	0.237***	–0.181**	0.405***	0.071**
	(0.045)	(0.088)	(0.078)	(0.039)
Share of apprentices	–0.087	–1.825***	0.930***	–0.409***
	(0.185)	(0.346)	(0.345)	(0.126)
Share of part-time workers	–0.002	1.113***	–0.606***	0.520***
	(0.088)	(0.148)	(0.162)	(0.065)
Share of female workers	–0.504***	0.238**	-1.044***	-0.219***
	(0.068)	(0.117)	(0.116)	(0.049)
Exporting activity	0.105***	–0.150***	0.135***	0.005
	(0.025)	(0.045)	(0.036)	(0.021)
R^2	0.552	0.067	0.235	0.170
Number of observations	13,251			

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is the standardised AKM plant wage effect. Reported numbers are coefficients from OLS and RIF regressions with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Further covariates included in all specifications are region, year, and two-digit sector dummies as well as a dummy for a single-plant company.

Table D.4: Level and dispersion of employer wage premia and workers' relative bargaining power under right-to-manage bargaining (OLS and RIF regressions)

	(1) Mean	(2) Variance	(3) First decile	(4) Ninth decile
Log of workers' relative	0.052***	0.006	0.066***	0.048***
bargaining power (γ_{it}^{RTM})	(0.006)	(0.013)	(0.011)	(0.006)
Quasi rent per worker	0.001***	–0.001***	0.001***	0.001***
(in €100,000)	(0.000)	(0.000)	(0.000)	(0.000)
Log employment	0.186***	–0.046**	0.172***	0.144***
	(0.011)	(0.017)	(0.014)	(0.009)
Plant age 5–9 years	–0.054	0.315***	–0.188**	0.103**
	(0.039)	(0.107)	(0.086)	(0.047)
Plant age 10–14 years	–0.091**	0.358***	–0.397***	0.031
	(0.040)	(0.105)	(0.090)	(0.043)
Plant age 15–19 years	0.015	0.278**	–0.393***	0.062
	(0.044)	(0.110)	(0.096)	(0.046)
Plant age ⩾ 20 years	0.024	0.231**	–0.189***	0.025
	(0.036)	(0.093)	(0.071)	(0.041)
Share of skilled workers	0.229***	–0.176*	0.395***	0.066*
	(0.045)	(0.088)	(0.078)	(0.039)
Share of apprentices	–0.059	–1.846***	0.966***	–0.391***
	(0.184)	(0.346)	(0.345)	(0.125)
Share of part-time workers	0.009	1.109***	–0.597***	0.524***
	(0.088)	(0.148)	(0.162)	(0.065)
Share of female workers	–0.498***	0.236*	–1.036***	–0.215***
	(0.067)	(0.117)	(0.116)	(0.049)
Exporting activity	0.104***	–0.149***	0.134***	0.005
	(0.025)	(0.045)	(0.036)	(0.021)
R^2	0.556	0.067	0.236	0.171
Number of observations	13,251			

Notes: IAB Establishment Panel, 1999–2016. The dependent variable is the standardised AKM plant wage effect. Reported numbers are coefficients from OLS and RIF regressions with standard errors clustered at the plant level in parentheses. ***/**/* denotes statistical significance at the 1%/5%/10% level. Further covariates included in all specifications are region, year, and two-digit sector dummies as well as a dummy for a single-plant company.

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