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ABSTRACT

Minimum Wage Non-compliance: The Role of Co-determination*

We analyse in what way co-determination affects non-compliance with the German minimum wage, which was introduced in 2015. The Works Constitution Act (WCA), the law regulating co-determination at the plant level, provides works councils with indirect means to ensure compliance with the statutory minimum wage. Based on this legal situation, our theoretical model predicts that non-compliance is less likely in co-determined firms because works councils enhance the enforcement of the law. The economic correlates of co-determination, such as higher productivity and wages, affect non-compliance in opposite directions. The empirical analysis, using data from the German Socio-economic Panel (SOEP) for the years 2016 and 2019, demonstrates that non-compliance occurs less often for employees in co-determined establishments, while there is no impact on the difference between the minimum wage and the amount, which was actually paid. Therefore, co-determination helps to secure the payment of minimum wages.

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1. Introduction

In 2015, Germany introduced a statutory minimum wage of € 8.50 per hour. Until 2022, it increased to € 12. Due to the fact that Germany has a sizeable low-wage sector (OECD 2022, p. 345), the minimum wage's bite has been substantial, increasing from around 11% of all jobs in 2015 to almost 22%, when it was last raised (Börschlein et al. 2022). Nonetheless, adverse employment consequences are modest and restricted to particular labour market segments (Bossler and Gerner 2020, Dustmann et al. 2022). One reason was the high demand for labour prior to the Covid-19 pandemic. Another cause may have been that many firms did not immediately adjust hourly wages but paid less than the minimum wage (Caliendo et al. 2019). Non-compliance with the legislation, or underpayment of minimum wages, requires the consent of the affected employees or, at least, the absence of attempts to enforce the regulation. From an Industrial Relations vantage point, therefore, non-compliance is less likely to arise in settings in which employees have extensive information about a firm's remuneration and personnel policy, and can thus influence the employer's decisions in these areas. In Germany, co-determination at plant level provides works councils with information, consultation, and co-determination rights, which are particularly pronounced regarding personnel policy and social affairs. Therefore, co-determination could constitute a mechanism to voice the employees' desire for adequate remuneration and deter non-compliance with minimum wage legislation. From a Law and Economics perspective, the firm's choice whether and to what extent it should comply with minimum wage legislation is, in the spirit of Becker (1968), a decision under uncertainty because a violation of the law may be detected and then be punished. In Germany, co-determination increases the expected costs of this non-compliance and, therefore, makes it less likely.

In this paper, we provide a theoretical analysis of the aforementioned conjecture that co-determination makes non-compliance with minimum wage legislation less likely and subject it to empirical scrutiny. First, we outline the minimum wage legislation in Germany and clarify the influence the law on works councils, the Works Constitution Act (WCA), grants them regarding the enforcement of minimum wages. Second, we use a simple theoretical model of a competitive labour market to predict the impact of co-determination on the incidence of non-compliance, i.e. the number of underpaid workers in total employment. We show that if works councils are associated with stricter enforcement of minimum wage legislation, co-determined firms will exhibit a lower incidence. We further demonstrate that if co-determined establishments and those without works councils differ in economic parameters, such as productivity and wages, the impact of co-determination on minimum wage non-compliance becomes ambiguous because they affect the incentives to underpay differently. We can obtain comparable predictions about

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the incidence of non-compliance when analysing a monopsonistic setting. For such a model, the theoretical analysis additionally indicates that the extent of non-compliance, defined as the difference between the minimum wage and the amount actually paid, is more pronounced in co-determined firms. Third, we use data from the German Socio-Economic Panel (SOEP), which contains information about works councils in 2016 and 2019, to investigate the association between non-compliance and co-determination in the private sector. We find that the probability of non-compliance for an employee in a co-determined establishment is between 2.2 and 4.1 percentage points lower in comparison to a comparable employee who works in an establishment without a works council. This is a sizeable effect, given that we observe underpayments for 6.3% to 10.8% of all employees. Accordingly, our empirical findings are consistent with the theoretical prediction related to enforcement activities. They further indicate that works councils fulfil regulatory tasks for which government institutions are responsible, according to the letter and spirit of the law (cf. Rogers and Streeck 1995, Nienhüser 2020). Moreover, we find no evidence that the extent of non-compliance, conditional on its occurrence, is associated with co-determination.

Our contribution is related to (1) theoretical analyses of minimum wage underpayments, (2) empirical investigations of such behaviour, and (3) studies analysing the effects of works councils. Many theoretical analyses consider minimum wage underpayments in competitive settings (see, for example, Ashenfelter and Smith (1979), Chang and Ehrlich (1985), Chang (1992), Yaniv (2001), Bhorat et al. (2015), or Garneiro and Lucifora (2022)). Yaniv (1988) marks an initial exploration of underpayments in a monopsonistic framework, assuming that labour supply is increasing in the wage. Later contributions develop the workers' optimal behaviour in Salop (1979) type settings from first principles (see, for example, Basu et al. (2010) and Badaoui and Walsh (2022)). Insofar, as the studies consider changes in enforcement parameters, they predict a positive impact of the probability of detecting minimum wage underpayments and of associated fines on compliance with the law.

Empirical analyses of the statutory minimum wage in Germany have often been commissioned by the Minimum Wage Commission (*Mindestlohnkommission*). They cover various aspects, such as its impact on the structure of wages, employment and unemployment, working time, firms' investment behaviour, poverty risk, and consumption and savings patterns.[1] Some investigations also look at non-compliance with minimum wage legislation and document that a significant proportion of employees receive an hourly wage that is below the statutory minimum wage, especially in the years directly following its introduction (see, for example, Bachmann et al.

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[1] See the website of the German Minimum Wage Commission: www.mindestlohn-kommission.de/EN/Home/.

(2022), Beckmannshagen and Fedorets (2021), and Bossler et al. (2022)). The reported numbers vary, inter alia, with the data sets used and the methods to calculate hourly wages. Studies based on SOEP-data compute non-compliance rates between 5% and 12%, with substantial variation across different groups of employees and over time (Burauel et al. 2018, Pusch 2018, Bachmann et al. 2022).[2]

Empirical investigations concerning the effects of works councils have considered a wide variety of outcomes (see Addison (2009), Jäger et al. (2022), and Mohrenweiser (2022) for summaries and evaluations of relevant contributions). Some of the effects are directly related to regulations of the WCA, such as working time, vacation and health issues. Many studies consider the consequences on wages, productivity and profits, without necessarily being able to pin down the channels by which works councils affect them. One of the mechanisms emphasized to establish council effects is their role as an institutionalized voice (Freeman 1980, Freeman and Medoff 1984, Freeman and Lazear 1995). In the context of minimum wage compliance, the safeguards of the WCA allow councils to require adherence to the law at lower expected costs compared to what individual workers face, given the possibility that employers sanction individual requests. Moreover, minimum wage compliance features elements of a collective good if violations of the law affect all comparable workers of a plant. This public good component further strengthens the role of works councils, who are obliged to act to the advantage of the entire workforce. Frick (1996) and Garcia-Serrano (2002) highlight the role of firm-level voice, such as by works councils, in settings where sectorally negotiated bargaining agreements are applied to all workers in covered firms and unions. Findings that co-determined establishments pay higher wages and are more productive than comparable establishments without a works council are also particularly relevant from our perspective. The wage effect implies that co-determined establishments are less likely to be affected by minimum wage legislation, as documented by Bellmann et al. (2021). The productivity impact constitutes a prerequisite for the wage consequences if works councils do not only redistribute, but also help to create rents.

Despite extensive work on works councils, the link between co-determination and minimum wages has not found much attention yet. As an exception, Pusch (2018) documents a negative correlation between being paid less than the minimum wage and working in a firm with a works council, using the 2016 SOEP wave.[3]

In the remainder of the paper, we describe the legal situation concerning minimum wages and co-determination at plant level in Section 2. In Section 3, we outline a simple theoretical model of a competitive labour market in which the firm can decide about the number of workers it pays less than the minimum wage. The details of the analysis and the extension to a monopsonistic setting are relegated to an appendix. We commence the empirical part of the paper in Section 4 with a description of the approach and the data. Section 5 contains the findings from our main analysis and various extensions. The final Section 6 concludes our contribution.

2. Legal Background

2.1. Minimum Wage Legislation

In Germany, a statutory minimum wage of € 8.50 per hour was introduced on January 1, 2015, when the Act Regulating a General Minimum Wage (ARGM, *Mindestlohngesetz*) came into force. The minimum wage successively increased and amounts to € 12 since October 2022.[4] It is mandatory for most employees, with some exceptions being employees who are younger than 18 years, apprentices, individuals participating in selected education-related internships, and formerly long-term unemployed during their first six months of reemployment (§ 22 ARGM). Furthermore, sector-specific minimum wages below the statutory level were allowed in some industries until 2017 if they were based on collective agreements. The minimum wage in Germany is highly binding: it affected about 11% of employees in 2015, and estimates indicate that about 22% of employees earned € 12 or less per hour in 2022 (Börschlein et al. 2022).

The minimum wage is computed as the gross wage for each actual working hour. Most extra payments, such as for overtime or work on Sundays, are part of the gross wage. However, one-time payments, such as vacation pay or Christmas bonuses, can only be used to fulfil minimum wage requirements in the month before their payment, because the ARGM requires that the minimum wage is paid to employees within this well-defined time period (§ 2(1) ARGM). In contrast, non-monetary remuneration elements, reimbursements of costs incurred by the employee, or specific bonuses, such as for employee loyalty, do not count as components of the gross wage. The ARGM does not explicitly mention co-determination, as the law establishes an individual legal entitlement of employees against the employer.

Individual employees may not be able to accomplish their entitlements to adequate remuneration. Therefore, the German customs authorities are charged with enforcing the statutory minimum wage (§ 14 ARGM). Inspections are based on random sampling, especially in industries with a

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[4] The minimum wage increased to € 8.84/hour in 2017, € 9.19 in 2019, € 9.35 in 2020, and € 9.60 in 2021.

higher risk of non-compliance, or on information provided by employees (Mindestlohnkommission 2023). If non-compliance is established, employers must pay fines of up to € 500,000 (§ 21(3) ARGM). If the economic benefits of non-compliance exceed this limit, a higher penalty may be imposed. The customs authorities determine the level of the fine, which is an increasing function of the extent of wage underpayments and additional economic benefits. Moreover, its amount is doubled if willful intent of the employer is observed. If non-compliant firms contest the customs authority's decision, a court tends to settle the fine. The fines do not include the back payments of minimum wages. Instead, employees must file their case with a civil court to receive the wage to which they are legally entitled.

If firms pay less than the minimum wage, contributions to social security and withheld income tax payments are usually also insufficient. If non-compliance with minimum wage legislation is detected, firms must make up the insufficient tax and social security payments and pay an additional fine for their evasion. The resulting expenditure usually increases the expected costs of minimum wage non-compliance significantly.

2.2. Co-determination at Plant-level

Co-determination at plant-level is regulated primarily in the Works Constitution Act (WCA, *Betriebsverfassungsgesetz*).[5] Employees can establish works councils in all private sector establishments, which have at least five permanent employees who are entitled to vote in a works council election (§ 1 WCA).[6] Currently, about 8% of all relevant plants have a works council. Since they are more prevalent in large establishments, the share of employees working in works council plants amounts to 43% (Hohendanner and Kohaut 2022). According to the provisions of § 2 WCA, works councils bear a legal obligation to collaborate with management, with the overarching aim of benefiting not only the workforce but also the establishment. They have information, consultation, and co-determination rights, which become more extensive the larger the plant is. The legal entitlements of works councils are most comprehensive regarding personnel policy and social affairs.

The WCA does not explicitly endow a works council with rights concerning minimum wages. However, the paragraph on the general duties of a works council (§ 80 WCA) states that a council "has to ensure that laws, directives, safety regulations, collective bargaining contracts

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[5] There is also mandatory co-determination at the enterprise level in companies with 500 or more employees, which regulates representation on company boards (see Addison (2009) or Jäger et al. (2022) for details).
[6] While the law exclusively uses the expression 'establishment' (*Betrieb*), for stylistic reasons we employ the terms 'plant' and 'firm' as equivalents.

and agreements between a works council and an employer, which benefit employees, are executed" (own translation). These general obligations also relate to a statutory minimum wage and imply that a works council is entitled to obtain the necessary documentation and discuss minimum wage issues with the employer (Düwell and Schubert 2017, Lakies 2021). Moreover, the WCA provides the works council with information claims and establishes co-determination rights, for example regarding working time and the structure of compensation (§ 87 WCA), which make it more difficult for a firm to hide minimum wage underpayments. If a works council becomes aware of insufficient remuneration, it can inform the affected employees and help them enforce their legal entitlement (Düwell and Schubert 2017, Kleinebrink 2015).[7] Since employees can notify customs authorities of subminimum wage payments, the probability that such illegal remuneration is detected is likely higher in works council establishments than in firms without such an institution.

Once customs authorities inspect a firm, the works council is obliged to provide information about violations of the ARGM. In case the works council had discussed the issue with the employer before the inspection, and the firm continued to pay wages below the legally required level, it becomes more difficult to declare the insufficient remuneration as accidental, but at the same time a willful intent is easier to establish for customs authorities. In this case, the fine will be higher for a given underpayment.

In sum, works councils play no direct role in enforcing the statutory minimum wage in Germany (Düwell and Schubert 2017, Lakies 2021). However, given their information and co-determination rights in areas related to the calculation and payment of minimum wages, they are likely to know about intentional and substantial underpayments. This knowledge can result in a greater probability that non-compliance is detected by customs authorities and established in court, and in higher penalties for the firm.

3. A Simple Model of Non-compliance in the Presence of Works Councils

The starting point of our theoretical model is the notion that a profit-maximizing firm takes both the legal framework, e.g. minimum wage legislation, and labour market institutions, such as works councils, into account when deciding about employment. In our model, we assume two types of workers; one who is directly affected by minimum wage legislation, whereas the productivity of the other type is so high that the employee earns a wage above the legal

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[7] Bonin et al. (2020, p. 107 ff) show that members of a works council help to enforce minimum wage legislation primarily by providing employees with information about their entitlements and the law's content and by verifying the firm's adherence to it.

minimum level. This feature allows us to distinguish between workers subject to minimum wage legislation and those who are not. In considering the role of the works councils, we take into account that they cannot directly assist in the enforcement of minimum wage legislation, but have an indirect influence, as they can affect the probability that a firm will be inspected by the customs authority and the resulting fine. Furthermore, we examine how the positive productivity and wage effects associated with works councils influence non-compliance.

Outline of Model

We consider a representative, profit-maximising firm. Accordingly, interactions on the input or output market do not affect the non-compliance incentives.[8] As a further consequence of this simplification, we do not incorporate a distribution of firm characteristics that could explain heterogeneity in non-compliance choices (see Basu et al. 2010 and Badaoui and Walsh 2022). Therefore, the model is attuned to our empirical analysis, which relies on individual-level data.

The firm employs two types of workers. High-productivity workers do not supply labour at or below the minimum wage, w^M. We refer to them as *high-wage employees* who obtain a wage of w^H, $w^H > w^M$, which is exogenously given from the perspective of the firm. The second type of worker has a lower productivity and supplies labour at or below the minimum wage. They will henceforth be called *minimum-wage workers*. There is a market-clearing wage, w^C, $w^C < w^M$, for minimum-wage workers, which the firm has to pay if it employs such kind of worker and ignores the minimum-wage legislation. At this wage, it can hire as many minimum-wage workers as desired. However, a wage underpayment can be detected and will then be fined. Therefore, the firm can also decide on the quantity of minimum-wage workers it remunerates according to legal requirements.

The timing is as follows: First, the firm chooses the number, H, of high-wage employees, the number, K, of minimum-wage workers who obtain the minimum wage, w^M, and the number, L, of minimum-wage workers who are underpaid and receive the wage w^C. Subsequently, an inspection may take place. The probability of such an event is p, 0 < p < 1. In case of inspection, underpaid workers obtain a back payment so that they earn w^M. Additionally, the firm is penalised. The incidence, I, of non-compliance with minimum wage legislation is captured by the expected number of minimum-wage workers who receive less than w^M, (1 − p)L, relative to total employment, H + K + L.

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[8] Yaniv (2006) argues that an encompassing minimum wage shifts both the demand and the supply curve, resulting in a decline of the market wage, while the employment level may be unaffected. Our focus on one firm rules out such equilibrium repercussions.

In Appendix A.2, we analyse a variant of the model in which the firm has monopsonistic market power, and the labour supply of minimum-wage workers increases in the wage. We can then measure the extent of non-compliance as the difference between the minimum wage, w^M, and the wage the firm chooses to pay. If the firm is a price-taker, this difference is obviously constant.

Firm

The firm's revenues are given by a function $Q(L + K, H) = \alpha[L + K] + \beta\alpha H + q(L + K, H)$, which is increasing and strictly concave in each argument, implying that $Q_L(L + K, H) = Q_K(L + K, H) = \alpha + q_L(L + K, H), Q_H(L + K, H) = \beta\alpha + q_H(L + K, H) > 0 > Q_{LL} = q_{LL} = Q_{KK} = q_{KK} = Q_{LK} = q_{LK}, Q_{HH} = q_{HH}$ and $q_L = q_K, q_H > 0$ hold, where subscripts indicate partial derivatives and square brackets (parenthesis) indicate multiplicative terms (functional relationships). This specification of revenues implies that working hours are normalised to unity and that the productivity of minimum wage workers is the same, irrespective of whether they are being paid the minimum wage, w^M, or the market wage, w^C.[9] The parameter $\alpha, \alpha \geq 0$, constitutes a (marginal) productivity shifter, while $\beta, \beta > 0$, indicates that the shifter may affect high-wage employees and minimum-wage workers differently.

In the case of an inspection, the wage bill for minimum wage workers equals $[L + K]w^M$. Moreover, the firm has to pay a fine, F, which is an increasing and strictly concave function of the amount of underpayments, implying that $F = F(L[w^M - w^C]), F', F'' > 0$. The non-linearity of the fine function ensures an interior solution to the firm's optimisation problem.[10]

The assumptions outlined above imply that expected profits $E(\pi)$ are given by:

$$E(\pi) = Q(L + K, H) - w^H H - [1 - p][w^C L + w^M K] - p[w^M[L + K] + F(L[w^M - w^C])] \quad (1)$$

Optimal Choices

The maximisation of $E(\pi)$ with respect to H, K, and L yields (see Appendix A.1 for the derivation and the second-order conditions):

$$Q_H(L + K, H) - w^H = 0 \qquad (2)$$

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[9] If we assume $Q_L \neq Q_K$, very few analytical results can be obtained because the magnitudes of Q_L and Q_K depend on the absolute number of both categories of minimum-wage workers.

[10] If the fine were linear in the amount of underpayments, the firm would either comply with the law or just pay the competitive wage (see, for example, Ashenfelter and Smith (1979), Grenier (1982), or Chang and Ehrlich (1985)). Alternatively, an interior solution can result, for example, if the firm is strictly risk-averse (Yaniv 2001) or faces a detection probability or expected fine that are increasing and strictly convex in the number of underpaid minimum-wage workers (Bhorat et al. 2015, Garneiro and Lucifora 2022).

$$Q_L(L + K, H) - w^M = 0 \tag{3}$$

$$1 - p - pF'(L[w^M - w^C]) = 0 \tag{4}$$

Due to the feature that minimum wages and non-compliance do not affect the gains and costs of employing high-wage employees, their optimal number, H*, results from equating marginal revenues, Q_H, with the wage (cf. equation (2)). A comparable condition governs the optimal number, K*, of minimum-wage workers who are being paid according to the law (see equation (3) and, for example, Yaniv (2001), Bhorat et al. (2015), or Garneiro and Lucifora (2022)). If non-compliance remains undetected, an event occurring with the probability 1 – p, marginally raising the number of legally paid minimum-wage workers increases wage costs by w^M. With the probability p non-compliance is detected. In this case, all workers obtain the minimum wage. Consequently, marginally raising the number of legally paid minimum-wage workers also drives up wage costs by w^M, for a given positive number, L, of underpaid minimum-wage workers. Finally, the firm chooses the number, L*, of underpaid minimum-wage workers so that the probability of not being detected, 1 – p, equals the change in the expected fine, pF' (cf. equation (4)). This is the profit-maximising choice because altering the number of underpaid minimum-wage workers has no impact on total wage payments if non-compliance is detected for K* > 0, since underpaid workers have to be compensated for inadequate remuneration. In a profit-maximum, the expected increase in the fine if expanding the number of underpaid workers, $[w^M - w^C]pF'$, is set equal to the expected wage costs of employing one more worker of that type, which equal the probability of this event occurring times the reduction in wages, that is, $[1 - p][w^M - w^C]$.

Effects of Co-determination

Above we have argued that establishments with a works council are confronted with an elevated detection probability and higher fines than establishments without such an institution. In the present model, we incorporate this possibility by assuming that the probability, p, and the marginal fine, F', are higher in a co-determined firm. Furthermore, there is substantial evidence that productivity and wages are higher in co-determined establishments than in firms without works councils, though causal relationships are difficult to establish (Jäger et al. 2022, Mohrenweiser 2022). Therefore, we also take these two features into account.

We summarise our findings concerning the effects of enforcement and economic parameters on the optimal numbers of employees, H*, L*, and K*, and the incidence, I, as (see Appendix A.1 for the derivations):

Proposition

a) Enforcement parameters

An increase in the detection probability, p, and the marginal fine, F', induce the firm to lower the number of underpaid minimum-wage workers, L*, and to raise the quantity of minimum-wage workers paid according to law, K*, by the same number. Since high-wage employment, H*, remains the same, the incidence, I, of non-compliance declines.

b) Economic parameters

An increase in productivity, α, does not affect the number, L* of underpaid minimum-wage workers. If $Q_{KH} \geq 0$ holds, the firm employs more high-wage employees, H*, and minimum-wage workers who are being paid according to law, K*, so that the incidence, I, of non-compliance declines.

A higher wage for high-wage employees, w^H, reduces their number, H*, does not affect employment, L* of underpaid minimum-wage workers, and lowers the number, K*, of minimum-wage workers who are being paid according to law for $Q_{KH} \geq 0$ holds, so that the incidence, I, of non-compliance rises.

Finally, a rise in the market wage, w^C, of minimum-wage workers affects neither employment, H*, of high-wage employees nor overall employment of minimum-wage workers, K* + L*, while it increases employment, L* of underpaid minimum-wage workers and the incidence, I, of non-compliance.

To provide intuition, we may observe that a higher detection probability, p, and a greater marginal fine, F', make non-compliance more costly at the margin. Equation (4) clarifies that an increase in these marginal costs of non-compliance requires the effective amount of minimum wage underpayments, $L[w^M - w^C]$, to fall, given the strict convexity of the fine function. The firm achieves this adjustment by reducing the number, L*, of underpaid minimum-wage workers. The marginal gains and costs of employing high-wage employees and minimum-wage workers who are being paid according to law are not directly affected by variations in the detection probability and the fine. However, a decline in the number of underpaid minimum-wage workers, L*, raises the marginal productivity of their correctly paid counterparts. Accordingly, an increase in the quantity, K*, of minimum-wage workers who are being paid according to law by precisely the number by which employment, L*, of underpaid minimum-wage workers is reduced, while holding high-wage employment constant, re-establishes marginal productivities at the level prevailing before the rise in the marginal fine, F'. The same reasoning applies with regard to the detection probability, p.

A higher productivity of all workers does not alter the marginal costs and gains of non-compliance, as evidenced by equation (4). Therefore, the number of underpaid minimum-wage workers, L*, remains unchanged. Higher productivity induces the firm to expand the employment of the other two types of workers. If greater employment of high-wage employees does not reduce the marginal productivity of minimum-wage workers, that is, if $Q_{KH} \geq 0$ holds, the expansions in H* and K* (weakly) reinforce each other and employment of high-wage and minimum-wage workers paid according to the law rise.

A higher wage of high-wage employees, w^H, does not affect the marginal gains and costs of non-compliance. Therefore, the employment of underpaid minimum wage workers, L*, remains constant. The higher wage induces the firm to reduce the number, H*, of high-wage employees. This reduces the marginal gain from employing correctly paid minimum-wage workers if their marginal productivity rises with high-wage employment. Finally, a higher competitive wage, w^C, for minimum-wage workers reduces the marginal fine for their employment, so that the firm expands the number, L*, of underpaid minimum-wage workers. Since the wage of high-wage employees and the minimum wage remain unaffected, the firm retains the number of high-wage employees and overall employment of minimum-wage workers (see equations (2) and (3)).

The above analysis predicts that the incidence of non-compliance will be lower for workers employed in co-determined establishments than for individuals employed in firms without works councils, if co-determination affects non-compliance primarily through a stricter enforcement of minimum wage legislation. If co-determined establishments and firms without works councils differ predominantly in economic outcomes, such as productivity and wages, the model provides conflicting predictions about the impact of co-determination on non-compliance with minimum wage legislation.

Since the firm is a price-taker on the labour market, the extent of wage underpayments per worker, $w^M - w^c$, is exogenously given. To endogenise this difference in a partial equilibrium model with a representative firm, we assume that the firm is a monopsonist on the market for underpaid minimum-wage workers.[11] It faces an upward-sloping labour supply curve of these workers and chooses their wage, w^{Mon}. However, if it pays the minimum wage, it can hire as many of these minimum-wage workers as it desires. Accordingly, the firm can trade off the

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[11] Bhorat et al. (2015) assume a firm that can pay more than the market wage, w^C, although it does not have monopsonistic market power, but cannot determine the number of workers who are underpaid. This implies that all workers are being paid below the minimum wage, and allows the firm to influence the aggregate underpayment and, hence, the fine by selecting the difference between the minimum wage and the chosen level. Thus, there are alternative approaches to endogenise the extent of non-compliance. Chang (1992) assumes that the firm can decide on the number of workers and the wage in excess of the market-clearing level. In this set-up, workers would work for less than the wage the firm wants to pay, but the firm would not accept this offer to reduce the expected fine pay.

number of underpaid minimum-wage workers and the quantity of those paid according to the legal requirement, as in the model with a perfectly competitive setting.

The predictions concerning the directions of the changes in employment due to variations in the detection probability, p, the marginal fine, F', the productivity parameter, α, and the wage of high-wage employees, w^H, are the same for the model of a monopsonistic setting as for the competitive framework (see Appendix A.2 for details of the model and its analysis).[12] This is the case as the modification only affects the firm's trade-off with respect to the number, $L(w^{Mon})$, of underpaid minimum-wage workers (cf. equation (3)), which it determines by setting the wage optimally. Furthermore, the extent of non-compliance per worker, $w^M - w^{Mon}$, rises with a higher marginal fine and detection probability because the monopsonistic firm wants to reduce the number of underpaid workers. It can only do so by reducing the wage, w^{Mon}, which is paid to them. Finally, the extent of underpayments is unaffected by a change in the productivity parameter, α, and in the remuneration of high-wage employees, w^H. Table 1 sums up the predictions.

Table 1: Summary of Comparative Static Predictions

	L^*; $L(w^{Mon})$	K^*	H^*	I	$w^M - w^C$ (competitive)	$w^M - w^{Mon}$ (monopsonistic)
p	-	+	0	-	0	+
F'	-	+	0	-	0	+
α	0	+ if $Q_{KH} \geq 0$	+ if $Q_{KH} \geq 0$	- if $Q_{KH} \geq 0$	0	0
w^H	0	- if $Q_{KH} \geq 0$	-	+	0	0
w^C	+; n.a.	-	0	+	-	n.a.

n.a.: not applicable

4. Data and Empirical Strategy

4.1. Data

Our empirical analysis relies on the German Socio-Economic Panel (SOEP), a nationally representative household panel data set that is available for every year since the introduction of the statutory minimum wage in 2015 (see Goebel et al. 2019). The SOEP provides annual information on various aspects of the respondents' lives, including some characteristics concerning the workplace of employed individuals. However, the crucial information on whether a works council exists at the respondent's workplace is collected in irregular intervals only. Since

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[12] The competitive wage for minimum-wage employees, w^C, does not play a role in the monopsonistic setting.

the introduction of the minimum wage, the relevant question has been included in the survey years 2016 and 2019. Hence, we use data from these two years to examine the relationship between non-compliance with minimum wage legislation and co-determination.

Our attention centers on employees in private sector plants with at least five employees, given that the WCA only applies to these establishments. All respondents worked either full-time, part-time or were marginally employed in the particular year. Their ages varied between 18 and 67 and they were eligible for the statutory minimum wage. Furthermore, we excluded all employees working in industries with a legally binding sector-specific minimum wage because we are interested in non-compliance with the statutory minimum wage.[13]

In order to determine non-compliance with minimum wage legislation, we require evidence concerning the gross wage per working hour. The SOEP provides information about gross monthly earnings and two measures of reported weekly working hours. The first measure indicates hours as specified in the employment contract. The second one refers to actual hours. Using both measures of weekly working hours, we calculate hourly wages as monthly earnings divided by the product of weekly working hours and 4.35.[14] The measure based on contractual working hours is likely to be an upper bound of the legally relevant hourly wage since paid overtime is not included in the contractual working hours but in monthly earnings, for example. The second measure, relying on reported actual hours, presumably represents a lower bound since unpaid overtime is included, even if it is compensated, for instance, through a working time account in accordance with the ARGM regulations. Using both hourly wage measures throughout our empirical work helps us demonstrate the robustness of the results.

We calculate two indicators of non-compliance with minimum wage legislation for both wage variables. First, we generate a dummy variable, indicating the incidence of non-compliance, which equals one if the respective hourly wage is lower than the statutory minimum wage in the respective year. Second, we compute the extent of underpayment, or of non-compliance, as the difference between the statutory minimum wage and the hourly wage in €, conditional on the incidence of non-compliance in the respective year.

In our regression analyses, we investigate the relationship between non-compliance and the existence of a works council in the firm, conditional on individual and firm characteristics. Hence, the covariate of key interest is a dummy variable which equals one if the respondent works in a firm with a works council. To control for collective wage bargaining between

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[13] See Burauel et al. (2018, pp. 152f) and Bispinck (2023) for information on industries with a legally binding, sector-specific minimum wage.
[14] Hourly wage = [gross monthly earnings / (weekly working hours * 4.35)], with 4.35 = 365/(12 * 7).

employer associations and trade unions, we employ a dummy variable which equals one if the firm is bound by a collective bargaining agreement.[15] Firm size, industry affiliation and region are included with respective (vectors of) dummy variables. Furthermore, age (in years) and age squared, tenure (in years), dummy variables for gender (male), education (apprenticeship, university degree), white collar status, migration background, being married and a dummy variable for the year 2019 are included. To cater for the employee's wage bargaining power, we include a dummy variable which equals one if the employee is very concerned about job security. Furthermore, dummy variables for working part-time or in marginal employment (so-called "mini-jobs") are incorporated. Table A1 in Appendix A.3 presents descriptive statistics.

4.2. Empirical Strategy

Our two theoretical models predict a relationship between a works council within the firm and the incidence of non-compliance with the statutory minimum wage. In contrast, only the monopsonistic model establishes a link between co-determination and the wage the firm wants to pay and, consequently, with the extent of non-compliance. Taking advantage of a basic rule of probability, expected underpayments, conditional on our vector of covariates, X, $[E((w^M - w^{Mon})|X)]$ can be defined as the product of the propensity to receive a subminimum wage payment $[P(I((w^M - w^{Mon}) > 0) = 1|X)]$ and the expected underpayment, conditional on the incidence on non-compliance, $[E((w^M - w^{Mon})|X, I((w^M - w^{Mon}) > 0) = 1)]$, i.e. $E((w^M - w^{Mon})|X) = P(I((w^M - w^{Mon}) > 0) = 1|X) \times E((w^M - w^{Mon})|X, I((w^M - w^{Mon}) > 0) = 1)$. We employ a two-part model specification to analyse the two non-compliance decisions separately (e.g. see Wooldridge (2010), section 17.6, and Drukker (2017)). In order to accomplish this, we use a standard probit specification for the incidence and a standard OLS specification for the extent of non-compliance, conditional on its incidence. SOEP survey weights are used in all specifications to account for survey design and panel attrition.

5. Results

In this section we, first, present descriptive evidence. Second, we outline the main regression results for a pooled estimating sample based on both years, 2016 and 2019. Third, we investigate whether there are heterogenous effects regarding the time (2016 vs 2019), gender, region

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[15] Information on a respondent's membership in a trade union is available in 2019, but not in the 2016 wave.

(eastern vs. western Germany), working time, and firm size. Finally, we evaluate the robustness of the findings concerning the identification of non-compliance.

5.1. Descriptive Evidence

On average, 6.3% to 10.8% of all employees earned less than the statutory minimum wage (see Table A2 in Appendix A.3). Although the minimum wage increased from € 8.5 per hour in 2016 to € 9.19 in 2019, the incidence of non-compliance shrank significantly from 7.3% to 5.4% (*contractual hours*), respectively from 11.8% to 9.8% (*actual hours*) over the same period.[16,17] Considering the extent of non-compliance, we find that employees, who do not receive the statutory minimum wage, earn on average € 1.7 - € 2.0 per hour less than the respective minimum wage (see Table A2 in Appendix A.3). This average extent did not change significantly over time.

Focusing on the relationship between non-compliance and co-determination, we observe a strikingly large difference in the incidence (see Table 2): Employees in firms without a works council face a non-compliance risk that is three to four times higher than that of employees in co-determined firms. These differences are all significantly different from zero based on t-tests. Hence, the descriptive evidence is in line with the theoretical predictions concerning enforcement parameters and productivity effects.

- Table 2 about here –

Considering the extent of non-compliance, conditional on its incidence, the raw average underpayment is slightly larger for employees working in a firm with a works council than in one without such an institution. However, the differences in the range of € 0.1 - € 0.5 are never significantly different from zero at the $\alpha = 0.05$-level, based on t-tests. The descriptive evidence with respect to the extent of non-compliance is consistent with the implication of the competitive setting and the prediction for the monopsonistic model in cases in which works councils affect

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[16] For both wage measures, t-tests indicate that the changes over time are statistically significant. We can compare our estimates of the incidence of non-compliance based on contractual hours with estimates provided by Bachmann et al. (2022, p. 44, Table 3.3) who find a non-compliance rate of 7.5% in 2016 and of 5.9% in 2019. Note that our estimating sample differs from theirs, since we (a) focus on the private sector only, (b) require information on the existence of a works council in the firm, and (c) consider employees who work in a firm with at least 5 employees.
[17] The Federal Statistical Office Germany provides two other data sources for calculating non-compliance rates, namely the "Verdiensterhebung (VE)" and the "Verdienststrukturerhebung (VSE)". Based on these data sources, non-compliance rates are much lower, amounting to, for example, 3.0% instead of 5.4% (our study) or 5.9% (Bachmann et al. 2022, p. 44) in 2019. These notable differences are partly due to the fact that in the VE/ VSE (a) mini-jobs are not included, where non-compliance is much more prevalent, (b) only information on paid overtime is available, and (c) employers report wage information, which reduces the likelihood of reporting hourly wages that do not comply with the law (see Mindestlohnkommission (2023), Bachmann et al. (2022) or Caliendo et al (2023, online appendix C) for a detailed discussion).

non-compliance primarily through their economic consequences. If co-determination has an impact predominantly via stricter enforcement, the results suggest that monopsonistic markets do not play a vital role.

5.2. Main Findings

Our goal is to assess whether the existence of a works council within the firm has predictive power for non-compliance with the statutory minimum wage and the extent of underpayment, conditional on non-compliance. Table 3 displays the results of our main regression exercises.

- Table 3 about here -

The estimated average partial effects (APE) indicate that working in a co-determined firm goes along with a significant decrease in the probability of being paid less than the statutory minimum wage of 2.2 percentage points, respectively 4.1 percentage points (col. 1 and 2). This finding is consistent with the theoretical predictions concerning the impact of works councils on enforcement parameters and their correlation with productivity, though not on wages. Given that the raw average non-compliance rates are 6.3 percentage points when focusing on contractual hours and 10.8 percentage points when considering the wage calculated on the basis of actual hours (see Table A2 in Appendix A.3), taken at face value, our results imply that working in a co-determined firm reduces the individual likelihood of non-compliance by roughly 40%.

From Table 3, we also observe that the incidence of non-compliance is lower for males, higher in eastern Germany and also for employees who do not work full-time. Individual bargaining power, proxied by a dummy variable that equals one if the employee is very concerned about job security, is positively correlated with the incidence of non-compliance. The contractual hours wage indicator additionally suggests that non-compliance has decreased over time.

Furthermore, Table 3 reveals that the estimated correlations between the existence of a works council and the extent of non-compliance, conditional on its incidence, are positive but not significantly different from zero. The estimated sizes of the APEs are relatively small compared to the absolute magnitude of minimum wages, i.e. less than 5%. Therefore, we do not find empirical support for the prediction concerning the impact of enforcement parameters on the extent of non-compliance, based on the monopsonistic labour market model. The findings are consistent with the predictions derived from the competitive model and, concerning the effects of economic parameters, such as wages and productivity, the monopsonistic set-up (see Table 1).

The estimated APEs depicted in row 2 of Table 3, indicate that collective bargaining does not significantly predict the incidence or extent of non-compliance. Therefore, works councils and

collective bargaining, as two important labour market institutions in Germany, appear to have different consequences for non-compliance with minimum wage legislation. One possible explanation could be that works councilors and employers directly cooperate at the shop floor level, while collective bargaining agreements are mainly settled at the industry level between employer associations and unions.[18]

The above interpretation is consistent with the findings we obtain when trying to cater for individual union membership. As we mentioned in Section 4.1., this information is unavailable for 2016. However, respondents provided a statement about their union membership status in 2015. If we impute membership for 2016 with this information and rerun the specifications in Table 3, including a union membership dummy as additional covariate, our main results regarding the association between co-determination and non-compliance remain unaffected. In addition, we find a negative correlation between individual union membership and the incidence of underpayments.[19]

All in all, our findings indicate that co-determination may constitute an effective institution for the enforcement of minimum wages. This is the case, although the relevant laws do not explicitly endow works councils with corresponding rights. Consequently, they undertake regulatory tasks for which, for example, the Works Constitution Act (WCA) only empowers them indirectly through a general norm, aimed at overseeing the execution of laws designed to safeguard the well-being of the staff. An alternative interpretation, which is also compatible with our evidence, is that the productivity effects associated with co-determination alter a firm's incentives in such a way that non-compliance becomes less attractive. Interestingly, the extent of non-compliance, given its existence, is unrelated to co-determination at plant level.

5.3. Heterogeneity

The relationship between working in a firm with a works council and non-compliance with the statutory minimum wage might vary across different groups of employees. In particular, we consider differences according to gender, place of residence, working time, and firm size. Moreover, non-compliance may diminish over time. Because our main specifications do not indicate a correlation between co-determination and the extent of non-compliance, we subsequently focus on the incidence. Table 4 displays the results.

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[18] Our finding contrasts with the result presented by Pusch (2018) for 2016 who reports a negative correlation. It should be noted that Pusch (2018) includes public sector employees in his estimating sample, whereas they are excluded from our analysis.
[19] Results are available upon request.

Changes over Time

Table 3 suggests that the incidence of non-compliance with minimum wage legislation may have declined from 2016 to 2019 (see also Bachmann et al. (2022), for example). Hence, we investigate whether there is a change over time in the probability differential of non-compliance between employees in co-determined firms and employees in firms without works councils.

- Table 4 about here -

The estimated APEs of the presence of a works council remain virtually unchanged for the wage computed on the basis of contractual hours. With respect to actual hours, we observe a decrease in the absolute value of the size of the corresponding APEs by roughly 50% from 2016 to 2019. Therefore, there is some evidence that the role of co-determination for non-compliance with minimum wage legislation has weakened from 2016 to 2019.

Gender

The introduction of the statutory minimum wage has reduced the regional gender wage gap in Germany, with the effect being most pronounced for low-paid individuals (Caliendo and Wittbrodt 2022). In line with these results, we find that female employees face a higher risk of being underpaid than male employees (see Table 3). This suggests that works councils can play a more significant role for females because there is a greater scope for their influence. However, works council members are still predominantly male (Goerke and Pannenberg 2023). To analyse whether gender plays a role, we estimate the probit specification for the incidence of non-compliance for males and females separately.

When we compare the absolute values of the estimated APEs, we find that working in a co-determined firm reduces the risk of non-compliance for females much more than for males, regardless of the hourly wage measure used (Table 4).

Place of Residence

The bite of the statutory minimum wage was and still is more pronounced in eastern than in western Germany (e.g. Börschlein et al. 2022). Moreover, our results indicate that non-compliance is more prevalent in the eastern part of the country (see Table 3). This suggests that the works councils' scope for influence is greater there.

The comparison of the estimated APEs for separate samples of employees (see Table 4) is consistent with this expectation: The probability differential of non-compliance between

employees in co-determined firms and employees in firms without works councils is much more pronounced in eastern than in western Germany.[20]

Working Time

The incidence of non-compliance is higher for employees working in marginal and in part-time employment (labelled 'other employees' for simplicity) than for full-time employees (see Table 3). Therefore, the scope for works council activities is greater for the former group of employees. Consequently, we check whether there are differences with respect to the correlation between the incidence of non-compliance and co-determination according to the respondents' working time.

The estimated APEs indicate that the probability of non-compliance decreases more significantly for other employees in a co-determined company than for full-time employees (see Table 4).

Firm Size

Table 3 indicates that the incidence of non-compliance with minimum wage legislation tends to decrease with firm size. One reason could be that larger firms pay higher wages. Moreover, our theoretical model suggests that the gains from non-compliance do not depend on firm size, while the expected costs rise with the number of employees who are not paid according to law. This penalty effect may constitute another reason for a lower non-compliance rate of larger firms. Both aspects mentioned above suggest that the scope for a works council effect is smaller in larger firms. On the one hand, a lower correlation between co-determination and non-compliance with minimum requirements can, therefore, be expected with increasing firm size. On the other hand, a works council's information, consultation, and co-determination rights increase with firm size. Furthermore, in establishments with more than 200 employees, there is a legal entitlement for at least one works councilor to be released from normal work obligations and to become a full-time councilor. Accordingly, professionalism of works councils can be argued to rise with firm size.[21] This would suggest that the effect of works councils on non-compliance is more pronounced in larger firms.

Estimating the probit specification for three different firm size categories, namely establishments with 5 to 199, between 200 and 1999, and 2000 or more employees, we find that the estimated APEs tend to decline with firm size (see Table 4). Therefore, the impact of more extensive co-

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[20] This result also holds when we take into account regional aspects in more detail and additionally include sets of federal state dummies in the two separate specifications.

[21] According to § 38 WCA, the number of works councilor exempted from normal work obligations rises at a weakly decreasing rate with the number of employees as, for example, establishments with more than 500 and less than 900 employees have two full-time councilors, while the respective number for firms with 2000 to 3000 employees equals five.

determination entitlements in larger firms appears to be dominated by a smaller scope for a works council effect.

Summary

There is some evidence that a positive effect of co-determination on compliance with minimum wage legislation might be stronger for groups of employees who earn lower wages and are on average more affected by minimum wage laws, such as females, employees in smaller firms, those living in eastern Germany and those not working full-time.

5.4. Measurement Issues

In this section, we provide some robustness checks to demonstrate that our main results are not affected by measurement issues (see Table A3 in Appendix A.3).

Variable Pay

One-time payments, such as vacation pay, Christmas or profit-sharing bonuses, can be used to fulfil minimum wage requirements only in the month prior to their payment (§ 2(1) ARGM). Unfortunately, the SOEP provides information on such bonuses retrospectively, and the exact date of their payment is not known. Hence, we do not use this information in our main empirical work. To account for this aspect, we divide the sum of all individual one-time payments by twelve and add the resulting number to the individual monthly earnings measure, making non-compliance with minimum wage legislation less likely. Based on the new earnings measure, we re-estimate the probit specifications and find no differences to our main results.

Working Time Recording

To calculate the hourly wage according to the regulations of the ARGM, reliable information on working hours is required. Non-compliance with the minimum wage due to incorrect recording of working time seems to play a certain role in Germany (e.g. Mindestlohnkommission 2023). Accordingly, the ARGM (§ 17) stipulates that working hours must be recorded in a very detailed manner in some sectors deemed to be especially susceptible to non-compliance with minimum wage regulations and for marginal employees ("mini-jobs"). Works councils have information and co-determination rights regarding working time (§ 87 WCA). Therefore, a positive correlation between the existence of a works council and the presence of a system of working time recording is likely.

The SOEP provides information on different types of working time recording (*by hand, time recording system, or none*) in 2018 and 2020 only. When we merge this information with an estimating sample of workers who stay with their firm in 2018 and 2019, 2019 and 2020 or 2018 to 2020, we find a significantly positive correlation between the existence of a works council and the presence of a working time recording system in the firm. However, when we run regressions that include covariates for both the existence of a works council and the presence of a working time recording system, our main results regarding the correlation between non-compliance and the existence of a works council do not change. In consequence, they are not due to the feature that working time is recorded differently in co-determined plants than in establishments without works councils.

Rounding and Reporting Errors

Most respondents report their monthly gross earnings as a multiple of five, which indicates rounding. To address this potential measurement error, we used 0.95 times the observed minimum wage as the threshold for calculating the non-compliance indicator variable, i.e. € 8.075 and € 8.7305, instead of the actual values of € 8.50 (2016) and € 9.19 (2019). This makes misclassification of non-compliance with the statutory minimum wage less likely.[22] When we re-estimate the probit specifications with the lower minimum wage thresholds, the results in terms of non-compliance are similar to those obtained from specifications based on the actual values.

Conversion of Weekly into Monthly Working Hours

To convert weekly hours into monthly hours, most reports for the German government use a factor of 4.33 = (52 weeks/ 12 months), although the value of 4.35 = (365 days/ (12 months *7 days)), which we have used, is more accurate. Our main results are very similar if we apply the factor of 4.33.

In sum, we find no evidence that the calculation of the hourly wage, on which our identification of non-compliance with minimum wage legislation is based, affects the findings.

6. Summary and Conclusions

Our empirical analysis indicates that employees in co-determined establishments face a lower risk of being paid less than the statutory minimum wage than comparable employees in plants without works council. This result is in line with the predictions of the simple theoretical models

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[22] Estimated average non-compliance rates based on these lower thresholds range from 5.1% (contractual hours) to 8.6% (actual hours). They are therefore still substantial from an economic point of view.

if works councils primarily affect the enforcement of minimum wage legislation. Furthermore, the result is consistent with the view that the economic consequences associated with co-determination impact non-compliance predominantly via the productivity channel. Given the prevalence of non-compliance, we do not observe a correlation between co-determination and the difference between the minimum wage and the amount paid. All in all, our results suggest that even though the WCA does not explicitly grant works councils competences to enforce a minimum wage, information and co-determination entitlements in other areas bestow them with sufficient power to substantially reduce non-compliance or mitigate incentives to underpay.

Most of the research on co-determination at the plant level has focused on economic outcomes on which works councils could have a *direct* impact, such as wages, productivity, or profitability (e.g. Jäger et al. 2022, Mohrenweiser 2022). This paper examines an outcome on which works councils may have an *indirect* impact only. However, the combination of a general statutory obligation to ensure that laws must be executed, notable co-determination rights, and enforcement by government agencies apparently creates sufficient incentives for labour market institutions such as works councils to support the enforcement of a law. Consequently, instead of trying to optimise law enforcement, e.g. through stricter legal regulations, it might make more sense from a regulatory perspective, to provide economic incentives to increase the prevalence of labour market institutions that indirectly impact the outcomes of interest. To achieve the desired outcome, it is irrelevant whether co-determination affects non-compliance via enhancing enforcement directly or by mitigating the incentives to underpay, for example, because of associated productivity effects.

However, potential adverse effects should also be assessed before considering alterations to the WCA to strengthen the role of works councils in ensuring the payment of minimum wages. If firms attempt not complying with the minimum wage legislation and works councils restrict such activities, the incentives to prevent the establishment of plant-level co-determination may be strengthened. Moreover, relying on works councils means that minimum wages are enforced very unevenly, as councils exist in less than 10% of all eligible private sector establishments.

From a conceptual vantage point, our analysis suggests that the decision to comply with labour law is affected by implicit enforcement mechanisms or indirect determinants of the gains and costs of law abidance. Therefore, a standard Law and Economics perspective in which the detection probability is approximated by the frequency of inspections by the customs authorities may be inadequate. Instead, a more comprehensive interpretation of legal enforcement parameters in the light of interactions with labour market institutions such as works councils provides valuable insights.

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Tables

Table 2: Non-compliance with the statutory minimum wage and Works Councils

	Incidence of non-compliance with statutory minimum wage (in %)					
	Contractual hours			Actual hours		
	Works Council exists within firm					
	Pooled	2016	2019	Pooled	2016	2019
	2.6	3.0	2.2	4.7	4.6	4.7
N	6209	3035	3174	6518	3189	3329
	Works Council does not exist within firm					
	Pooled	2016	2019	Pooled	2016	2019
	10.3	11.9	8.8	17.1	19.1	15.2
N	6120	2979	3141	6737	3222	3515
	Amount of subminimum wage payment (conditional on incidence, mean, in €)					
E	Contractual hours			Actual hours		
	Works Council exists within firm					
	Pooled	2016	2019	Pooled	2016	2019
	2.0	1.8	2.2	2.0	1.8	2.1
N	207	117	90	351	174	177
	Works Council does not exist within firm					
	Pooled	2016	2019	Pooled	2016	2019
	1.7	1.7	1.7	1.8	1.7	1.9
N	698	377	321	1193	629	564

Notes: SOEP 2016, 2019; SOEP survey weights are used.

Table 3: Determinants of non-compliance with the statutory minimum wage
- (*average partial effects*) -

	Incidence of non-compliance with statutory minimum wage		Amount of subminimum wage payment conditional on non-compliance	
	Contractual hours	*Actual hours*	*Contractual hours*	*Actual hours*
Works council	-0.022**	-0.041**	0.305	0.187
	(0.007)	(0.010)	(0.252)	(0.200)
Collective	-0.006	-0.006	0.277	0.130
bargaining	(0.007)	(0.009)	(0.232)	(0.169)
Part-time work	0.029**	0.049**	-0.027	0.028
	(0.009)	(0.012)	(0.229)	(0.170)
Minijob	0.198**	0.231**	0.321	0.640**
	(0.027)	(0.029)	(0.214)	(0.169)
Age (in years)	-0.006**	-0.010**	-0.126*	-0.142**
	(0.002)	(0.002)	(0.054)	(0.037)
Age sqrd.	0.0001**	0.0001**	0.001+	0.002**
	(0.000)	(0.000)	(0.001)	(0.000)
Tenure (in years)	-0.003**	-0.004**	0.003	-0.010
	(0.000)	(0.001)	(0.012)	(0.008)
Male	-0.024**	-0.040**	0.166	0.255+
	(0.007)	(0.009)	(0.212)	(0.154)
Migration	0.006	0.014	-0.009	-0.125
background	(0.007)	(0.009)	(0.210)	(0.162)
Married	-0.007	-0.022**	0.387*	0.279+
	(0.006)	(0.008)	(0.181)	(0.146)
Apprenticeship-	-0.031**	-0.036**	-0.187	-0.267
	(0.009)	(0.012)	(0.228)	(0.174)
University degree	-0.047**	-0.069**	0.737+	0.387
	(0.007)	(0.011)	(0.393)	(0.273)
White-collar	-0.046**	-0.064**	-0.553**	-0.488**
worker	(0.010)	(0.012)	(0.184)	(0.153)
Firm size	-0.006	0.000	-0.198	-0.191
< 20 empl.	(0.009)	(0.014)	(0.283)	(0.216)
Firm size	-0.022**	-0.018+	-0.396	-0.534**
< 100 empl.	(0.008)	(0.010)	(0.269)	(0.200)
Firm size	-0.026**	-0.034**	-0.195	-0.339
< 200 empl.	(0.008)	(0.012)	(0.377)	(0.286)
Firm size	-0.028**	-0.042**	-0.339	-0.388+
< 2000 empl.	(0.009)	(0.011)	(0.283)	(0.225)
Firm size	-0.034**	-0.044**	-0.563	-0.586*
>= 2000 empl.	(0.008)	(0.013)	(0.346)	(0.237)
East Germany	0.038**	0.070**	-0.276	-0.186
	(0.008)	(0.012)	(0.206)	(0.149)
Worried about	0.028*	0.037*	0.493+	0.436+
job security	(0.012)	(0.015)	(0.282)	(0.248)
Year 2019	-0.016**	-0.009	0.276	0.149
	(0.005)	(0.007)	(0.179)	(0.129)
Industry Dummies	*yes*	*yes*	*yes*	*yes*
N	11703	12533	796	1362
(Pseudo) R^2	0.30	0.28	0.18	0.17

Notes: SOEP 2016, 2019. Col.1,2: Probit specifications. Col. 3,4: OLS specifications. Clustered standard errors in parentheses.
$^+ p < 0.1$, $^* p < 0.05$, $^{**} p < 0.01$. SOEP survey weights are used.

Table 4: Non-compliance with the statutory minimum wage – Heterogeneity

Incidence of non-compliance with statutory minimum wage
(average partial effects)

By years

	Contractual hours		Actual hours	
	2016	2019	2016	2019
Works council	-0.020$^+$	-0.019*	-0.055**	-0.026*
	(0.011)	(0.009)	(0.014)	(0.013)
N	5717	5986	6075	6458
Pseudo R^2	0.32	0.29	0.29	0.29

By gender

	Contractual hours		Actual hours	
	Male	Female	Male	Female
Works council	-0.005	-0.042**	-0.022*	-0.064**
	(0.008)	(0.011)	(0.011)	(0.017)
N	5966	5737	6487	6046
Pseudo R^2	0.35	0.27	0.31	0.25

By region

	Contractual hours		Actual hours	
	West	East	West	East
Works council	-0.014$^+$	-0.058**	-0.025**	-0.110**
	(0.008)	(0.019)	(0.009)	(0.029)
N	9431	2272	10107	2426
Pseudo R^2	0.30	0.32	0.29	0.27

By employment status

	Contractual hours		Actual hours	
	Full-time	Other	Full-time	Other
Works council	-0.008	-0.074**	-0.028**	-0.086**
	(0.007)	(0.020)	(0.009)	(0.025)
N	8146	3557	8635	3898
Pseudo R^2	0.25	0.19	0.24	0.17

By firm size

	Contractual hours			Actual hours		
	number of employees			number of employees		
	5 to 199	200 to 1999	$\geq$ 2000	5 to 199	200 to 1999	$\geq$ 2000
Works council	-0.039**	-0.017+	-0.016*	-0.058**	-0.044**	-0.025*
	(0.012)	(0.009)	(0.007)	(0.016)	(0.013)	(0.011)
N	5670	2631	3402	6201	2736	3596
Pseudo R^2	0.23	0.36	0.44	0.20	0.34	0.42

Notes: SOEP 2016, 2019. Clustered standard errors in parentheses. $^+ p < 0.1$, $^* p < 0.05$, $^{**} p < 0.01$. SOEP survey weights are used.

Appendix

A.1 Competitive Labour Market

First-order conditions:

Maximisation of expected profits, as defined in (1), with respect to L, K, and H yields:

$$\frac{\partial E(\pi)}{\partial H} := \pi_H = Q_H(L + K, H) - w^H = 0 \tag{8.1.1}$$

$$\frac{\partial E(\pi)}{\partial L} = Q_L(L + K, H) - [1 - p]w^C - pw^M - pF'(L[w^M - w^C])[w^M - w^C]$$

$$= Q_L(L + K, H) - w^M + [w^M - w^C][1 - p - pF'(L[w^M - w^C])] = 0 \tag{8.1.2}$$

$$\frac{\partial E(\pi)}{\partial K} := \pi_K = Q_L(L + K, H) - [1 - p]w^M - pw^M = Q_L(L + K, H) - w^M = 0 \tag{8.1.3}$$

Substituting (8.1.3) into (8.1.2) yields $\pi_L = 0$ because:

$$[1 - p][w^M - w^C]\underbrace{[1 - p - pF'(L[w^M - w^C])]}_{=\pi_L=0} = 0 \tag{8.1.4}$$

Second-order derivatives and conditions:

For further use note that $\pi_{KL} = \pi_{KK}$ and $\pi_{HL} = \pi_{HK} = \pi_{KH} = Q_{LH}$, while $\pi_{LK} = \pi_{LH} = 0$. The employment levels H*, L*, and K*, which ensure that the derivatives in (8.1.1), (8.1.2) and (8.1.4) are zero, define a maximum of expected profits if the second-order conditions hold. They are $\pi_{HH} = Q_{HH} < 0$, $\pi_{KK} = Q_{LL} < 0$ and:

$$\pi_{LL} = -[w^M - w^C]pF''(L[w^M - w^C]) < 0 \tag{8.1.5}$$

$$\pi_{HH}\pi_{KK} - \pi_{KH}^2 = Q_{HH}Q_{LL} - Q_{KH}^2 > 0 \tag{8.1.6}$$

$$D = \pi_{HH}\pi_{LL}\pi_{KK} - \pi_{KH}^2\pi_{LL} = \pi_{LL}[\pi_{HH}\pi_{KK} - \pi_{KH}^2] < 0 \tag{8.1.7}$$

Totally differentiating the first-order conditions (8.1.1), (8.1.2) and (8.1.4) with respect to the endogenous variables and an exogenous parameter x, x = p, F', α, we obtain:

$$\begin{bmatrix} \pi_{HH} & \pi_{KH} & \pi_{KH} \\ 0 & \pi_{LL} & 0 \\ \pi_{KH} & \pi_{KK} & \pi_{KK} \end{bmatrix} \begin{bmatrix} dH \\ dL \\ dK \end{bmatrix} = \begin{bmatrix} -\pi_{Hx} \\ -\pi_{Lx} \\ -\pi_{Kx} \end{bmatrix} [dx] \tag{8.1.8}$$

Probability of fine payment (x = p):

The derivatives of the first-order conditions with respect to p are $\pi_{Hp} = \pi_{Kp} = 0$ and $\pi_{Lp} = -[1 + F']$. Applying Cramer's rule, we obtain $dH^*/dp = 0$ and:

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$$\frac{dL^*}{dp} = -\frac{dK^*}{dp} = [1 + F']\frac{\pi_{HH}\pi_{KK} - \pi_{KH}^2}{D} < 0 \qquad (8.1.9)$$

As $[1 - p]L^*$ declines with p, while $H^* + L^* + K^*$ remains unaffected, the incidence, I, falls.

Marginal fine ($x = F'$):

The relevant derivatives with respect to the marginal fine, F', equal $\pi_{HF'} = \pi_{KF'} = 0$, and $\pi_{LF'} = -p$. Therefore, the changes in employment are given by $dH^*/dF' = 0$ and:

$$\frac{dL^*}{dF'} = -\frac{dK^*}{dF'} = p\frac{\pi_{HH}\pi_{KK} - \pi_{KH}^2}{D} < 0 \qquad (8.1.10)$$

A fall in L^* and constant overall employment result in a lower incidence, I.

Productivity ($x = \alpha$):

The relevant derivatives are $\pi_{L\alpha} = 0$, $\pi_{H\alpha} = \beta$ and $\pi_{K\alpha} = 1$. We obtain $dL^*/d\alpha = 0$ and:

$$\frac{dH^*}{d\alpha} = \pi_{LL}\frac{\pi_{KH} - \beta\pi_{KK}}{D} \qquad (8.1.11)$$

$$\frac{dK^*}{d\alpha} = \pi_{LL}\frac{\beta\pi_{KH} - \pi_{KK}}{D} \qquad (8.1.12)$$

For $\pi_{KH} = Q_{KH} \geq 0$, employment, H^*, of high wage workers and, K^*, of minimum-wage workers paid according to law certainly rise. Because, the number, L^*, of underpaid minimum wage workers remains unaffected, the incidence, I, declines.

Wage of high-wage employees ($x = w^H$):

The relevant derivatives with respect to w^H, are $\pi_{Hw^H} = -1$ and $\pi_{Kw^H} = \pi_{Lw^H} = 0$. Applying Cramer's rule, we obtain $dL^*/dw^H = 0$ and:

$$\frac{dH^*}{dw^H} = \frac{\pi_{LL}\pi_{KK}}{D} < 0 \qquad (8.1.13)$$

$$\frac{dK^*}{dw^H} = -\frac{\pi_{LL}\pi_{KH}}{D} \qquad (8.1.14)$$

For $\pi_{KH} = Q_{KH} > 0$, employment, K^*, of minimum-wage workers paid according to law falls. As $[1 - p]L^*$ does not vary with w^H, while $H^* + L^* + K^*$ surely falls for $\pi_{KH} \geq 0$, the incidence, I, rises.

Competitive wage of minimum-wage employees ($x = w^C$):

The derivatives with respect to w^C, are $\pi_{Hw^C} = \pi_{Kw^C} = 0$, and $\pi_{Lw^C} = pF''L < 0$. Applying Cramer's rule yields $dH^*/dw^C = 0$ and:

$$\frac{dL^*}{dw^C} = -\frac{dK^*}{dw^C} = -pF''L\frac{\pi_{HH}\pi_{KK} - \pi_{KH}^2}{D} > 0 \qquad (8.1.15)$$

As $[1 - p]L^*$ rises with w^C, while $d(H^* + L^* + K^*)/dw^C = 0$, the incidence, I, increases.

A.2 Monopsonistic Setting

In this modification of the basic model, we assume that the firm can determine the extent of non-compliance per minimum-wage worker, that is, the difference between the minimum wage, w^M, and the monopsonistic wage, w^{Mon}, it decides to pay to minimum-wage worker. We follow Yaniv (1988) and assume that the labour supply curve of minimum-wage workers who are underpaid, L, which the firm faces is increasing in the wage, w^{Mon}, implying that $L = L(w^{Mon})$ and $\partial L/\partial w^{Mon} := L_w > 0$. Since we are interested in non-compliance, we assume $w^{Mon} < w^M$. Moreover, the firm can decide about the number of minimum-wage workers, K, it pays the minimum wage, as in the model with the competitive labour market. We assume that the firm can hire as many minimum-wage workers at the wage w^M as it wants. We further retain the assumption that the firm is a price taker on the market for high-wage employees.

Expected profits $E(\pi)$ are given by:

$$E(\pi) = Q(L + K, H) - w^H H - [1 - p][w^{Mon}L + w^M K] - p[w^M L + K]$$
$$-pF(L[w^M - w^{Mon}]), \qquad (8.2.1)$$

where $Q(L + K, H)$ and $F(L[w^M - w^{Mon}])$ and their properties are defined in the main text. The firm maximises expected profits by choosing the wage, w^{Mon}, paid to minimum workers, the number of minimum-wage workers paid the minimum wage, K, and the number of high wage workers, H.

$$\frac{\partial E(\pi)}{\partial w^{Mon}} = Q_K(L + K, H)L_w - [1 - p][L + w^{Mon}L_w] - pw^M L_w[1 + F']$$

$$+pF'[L + w^{Mon}L_w]$$

$$= Q_K(L + K, H)L_w - [L + w^{Mon}L_w] + \underbrace{p[1 + F'][L + w^{Mon}L_w - w^M L_w]}_{expected\ marginal\ costs\ of\ non-compliance} \qquad (8.2.2)$$

$$\frac{\partial E(\pi)}{\partial K} := \pi_K = Q_K(L + K, H) - w^M = 0 \qquad (8.2.3)$$

$$\frac{\partial E(\pi)}{\partial H} := \pi_H = Q_H(L + K, H) - w^H = 0 \qquad (8.2.4)$$

We assume that the expected marginal costs of non-compliance, $p[1 + F'][L + w^{Mon}L_w - w^M L_w]$, as defined in (8.2.2), are negative (see Yaniv 1988). Inserting (8.2.3) into (8.2.2), we obtain:

$$\frac{\partial E(\pi)}{\partial w^{Mon}} = Q_K(L, H)L_w - [L + w^{Mon}L_w] + p[1 + F'][L + w^{Mon}L_w - w^M L_w]$$

$$= w^M L_w - [L + w^{Mon}L_w] + p[1 + F'][L + w^{Mon}L_w - w^M L_w]$$

$$= \underbrace{[1 - p - pF'(L[w^M - w^{Mon}])]}_{:=\pi_w} [L + w^{Mon}L_w - w^M L_w] = 0 \quad (8.2.5)$$

Given that the second factor in (8.2.5) is non-zero, $\pi_w = 0$ holds.

For further use note that $\pi_{Kw} = \pi_{KK}L_w$ and $\pi_{Hw} = \pi_{HK}L_w = \pi_{KH}L_w = Q_{KH}L_w$, while $\pi_{wK} = \pi_{wH} = 0$. The wage, w^{Mon}, the number of high wage employees, H*, and the number of minimum-wage workers, K*, actually paid w^M, which ensure that the derivatives in (8.2.3) to (8.2.5) are zero, define a maximum of expected profits if the second-order conditions hold. They are $\pi_{KK}, \pi_{HH} < 0$ and:

$$\pi_{ww} = pF''[L + w^{Mon}L_w - w^M L_w] < 0 \quad (8.2.6)$$

$$\pi_{HH}\pi_{KK} - \pi_{KH}^2 = Q_{HH}Q_{LL} - Q_{KH}^2 > 0 \quad (8.2.7)$$

$$D = \pi_{HH}\pi_{ww}\pi_{KK} - \pi_{KH}^2\pi_{ww} = \pi_{ww}[\pi_{HH}\pi_{KK} - \pi_{KH}^2] < 0 \quad (8.2.8)$$

Totally differentiating the first-order conditions (8.2.3) to (8.2.5), we obtain:

$$\begin{bmatrix} \pi_{HH} & \pi_{KH}L_w & \pi_{KH} \\ 0 & \pi_{ww} & 0 \\ \pi_{KH} & \pi_{KK}L_w & \pi_{KK} \end{bmatrix} \begin{bmatrix} dH \\ dw^{Mon} \\ dK \end{bmatrix} = \begin{bmatrix} -\pi_{Hx} \\ -\pi_{wx} \\ -\pi_{Kx} \end{bmatrix} [dx] \quad (8.2.9)$$

Probability of fine payment (x = p):

The derivatives of the first-order conditions (8.2.3) to (8.2.5) with respect to p are $\pi_{Hp} = \pi_{Kp} = 0$ and $\pi_{wp} = -[1 + F']$. Applying Cramer's rule, we obtain $dH^*/dp = 0$ and:

$$\frac{dw^{Mon}}{dp}L_w = -\frac{dK^*}{dp} = [1 + F']L_w \frac{\pi_{HH}\pi_{KK} - \pi_{KH}^2}{D} < 0 \quad (8.2.10)$$

As L falls, given the decline in w^{Mon}, while $L(w^{Mon}) + K^*$ remains constant, given $d[L(w^{Mon}) + K^*]/dp = L_w dw^{Mon}/dp + dK^*/dp$, $[1 - p]L^*$ declines with p, while $H^* + L + K^*$ is unaffected. Therefore, the incidence, I, falls. Finally, the extent of non-compliance, $w^M - w^{Mon}$, rises.

Marginal fine (x = F'):

The derivatives of (8.2.3) to (8.2.5) with respect to F' equal $\pi_{HF'} = \pi_{KF'} = 0$ and $\pi_{wF'} = -p$. Therefore, the changes in employment and the wage are given by $dH^*/dF' = 0$ and:

$$\frac{dw^{Mon}}{dF'} L_w = -\frac{dK^*}{dF'} = pL_w \frac{\pi_{HH}\pi_{KK} - \pi_{KH}{}^2}{D} < 0 \qquad (8.2.11)$$

The number of underpaid minimum-wage workers, $L(w^{Mon})$ declines, while the overall number of minimum-wage workers, $L(w^{Mon}) + K^*$, remains constant. A fall in $L(w^{Mon})$ and constant overall employment result in a lower incidence, I. Finally, a lower wage, w^{Mon}, results in a higher extent of non-compliance, $w^M - w^{Mon}$.

Productivity $(x = \alpha)$:

The derivatives of (8.2.3) to (8.2.5) with respect to α, are $\pi_{w\alpha} = 0$, $\pi_{H\alpha} = \beta$ and $\pi_{K\alpha} = 1$. Applying Cramer's rule, we obtain $dw^{Mon}/d\alpha = 0$ and:

$$\frac{dH^*}{d\alpha} = \pi_{ww} \frac{\pi_{KH} - \beta\pi_{KK}}{D} \qquad (8.2.12)$$

$$\frac{dK^*}{d\alpha} = \pi_{ww} \frac{\beta\pi_{KH} - \pi_{KK}}{D} \qquad (8.2.13)$$

For $\pi_{KH} = Q_{KH} \geq 0$, employment, H^*, of high wage workers and, K^*, of minimum-wage workers paid according to law certainly rise. Because, the number, $L(w^{Mon})$, of underpaid minimum wage workers remains unaffected, the incidence, I, declines, while the extent of non-compliance, $w^M - w^{Mon}$, does not change.

Wage of high-wage employees $(x = w^H)$:

The derivatives of (8.2.3) to (8.2.5) with respect to w^H, are $\pi_{Hw^H} = -1$ and $\pi_{Kw^H} = \pi_{Lw^H} = 0$. Applying Cramer's rule, we obtain $dw^{Mon}/dw^H = 0$ and:

$$\frac{dH^*}{dw^H} = \frac{\pi_{ww}\pi_{KK}}{D} < 0 \qquad (8.2.14)$$

$$\frac{dK^*}{dw^H} = -\frac{\pi_{ww}\pi_{KH}}{D} \qquad (8.2.15)$$

For $\pi_{KH} = Q_{KH} > 0$, employment, K^*, of minimum-wage workers paid according to law falls. As $[1 - p] L(w^{Mon})$, is unaffected, while $H^* + L^* + K^*$ surely falls for $\pi_{KH} \geq 0$, the incidence, I, then rises.

A.3 Tables

Table A1: Descriptive Statistics – Covariates

Variable	Mean	Sd.
Collective bargaining	0.42	0.49
Part-time work	0.20	0.40
Mini-job	0.06	0.23
Age (in years)	43.93	11.68
Tenure (in years)	10.72	10.41
Male	0.56	0.50
Migration background	0.24	0.43
Married	0.57	0.49
Apprenticeship	0.61	0.49
University	0.26	0.44
White-collar worker	0.76	0.42
Firm size 5 to < 20 employees	0.09	0.29
Firm size < 100 employees	0.18	0.39
Firm size < 200 employees	0.08	0.28
Firm size < 2000 employees	0.23	0.42
Firm size > 2000 employees	0.31	0.46
East Germany	0.16	0.37
Worried about job security	0.07	0.26
Manufacturing	0.33	0.47
Wholesale	0.15	0.36
Transport	0.06	0.24
Education	0.03	0.16
Health	0.09	0.29
Other private industry	0.19	0.39
Year 2019	0.51	0.50

Notes: SOEP 2016, 2019; N=12533. SOEP survey weights are used.

Table A2: Non-compliance with the statutory minimum wage

Incidence of non-compliance with statutory minimum wage (in %)					
Contractual hours			Actual hours		
Pooled	2016	2019	Pooled	2016	2019
6.3	7.3	5.4	10.8	11.8	9.8
Amount of subminimum wage payment					
(conditional on incidence, mean, in €)					
Contractual hours			Actual hourse		
Pooled	2016	2019	Pooled	2016	2019
1.8	1.7	1.8	1.9	1.8	2.0

Notes: SOEP 2016, 2019. N_pooled_incidence=12329/13255; N_2016_incidence=6014/6411; N_2019_incidence=6315/6844.
N_pooled_amount=905/1544; N_2016_ amount=494/803; N_2019_ amount=411/741. SOEP survey weights are used.

Table A3: Non-compliance with the statutory minimum wage
– Robustness Checks (*average partial effects*) –

	Incidence of non-compliance with statutory minimum wage	
	Contractual hours	*Actual hours*
	Variable pay	
Works council	-0.022**	-0.041**
	(0.007)	(0.009)
N	11703	12533
Pseudo R^2	0.30	0.28
	Working time recording system	
Works council	-0.017*	-0.026*
	(0.008)	(0.012)
N	5303	5704
Pseudo R^2	0.31	0.29
	Rounding and reporting errors	
Works council	-0.012+	-0.035**
	(0.006)	(0.009)
N	11703	12533
Pseudo R^2	0.31	0.28
	Conversion of weekly into monthly working hours	
Works council	-0.022**	-0.039**
	(0.007)	(0.010)
N	11703	12533
Pseudo R^2	0.30	0.28

Notes: SOEP 2016, 2019. Probit specifications. Clustered standard errors in parentheses. $^+ p < 0.1, ^* p < 0.05, ^{**} p < 0.01$. SOEP survey weights are used.