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**Minimum Wage Effects on Gender
Gaps in Working Hours and
Earnings in Germany**

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Keyword: minimum wage, gender pay gap, gender time gap, gender earnings gap

JEL Classification: J08, J16, J22, J31

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1 Introduction

Women are overrepresented in the low-wage sector in Germany and are significantly more likely than men to be affected by the statutory minimum wage (Kalina and Weinkopf 2021: 11; Grabka and Göbler 2020). In 2014, before the introduction of the minimum wage, around 14 percent of women and of around 8 percent of men received earnings below 8.50 euros per hour (Mindestlohnkommission 2016: 41). The latest increase in the minimum wage to 12 euros from October 2022 will also affect more women than men (DGB 2022). Mainly for this reason, it is assumed that the statutory minimum wage can achieve a contribution to reducing gender inequalities (Weinkopf 2012). Furthermore, the question arises whether women are not only more frequently affected by the minimum wage, but whether the minimum wage also has different effects on women than on men. Reasons for this could be that the wage gap to be closed by the minimum wage could be larger for affected women than for men, that women are more often paid below the minimum wage, or that working time effects may differ due to restrictions and preferences that differ by gender.

While many evaluation results are already available on the general effects of the statutory minimum wage (see overview in Bruttel 2019; Minimum Wage Commission 2020), comparatively little is known about its gender-specific effects. Initial studies based on the Structure of Earnings Survey suggest that the minimum wage reduces the gender pay gap in hourly wages (Caliendo and Wittbrodt 2022; Ohlert 2018; Boll et al. 2017). Using the Socioeconomic Panel, it was shown that there were reductions in working hours of similar magnitude for women and men due to the introduction of the minimum wage (Bonin et al. 2018; Bachmann et al. 2020). However, whether, to what extent, and over what period of time there were working time effects of the minimum wage is still debated in light of different findings (Pusch et al. 2020). There has been no conclusive evidence yet on the gendered effect of the minimum wage on monthly earnings. The impact of the minimum wage on working hours and earnings of women and men is of great interest, as these variables are jointly decisive for earnings and thus also for social security (Bruckmeier and Bruttel 2021; Bach et al. 2022). Further, gender-specific evaluation results allow an assessment of the statutory minimum wage as a gender equality policy measure.

The minimum wage and Germany's regulation of marginal employment are of particular importance for working time decisions of women and men with low wages. This is because marginal employees and, to a lesser extent, part-time employees are strongly affected by low wages (Mindestlohnkommission 2016: 41) and at the same time women are strongly overrepresented in these forms of employment (Bundesagentur für Arbeit 2022). The combination of tax and social contribution exemption for marginal employment and spousal tax splitting creates incentives for second earners, and especially for married women, not to expand their employment beyond a marginal employment, which is also referred to as the "mini-job trap" (Blömer et al. 2021a; Krebs and Scheffel 2021). This contrasts with the interests of part-time workers, and thus many women, who rather would like to expand their working hours (Harnisch et al.

2018; Blömer et al. 2021b). The minimum wage could therefore cause gender-specific adjustments in working hours, which would influence gender inequality in monthly earnings.

This paper examines the impact of the introduction of the statutory minimum wage on hourly wages, working hours and monthly earnings of women and men in establishments affected by the introduction of a minimum wage compared to establishments that were not affected. Thus, effects on the gender pay gap, the gender time gap and the gender earnings gap are determined. To this end, the empirical investigation uses the special possibility of linking the 2014 Earnings Structure Survey (VSE) and the 2015 Earnings Survey (VE) at the establishment level to form a panel data set. Using a difference-in-differences approach, the gender specific differences in changes in hourly wages, working hours, and monthly earnings are compared across establishments affected and not affected by the minimum wage introduction. The analysis is conducted separately for average working hours and earnings of all employees and those of low-wage workers. Further, I provide evidence of minimum wage effects on unadjusted gender gaps as well as on gender gaps adjusted for selected factors. Using adjusted gender gaps sheds light on the role that the unequal distribution of women and men across full-time, part-time and marginal employment plays for effects of the minimum wage.

Section 2 of this paper presents theoretical expectations regarding minimum wage effects on women and men. Section 3 reviews previous literature on this topic. Section 4 describes the data and Section 5 explains the methodology. Section 6 shows descriptive results and Section 7 presents results from difference-in-differences analyses. Section 8 concludes.

2 Theoretical expectations

The introduction of the statutory minimum wage in 2015 required that the wages from employees who previously earned less than €8.50 per hour had to increase to at least this level. Minimum wages therefore typically cause a reduction in employment with pay below the minimum wage and an increase in employment at and above the minimum wage (Cengiz et al. 2019). 14 percent of women were in employment with an hourly wage below €8.50 in 2014, while this was the case for 8 percent of men. Of the approximately 4 million employees affected by the introduction of the minimum wage, around 2.5 million were held by women. Women are therefore likely to have benefited from the minimum wage more frequently in absolute and proportional terms. In establishments affected by the minimum wage, the average hourly wages of women are therefore likely to increase more than those of men, which would reduce the average gender pay gap (in these establishments).

Hypothesis 1a: The minimum wage reduces the average gender pay gap.

A distinction must be made between the minimum wage effects on the average wages of women and men and the effects on women and men who are directly affected by the minimum

wage, i.e. workers with low hourly wages. Following Cengiz et al. (2019), this study defines those with hourly wages up to and just above the minimum wage as workers affected by the minimum wage. The specific threshold is set at up to 10 euros per hour, which corresponded to the low-wage threshold in both 2014 and 2015.¹ The hourly wage effects on low-wage workers are likely to be similar by gender on average, because they are independent of how many women and men are in that group or what share they each make up of the population of women and men.² Different effects could arise in this case if there is also a gender pay gap in the lower wage range, so that the wage gap to be closed up to the minimum wage is larger for women than for men. According to previous findings, however, the gender pay gap among low-wage workers is small (Ohlert 2018). A different hourly wage effect on women and men in low-wage jobs could further arise if compliance with the minimum wage would differ by gender or if there were wage effects above the minimum wage for women and men to different degrees (spillover effects).

Hypothesis 1b: The minimum wage does not change the gender pay gap among low-wage employees.

The gender pay gap in Germany can be partly explained by structural differences between women and men regarding qualifications, work experience or scope of employment, as well as by gender segregation into different occupations and different management levels (Finke et al. 2017). A gender pay gap adjusted for such factors indicates the size of the pay gap between women and men with comparable characteristics. A different set of structural characteristics may be considered, depending on epistemic interest. Usually, some individual characteristics that are relevant to wages cannot be observed and therefore cannot be controlled for, such as individual ability beyond educational attainment. On the other hand, the distribution of characteristics, such as managerial positions, may itself be the result of gendered processes.

In this study, the impact of the minimum wage on gender inequalities is adjusted for differences in women's and men's endowments in educational attainment, work experience, and form of employment (full-time, part-time, or marginal). The form of employment is primarily an indicator of the scope of employment, but also of the institutional arrangements of the different forms of employment. The reason for this specification is that, in addition to controls for human capital indicators (education and work experience), there is an explicit interest in the extent to which the differential distribution of women and men in forms of employment explains gender inequalities in hourly wages, hours of work, and monthly wages. It is also of interest how the

¹ The low-wage range is defined by wages below two-thirds of the median wage. The low-wage threshold determined on the basis of the SES and ES is €9.84 for 2014 and €9.94 for 2015.

² Here, I focus on the average earnings and working hours of low-wage employees and not on different percentiles of the hourly wage distribution, as in Caliendo and Wittbrodt (2021), for example. This is to determine the mean effect on the women and men affected by the minimum wage. This includes possible spillover effects on employees with hourly earnings of up to 10 euros.

minimum wage influences gender inequalities independent of different types of employment. As described above, the overrepresentation of women in part-time work and marginal employment is a significant explanation for the gender pay gap and also for the fact that women are affected by the minimum wage more often than men. Thus, we are interested in the question of what effect the minimum wage would have on the gender pay gap if women and men were equally distributed across different forms of employment.

With regard to hourly wages, it can be assumed that the minimum wage has a reducing effect on the average adjusted gender pay gap. While the scope of employment is an important explanation for the gender pay gap, it is also to a large extent determined by segregation processes in the same type of employment. The minimum wage requires hourly wages to be raised for affected employees regardless of occupation and position. This means that gender wage differentials that exist due to occupational and vertical segregation or discrimination in the workplace should be reduced by the minimum wage.

Hypothesis 1c: The minimum wage reduces the average adjusted gender pay gap.

Next, we need to take a closer look at whether there are gender-specific minimum wage effects on working hours. Reducing working hours is one of the most frequently mentioned company adjustment reactions to the minimum wage (Bellmann et al. 2016). This can be a measure to reduce increased wage costs in the short term. Adjustments to working hours can also be seen as a way for firms to adjust employment. However, gender bias does not seem particularly plausible here. However, employees may want to reduce or extend their working hours due to a minimum wage-induced increase in hourly wages (Bachmann et al. 2022: 115). At this point, there could be relevant behavioral differences between women and men that would also have consequences for monthly earnings. With the introduction of the minimum wage, there were incentives for marginally employed persons to reduce their working hours in order not to exceed the upper earnings limit of 450 euros and thus to remain in this form of employment. Due to spousal splitting and tax class V, transitions to regular employment are relatively unprofitable for women (Blömer et al. 2021a). Therefore, especially for women in marginal employment, the main benefit of the minimum wage could be to achieve a similar amount of (tax-free) earnings, with fewer working hours. Women account for about 60 percent of the exclusively marginally paid employment in Germany. The inflows and outflows of exclusively marginally paid employees show that the development after the introduction of the statutory minimum wage in 2015 was initially almost identical for both genders, while from the end of 2015 the number of women entering this form of employment decreased significantly more than that of men (vom Berge et al. 2018: 48).

Women are much more overrepresented in part-time employment than in marginal employment. A priori, it is not clear whether it is more attractive for part time employees to earn more with unchanged or even higher working hours, or to reduce working hours in order to earn a

similar amount with less working time. Even in part-time work with low hourly wages (midijob sector), the tax and contribution system provide incentives for a low level of employment, especially for women. On the other hand, studies on working time preferences found that, on average, women working part-time would like to see a somewhat greater expansion of working hours than men working part-time (Harnisch et al. 2018; Blömer et al. 2021b). Women and men employed full-time however tend to desire lower working hours. Due to the high proportion of women and the low proportion of men in part-time employment overall, more women than men would like to see their working hours extended (ibid.). Knowing these preferences of women and men suggests that the minimum wage has reduced women's working hours less or even increased them more than men's. Accordingly, the minimum wage is expected to have reduced the working time gap (gender time gap) between women and men.

Hypothesis 2a: The minimum wage reduces the average gender time gap.

Gender specific adjustments of working hours are likely to be particularly evident among low-wage workers since they are directly affected by the introduction of the minimum wage.

Hypothesis 2b: The minimum wage reduces the gender time gap among low-wage employees.

Among employees in the same form of employment and with otherwise similar characteristics no or significantly smaller different working time responses of women to the minimum wage are to be expected. Accordingly, we test the hypothesis that the adjusted gender time gap is not reduced by the minimum wage.

Hypothesis 2c: The minimum wage does not reduce the average adjusted gender time gap.

The expected different hourly wage and working time effects of the minimum wage on women and men lead to the expectation that positive effects on monthly earnings will tend to be higher for women than for men. The average earnings gap between women and men (gender earnings gap) is therefore expected to narrow as a result of the minimum wage. According to hypotheses 1a and 2a, both the average gender pay gap and the average gender time gap are expected to decrease.

Hypothesis 3a: The minimum wage reduces the average gender earnings gap.

For the effect of the minimum wage on the gender earnings gap among low-wage workers, the hypotheses on hourly wage and working time effects do not provide a very clear picture. No gender-specific minimum wage effect on hourly wages is expected, but a weak reduction in working hours is expected for women in low-wage jobs. Overall, a reduction in the gender

earnings gap is thus expected for low-wage workers, although this reduction is presumably weaker than on average for all employees.

Hypothesis 3b: The minimum wage reduces the average gender earnings gap among low-wage employees.

The reducing effect of the minimum wage on the adjusted gender pay gap expected in 1c suggests in principle that the minimum wage also reduces the adjusted gender earnings gap. However, since no effect on the adjusted gender time gap is expected (hypothesis 2c), the gender earnings effect is not additionally reduced by gender-specific working time effects. Overall, the adjusted gender earnings gap is expected to be reduced, but to a lesser extent than the unadjusted average gender earnings gap (see hypothesis 3c).

Hypothesis 3c: The minimum wage reduces the adjusted gender earnings gap.

3 Previous findings

Internationally, minimum wages have been established for much longer than in Germany, and therefore a body of research on the specific effects of minimum wages on women and men and the gender pay gap exists. Most studies examine the effects on hourly wages. For example, DiNardo et al. (1996) show for the U.S. that the reduction in the real minimum wage in the period 1979 to 1988 explains a substantial share of the increase in wage inequality, especially for women. In a study of minimum wage increases in U.S. states between 1979 and 2016, Cengiz et al. (2019) find a higher minimum wage impact among women than in the overall population and, accordingly, a larger shift in women's earnings to the wage level of each new minimum wage. The overall employment effect for women is positive. However, there are hardly any other recent studies for the U.S. that differentiate by gender. Instead, many conceptually point out that raising the federal minimum wage, for example to the discussed level of \$15, would benefit women in particular (e.g., Boesch et al. 2021). The federal minimum wage in the United States has been \$7.25 since 2009. Looking to other countries, Bargain et al. (2019) found that after the respective introduction of a minimum wage, there was a significant reduction in the gender gap in low wages in Ireland, while there was little change in the UK. Other studies for the UK also show that the initially low level of the minimum wage there had no significant impact on the gender pay gap (Robinson 2005; Dex et al. 2000), which was partly attributed to a higher degree of noncompliance with the minimum wage among women. Other studies show a reduction in the gender pay gap due to minimum wages in Poland (Majchrowska and Strawiński 2018), Canada (Shannon 2010), and Indonesia (Hallward-Driemeier et al. 2017).

For Germany, only a few studies have so far focused on different minimum wage effects on women and men. A simulation study by Boll et al. (2017), based on the SOEP, predicted a decrease in the mean gender pay gap by 2.4 percentage points due to the introduction of the minimum wage, based on effects up to the 10th percentile of the hourly wage distribution. The result is based on the assumption that all wages below the €8.50 threshold would be raised to the minimum wage level in 2014. Descriptive findings show somewhat but not significantly stronger wage growth for women than for men after the introduction of the minimum wage, especially for unskilled and semi-skilled workers (Mindestlohnkommission 2018: 48). For women, there was a significant increase in the number of jobs, not only at but also just above the minimum wage (Ohlert 2018: 28). For men, on the other hand, the increase in jobs at and above the minimum wage was weaker overall, but extended into higher wage ranges in eastern Germany than for women (ibid.). Even after the introduction of the minimum wage, women were still more likely than men to be in jobs paying below the minimum wage (Mindestlohnkommission 2016: 53). In eastern Germany, the average gender wage gap within the low-wage sector³ reduced from about four percent in 2014 to about one percent in 2015, indicating an effect of the minimum wage introduction (Ohlert 2018). In West Germany, however, the gender wage gap within the low-wage sector was around -1 percent in both 2014 and 2015, meaning that women earned slightly more per hour than men on average (ibid.).

The study by Caliendo and Wittbrodt (2022) is the first to date to explicitly address the impact of the minimum wage in Germany on the gender pay gap in an evaluation study. Based on data from the 2014 and 2018 Structure of Earnings Surveys, they use regional differences in the bite of the minimum wage to estimate the impact of the minimum wage on the unadjusted gender hourly wage gap. The study finds a significant negative effect of the minimum wage on the regional gender pay gap. Between 2014 and 2018, the pay gap at the 10th percentile of the wage distribution narrowed by 4.6 percentage points (or 32 percent) in regions that were heavily affected by the minimum wage compared to regions that were less affected. For the wage gap at the 25th percentile, the effect was still -18 percent, while for the mean it was smaller (-11 percent) and only weakly statistically significant. The effect is thus be strongest at the lower end of the wage distribution, but also extends to higher parts of the wage distribution.

Other available evidence on causal effects of the statutory minimum wage on earnings and working hours of women and men is based on the Socio-Economic Panel. Burauel et al. (2018) and Bachmann et al. (2020) compared the individual wage growth of workers who earned less than 8.50 euros before the introduction of the minimum wage with the wage growth of workers who earned between 8.50 euros to 10 euros before the introduction. The study shows a robust minimum wage effect of around 5.9 percent on women's hourly wages in the short run, but not on men's (Burauel et al. 2018: 66ff.). Bachmann et al. (2020) confirm this finding for 2015, but

³ For employment with hourly earnings of up to 10 euros.

find positive effects on men's hourly wages and none on women's for 2016 and 2017. The same approach found no significant effects on gross monthly wages for women or men for the period from 2015 to 2017 (Burauel et al. 2018: 139; Bachmann et al. 2020: 190).

To examine the effects on working hours, Bonin et al. (2018) also compare the development of employees who earned less than 8.50 euros per hour in 2014 with that of employees who earned 8.50 euros to 10 euros per hour. They find a highly significant decrease in contractual working hours of -5.6 percent for women affected by the minimum wage, which is slightly smaller for men (Bonin et al. 2018: 102ff.). The study by Bachmann et al. (2020) compares the development of working hours in regions highly and low affected by the minimum wage. Here, too, the introduction of the minimum wage results in reductions in working hours for women and men, which are even somewhat greater for women than for men. The study also finds a stronger negative effect on working hours for women than for men for the increase in the minimum wage in 2017. Both studies use control variables, such as individual age, education level, and other characteristics. The consequences of the minimum wage for women and men are thus determined *ceteris paribus*, i.e. under otherwise identical conditions.

With regard to the effects of the minimum wage on the monthly earnings of women and men, no (unequal) effects have been demonstrated so far. The estimators from Bachmann et al. (2020) are statistically insignificant for both women and men.

Against the backdrop of the unequal distribution of women and men in full-time and part-time employment, but also due to the legal regulations of different forms of employment in Germany, the impact of the minimum wage by form of employment is relevant too. The minimum wage, as a value set per hour, in combination with the fixed earnings ceiling of 450 euros for marginal employment, which was in effect until September 2022, represented a *de facto* upper limit on working hours. Bossler and Schank (2022) show that the monthly wage effects of the minimum wage were small at the mini-job threshold. This suggests that working hours were often reduced in minijobs. Also, according to Ohlert (2022), this form of employment experienced relatively large reductions in working hours and no significant increases in monthly earnings when the minimum wage was introduced. In contrast, regular part-time workers tended to experience expansions in working hours and, in combination with the increased hourly wage, higher monthly earnings (Ohlert 2022). This suggests that women in regular part-time employment may have benefited most from higher earnings due to the minimum wage. Marginally employed workers, on the other hand, received significantly higher hourly wages and thus had to work fewer hours to earn a similarly high wage as before. However, there was only a very small increase in earnings (*ibid.*).

4 Data and variables

This study uses the 2014 Structure of Earnings Survey (SES) and the 2015 Earnings Survey (ES) to analyze the short-term effects of the introduction of a general minimum wage on women and men (Federal Statistical Office 2016a, 2017).⁴ To enable a causal analysis, information on establishments surveyed in both years is linked. With the exception of establishments in the public sector and establishments employing only marginal employees, this is possible for all establishments surveyed in the 2015 ES. It is therefore possible to make statements about minimum wage effects in the private sector.

The Structure of Earnings Survey is a large official compulsory survey of establishments conducted by the Federal Statistical Office every four years. It collects information on characteristics of the establishment as well as on employees⁵ in the establishment, with a focus on earnings and working hours. The 2015 earnings survey is a special survey that is smaller and not mandatory, but largely identical to the 2014 SES in terms of the content surveyed and methodological design. It was initiated with the specific aim of obtaining information on the impact of the minimum wage in the years following its introduction. Both the SES and the ES cover establishments of all sizes and the entire spectrum of industries, with the exception of employment in private households and extraterritorial organizations.

Sampling for the SES and ES is carried out in two stages. In the first stage, a sample stratified by industry, region and establishment size is drawn at the establishment level from the Business Register (URS) of the Federal Statistical Office. In the second stage, a simple random selection of employees within establishments is made. While all employees are recorded in small establishments, the proportion of employees recorded decreases with establishment size.⁶

Both the Structure of Earnings Survey and the Earnings Survey are usually repeated cross-sectional surveys. However, the 2014 and 2015 waves can be linked to form a panel data set at the establishment level due to the same sample base. This means that changes in establishments affected by the minimum wage as well as in establishments not affected by the minimum wage can be tracked over time. In these establishments, however, information on the same employees is not necessarily collected at the different points in time. Rather, it is assumed that a representative sample of employment in establishments is available at both points in time. Changes in wages or working hours can therefore be caused by personnel departures or arrivals in the

⁴ Source: FDZ of the Federal and State Statistical Offices, DOI: 10.21242/62111.2014.00.00.1.1.1 and 10.21242/62112.2015.00.00.1.1.0.

⁵ Employees can be in a main job or a side job. Therefore, strictly speaking, the data represents employment relationships.

⁶ 1 to 9 employees: every employee; 10 to 49 employees: every 2nd employee; 50 to 99 employees: every 3rd employee; 100 to 249 employees: every 6th employee; 250 to 499 employees: every 10th employee; 500 to 999 employees: every 20th employee; 1000 and more employees: every 40th employee.

companies. For the analysis sample, the linkage of the 2014 and 2015 data results in case numbers of about 70,000 employment relationships in about 6,500 establishments that were surveyed in both years. The sample size of the regular SES, i.e. the whole cross-sectional data for 2014, is significantly larger.

The participation rate of establishments in the ES 2015 was lower than in the SES 2014 because, unlike the regular Structure of Earnings Survey, the ES 2015 was not mandatory for establishments. Validity of the VE 2015 data would be compromised if the response was selective. Hence, the Federal Statistical Office analyzed the survey response and found that the ES covers establishments with lower wage levels better than establishments with high wage levels (Frentzen and Günther 2017). A comparison of the wage distributions of the full sample of the SES 2014 and the panel sample of the SES 2014 shows that deviations, if any, are only present in the upper part of the wage distribution (Ohlert 2022). Trends in average earnings in years with SES and ES surveys also indicate an underrepresentation of establishments with high earnings (Bachmann et al. 2022). Concerns that establishments affected by the minimum wage have overproportionally not participated in the survey were thus not confirmed by the analyses. Against the background of a potentially selective survey participation, it is an advantage of this study that the exact same establishments are examined over time.

The key characteristics for the analyses performed in this study are gross monthly wages excluding overtime pay and paid hours worked per month excluding paid overtime. Hourly wages are calculated by dividing monthly wages by hours worked per month. Information on wages is measured comparatively reliably in these data, since they are usually obtained from the firms' accounting records. However, in principle establishment surveys may be prone to underestimating noncompliance with the minimum wage if establishments document less paid working time than actually took place (Bachmann et al. 2020: 67ff.).

An establishment is assigned to the treatment group (affected by the minimum wage) if it had at least one employee earning less than 8.50 euros per hour in 2014. If this is not the case, it belongs to the control group. About 40 percent of the establishments in the sample are thus affected by the minimum wage (Ohlert 2021). An advantage of this operationalization is a clear interpretability of the results by comparing a group affected by the treatment and a group not affected. Alternatively, measures of the intensity of the minimum wage at the establishment level could be used, e.g., the share of employees in the establishment whose hourly wage was below the minimum wage or the wage gap of these employees up to the minimum wage (Bossler et al. 2022; Ohlert 2021). By using the establishment level, the analysis can be done at a more detailed level than in studies that use regional differences in the bite of the minimum wage. One advantage of the establishment level is that effects can be identified even if they originate from establishments affected by the minimum wage in weakly affected regions (Bossler et al. 2022: 7). A disadvantage is that measured effects could result from spillover effects of the minimum wage on the control group of unaffected establishments (*ibid.*). This would be the

case, for example, if jobs with low pay were reduced in establishments affected by the minimum wage and those with higher pay were built up in establishments not affected (ibid.).

5 Methodology

In this study, I apply a difference-in-differences (DID) approach that calculates the difference in the development of outcome variables between establishments affected by the minimum wage and establishments that were not affected. The outcome variables of interest are individual hourly wages, paid working hours and monthly earnings. Monthly earnings are defined as gross monthly earnings excluding overtime pay, and hours worked as paid hours worked per month excluding paid overtime. Hourly wages are calculated by dividing monthly earnings by paid hours worked per month. In the multivariate analyses, the outcome variables are used in logarithmic form.

The difference-in-differences approach is implemented through regressions that include a dummy variable for the year 2015 as well as the interaction of this variable with a dummy variable for establishments affected by the minimum wage. Furthermore, a dummy variable is used for the gender of the employees and the interaction of the treatment indicator (development in 2015 for establishments affected) by gender. The inclusion of fixed establishment effects controls for time-constant differences between establishments and thus also between the establishments affected by the minimum wage and those not affected. Gender differences and respective changes over time are estimated conditionally on the fixed establishment effects, i.e. they refer to the average or the average development within establishments.

A second model specification adds control variables that can change over time, namely the size of the establishment as well as the qualification, age and type of employment of the employees in the establishment. This controls for different developments in the employment structure in establishments affected and not affected by the minimum wage. Hence, calculated minimum wage effects on gender inequalities are conditional on these characteristics. In other words, gender inequalities are adjusted for these "endowment characteristics". Other potentially relevant characteristics, such as industry or region, do not vary over time and are controlled for via the fixed establishment effects. The results from the model with control variables are to be interpreted as effects of the minimum wage on adjusted gender gaps.

The central assumption of the DID approach is that the treatment and control group would develop in the same way in the absence of the treatment measure. However, on the basis of the data available for this study, equal trends of both groups before the introduction of the minimum wage cannot be verified, as the panel data set at the establishment level can only be compiled for the years 2014 and 2015. According to a study based on the IAB Establishment Panel, wage trends from 2013 to 2014 were slightly lower in establishments affected by the minimum wage than in unaffected establishments (Bossler and Gerner 2020). The same study shows that the

development of standard working hours did not differ between the two groups of establishments in the year before the introduction of the minimum wage. It can therefore be assumed that the DID model described above tends to overestimate the minimum wage effect on earnings. The results obtained on the effects on wages from models 1 and 2 are therefore interpreted as an upper bound.

Results on the effects of the minimum wage on earnings and working hours could in principle be influenced by employment effects of the minimum wage. However, employment effects of the introduction of the minimum wage were relatively small overall and, according to previous findings, did not differ by gender (Caliendo et al. 2022). The presumably minimum-wage-related additional transitions from marginal employment to employment subject to social security contributions comprised about 100 thousand employment relationships in 2015 and, according to vom Berge and Weber (2017: 4), have occurred more frequently among women than among men. These findings suggest a low quantitative relevance of gender-specific selection into employment.

6 Descriptive results

A comparison of the hourly wage distribution of women and men before the introduction of the minimum wage shows that women were significantly more frequently affected by the introduction of the minimum wage (15 percent) than men (8 percent) (table 1). The percentile values of the hourly wage distribution further show that women are overrepresented in low-wage work. Among women and men affected by the introduction of the minimum wage, however, there was no difference in average hourly earnings, which amounted to around 7 euros per hour in each group. The average gap to the minimum wage was therefore around 1.50 euros for both women and men. The hourly wage distribution differs only slightly depending on whether the results are extrapolated using the extrapolation factors for the cross-sectional data of the SES 2014 and VE 2015 or not. In the following, results without the use of extrapolation factors are used because they seem more suitable for comparisons over time and because the extrapolation factors of the SES 2014 are not designed for the specific sample of panel establishments (see sections 3 and 4).

Table 1: The hourly wage distribution of women and men in 2014

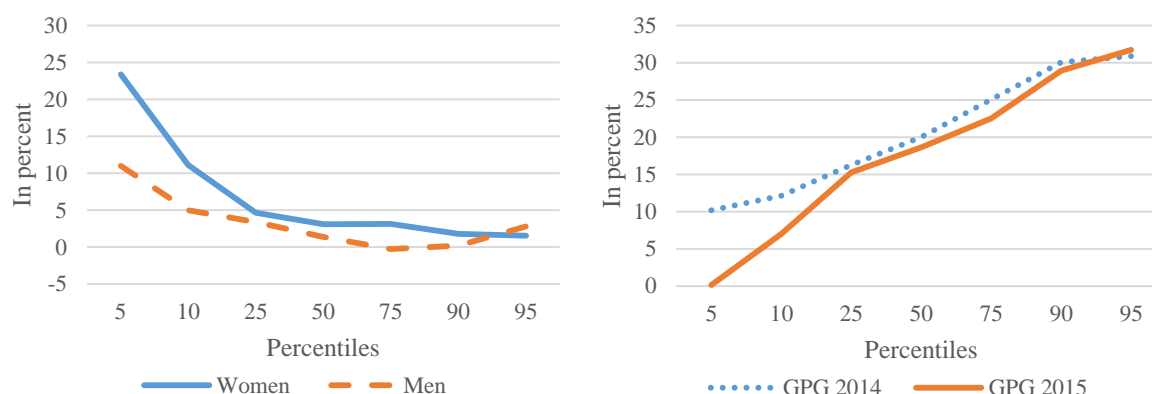
	SES 2014 (unweighted)			SES 2014 (weighted)		
	Total	Women	Men	Total	Women	Men
Proportion below 8.50€	13.0%	18.4%	8.8%	11.2%	15.2%	7.8%
Average wage below 8.50€	7.02	7.03	7.00	7.02	7.03	7.01
5 th percentile	6.99	6.51	7.50	7.14	6.89	7.67
10 th percentile	8.00	7.48	8.62	8.15	7.70	8.77
25 th percentile	10.00	9.09	11.10	10.00	9.30	11.11
50 th percentile	14.32	12.24	15.98	14.28	12.61	15.76
N	73,395	32,002	41,393	73,395	32,002	41,393

Notes: Percentiles and average wage in euros per hour.

Source: SES 2014, ES 2015, own calculations.

Hourly wage growth from 2014 to 2015 was most pronounced at the bottom of the wage distribution for both women and men. However, wage growth for women was significantly stronger than for men, particularly at the 5th and also at the 10th percentile of the distribution (see figure 1, left panel). This is due to the fact that at these points of the distribution, the wage gap that had to be closed to reach the minimum wage of 8.50 euros was larger for women than for men (see also table 1). From the 25th percentile onward, the growth in hourly wages for women and men was similar. This development in hourly wages had the effect of reducing the gender pay gap to zero at the 5th percentile. There was also a significant reduction in the gender pay gap at the 10th percentile (see figure 1, right-hand side).

Figure 1: Growth of hourly wages and the gender pay gap along the distribution, 2014-2015



Source: SES 2014, ES 2015, own calculations.

Left panel: Growth of hourly wages in percent. Right panel: Gender pay gap in percent.

Hourly wage growth at the mean was also stronger for women than for men. Growth in mean hourly wages was around two percentage points higher for women than for men in 2015 (see table 2). The gender pay gap published by the Federal Statistical Office was around 22 percent in 2014 and around 21 percent in 2015 (Federal Statistical Office 2016). In terms of growth in monthly earnings, the differences by gender are somewhat greater (table 2). It was about 4 percent higher for women than for men. While weekly working hours increased slightly on average for women, they decreased slightly on average for men.

Table 2: Means and changes in hourly wages, monthly wages and working hours by gender

	Women			Men		
	2014	2015	Change	2014	2015	Change
Hourly wage						
Mean	14.4	15.0	4.4%	18.9	19.3	2.1%
Monthly earnings						
Mean	1761	1859	5.6%	3036	3076	1.3%
Working time						
Mean	114.4	116.2	1.6%	154.2	152.7	-0.9%
N	32,002	28,365		41,393	38,417	

Source: SES 2014, ES 2015, own calculations.

7 Multivariate results

The DID approach carried out at the establishment level indicates the effects of the introduction of the statutory minimum wage on women and men in establishments affected by the minimum wage. The approach basically looks at the difference in the development of an outcome variable between establishments affected by the minimum wage and those not affected. The estimations were carried out in two different specifications, which differ in the consideration of control variables. Both models apply firm fixed effects so that only changes in outcome variables within establishments are considered. Model 1 does not include control variables and provides effects of the minimum wage on women and men or on the unadjusted gender pay gap within establishments. In model 2, the control variables are establishment size, educational attainment, age and type of employment. The calculated effects are adjusted for these factors and thus indicate the minimum wage effect on the gender gap in establishments adjusted for these factors.

Hourly wages

The gender pay gap in hourly wages within establishments averaged around 14 percent in 2014 (table 3). For women, the effect of the introduction of the minimum wage on average hourly wages was about 3.6 percentage points higher than for men and thus totaled 8.6 percent (table

3). For men, the introduction of the minimum wage led to an increase in mean hourly wages in establishments affected by the minimum wage that was about 5 percent larger than in establishments not affected. The average gender pay gap within establishments thus decreased by up to 3.6 percentage points more in establishments affected by the minimum wage than in unaffected establishments. The deviation of the measured effect from zero is statistically highly significant. Thus, the result confirms hypothesis 1a. However, the effect on the overall development of hourly wages for women and men and on the development of the gender pay gap (see figure 1) is much weaker, as only some of the establishments in Germany were affected by the introduction of the minimum wage.

When control variables are added, the main effect of the minimum wage on men hardly changes, but the differences between women and men become smaller. Accordingly, the minimum wage reduced the adjusted intra-firm gender pay gap in establishments affected by the minimum wage by up to 2.1 percent. This effect is also highly statistically significant and thus confirms hypothesis 1c. This means that part of the minimum wage effect on the gender pay gap results from the fact that women are more frequently affected by the minimum wage due to overrepresentation in part-time employment and marginal employment.

Table 3: Minimum wage effects on the hourly wages of women and men

	All employees		Low-wage employees	
	No control variables	With control variables	No control variables	With control variables
Year 2015	0.0248***	0.0256***	-0.0096	-0.0087
Treatment 2015	0.0503***	0.0486***	0.1360***	0.1350***
Women	-0.1390	-0.0938***	-0.0132***	-0.0122***
Women x Treatment 2015	0.0362***	0.0211***	0.0063	0.0042
N	140,177	140,177	34,496	34,496

Notes: * $p < 0,05$ ** $p < 0,01$, *** $p < 0,001$

Source: SES 2014, ES 2015, own calculations.

The minimum wage effect on hourly wages of low-wage employees is significantly higher than on the overall average. However, the effects on hourly wages of low-wage employees do not differ by gender in either specification. This is due to the fact that the mean gender pay gap among low-wage employees was small to begin with (between 1.1 percent and 1.3 percent), which reflects the fact that women are affected by the minimum wage more often but not stronger than men. The findings confirm hypothesis 1b. From the results, it can be concluded that the observed reduction of the average gender pay gap due to the minimum wage is caused

by the fact that women are clearly overrepresented in low-wage and minimum wage work. The effect of the minimum wage therefore extends to higher percentiles of the hourly wage distribution for women and a higher absolute number of women than men benefit from the measure. However, the minimum wage effect on women and men who are directly affected by the minimum wage is equal on average.

Working hours

The gender time gap in paid working hours averaged around 19 percent in 2014 (table 4). In establishments affected by the minimum wage, there was a slight increase in working hours for women, while there was no significant change in working hours for men. Thus, the overall gender time gap narrowed by about 2.4 percentage points. This difference in the minimum wage effect on women's and men's working hours is highly statistically significant and thus confirms hypothesis 3a. The result could be related to the fact that women on average have stronger preferences for working time extensions than men, so that they tend to react to the minimum wage induced increase in hourly wages with an increase in working time.

The gender time gap in establishments was around 9.4 percent for employees with low hourly wages. Among low-wage workers there was a reduction in the gender time gap in establishments affected by the minimum wage of 3.9 percentage points. The gender time gap among all workers was reduced by 2.4 percentage points. The result thus confirms hypothesis 2b. Controlling for employment type and other characteristics, the introduction of the minimum wage had a negative effect of around -5.7 percent on both women's and men's working time in the low-wage sector. The adjusted gender time gap in the low-wage sector was thus not reduced by the minimum wage.

The average gender time gap turns out to be small, at around 1.9 percent, when women and men in the same type of employment and with similar human capital endowments are compared. This results from the fact that the form of employment (full-time, part-time, marginal employment) adjusts for the largest part of working time differences by gender. Hence, there is no further reduction in the average adjusted gender time gap due to the introduction of the minimum wage. This again indicates that the differential effect of the minimum wage by gender is strongly related to the overrepresentation of women in part-time and marginal employment. The result confirms hypothesis 2c.

While the unadjusted gender time gap in establishments affected by the minimum wage narrowed on average and especially for low-wage employees, it remained unchanged at a low level for women and men in the same types of employment. This is consistent with the finding that the working time effects of the minimum wage also differ across employment types. Negative working time effects were relatively strong for marginally employed and full-time workers and comparatively weak for part-time workers (Ohlert 2022).

Table 4: Minimum wage effects on working hours of women and men

	All employees		Low-wage employees	
	No control variables	With control variables	No control variables	With control variables
Year 2015	-0.0044	-0.0075	-0.0222	-0.0113
Treatment 2015	-0.0073	-0.0262***	-0.0467	-0.0565***
Women	-0.1940	-0.0193***	-0.0940***	-0.0188*
Women x Treatment 2015	0.0242*	-0.0097	0.0391*	-0.0012
N	140,177	140,177	34,496	34,496

Notes: * $p < 0,05$ ** $p < 0,01$, *** $p < 0,001$
Source: SES 2014, ES 2015, own calculations.

Monthly earnings

In terms of monthly earnings, inequality by gender is much more pronounced than for hourly wages. On average, the gender earnings gap in establishments was about 33 percent in 2014 (table 5). Effects of the minimum wage on monthly earnings result from the combination of hourly wage effects and working time effects. The effect of the minimum wage introduction on men's earnings was about 4.3 percent. In contrast, in establishments affected by the minimum wage, women's monthly earnings increased by about 6 percentage points more. This difference is highly statistically significant and confirms hypothesis 3a.

Also, among low-wage workers, there is greater inequality by gender in terms of monthly earnings than in hourly wages. Overall, women in low-wage jobs received about 11 percent lower gross monthly earnings than men. The introduction of the statutory minimum wage reduced this gap by about 4.6 percentage points. The finding thus confirms hypothesis 3b. The effect is smaller among low-wage workers than for the mean of all workers, because there was a reduction in the gender time gap among low-wage employees, but not in the gender pay gap in hourly wages.

One of the decisive factors for the overall lower monthly earnings of women is their lower average working hours. Around 44 percent of employed women work part-time (about three times as many as men), and around 12 percent of employed women are in marginal employment only (about twice as many as men) (Bundesagentur für Arbeit 2022). Controlling for employment type and other characteristics, the mean gender earnings gap in establishments was still about 11 percent (table 5, model 2). A differential effect on mean earnings is no longer evident using these control variables. The finding thus contradicts hypothesis 3c, which assumed an effect on the adjusted earnings gap. The finding again illustrates that the gender-specific

earnings effects of the minimum wage depend crucially on the working time effects of the minimum wage on women and men.

Table 5: Minimum wage effects on monthly earnings of women and men

	All employees		Low-wage employees	
	No control variables	With control variables	No control variables	With control variables
Year 2015	0.0205***	0.0182***	-0.0313	-0.0194
Treatment 2015	0.0425***	0.0219**	0.0879***	0.0770***
Women	-0.3330	-0.1140	-0.1080	-0.0316***
Women x Treatment 2015	0.0605***	0.0115	0.0457*	0.0034
N	140,177	140,177	34,496	34,496

Notes: * $p < 0,05$ ** $p < 0,01$, *** $p < 0,001$

Source: SES 2014, ES 2015, own calculations.

8 Conclusions

According to the results, the introduction of the statutory minimum wage has reduced the mean gender pay gap in hourly wages by up to 3.6 percentage points. However, this does not result from stronger hourly wage effects on women affected by the minimum wage compared to men affected by it but stems predominantly from the fact that women are overrepresented in minimum wage work. The effect on hourly wages of low-wage workers does not differ by gender because the mean gender pay gap among low-wage employees was already small prior to the introduction of the minimum wage. The results do not show a reducing effect on the gender pay gap in hourly wages when the different distribution of women and men in full-time, part-time and marginal employment is controlled for. This finding highlights the importance of the overrepresentation of women in part-time employment and marginal employment for the gender pay gap.

The average gender time gap decreased more in establishments affected by the minimum wage than in establishments not affected (by 2.4 percentage points). This effect is stronger for low-wage employees. Hence, the working time adjustments of women and men differed in the year after the introduction of the minimum wage. While men tended to reduce their working hours, this did not or to lesser extent apply to women on average. When controlling for the type of employment, however, there is no difference in the minimum wage effect on working time by gender. This finding can be explained the fact that employees' working time preferences

differ mainly between forms of employment and that differences by gender result from the overrepresentation of women in marginal and part-time employment (Harnisch et al. 2018).

The negative effect of the introduction of the minimum wage on the gender earnings gap is on average significantly higher than the effect on the gender pay gap. The reason is that working time effects of the minimum wage additionally contribute to enhanced equality in monthly earnings. The gender earnings gap was reduced by up to 6 percentage points in establishments affected by the minimum wage. Among low-wage workers, the gender earnings gap was reduced by about 5 percentage points. The gender earnings gap adjusted for the type of employment and further control variables was not influenced by the minimum wage, which illustrates that the greater impact of the minimum wage on women's earnings is largely due to their overrepresentation in part-time employment and marginal employment.

The causal interpretation of the results from this study is subject to a limitation because the assumption of parallel trends in the treatment and control group for the period before the introduction of the minimum wage cannot be directly verified with the available data. A study based on the IAB Establishment Panel showed that the trends in earnings in establishments affected by the minimum wage were slightly lower than in establishments not affected by the minimum wage, but that the trends in working hours did not differ (Bossler and Gerner 2020). The minimum wage effects on earnings are therefore interpreted as an upper bound of the effects. The use of control variables can partially control for remaining unequal developments between groups. At the same time, inclusion of control variables changes the measurement and interpretation of gender inequalities from unadjusted to adjusted gender gaps.

The results point to three very plausible channels of the impact that the minimum wage has on gender inequalities. First, more women than men benefit from the minimum wage, resulting in a reducing effect on the mean gender pay gap of hourly wages. The finding is consistent with previous results on Germany (Caliendo and Wittbrodt 2022) as well as with the international literature (see Section 2). Second, as a result of the introduction of the minimum wage, there were, at least in the short run, different adjustments in working hours for women and men in low-wage jobs, which tends to reduce the gender time gap. This finding is new and seems to be closely related to the markedly different allocation of women and men to full- and part-time employment. Third, the consequence of these two effects together is to narrow gender gaps in gross monthly earnings substantially, both on average of all employees and of low-wage employees in minimum wage establishments. This is important because gender inequality in monthly earnings is substantially higher than in hourly wages and because earnings are a decisive factor for women's social security and economic independence.

The introduction of the minimum wage hence resulted in incentives for women to increase working hours and in better earnings opportunities for part-time working women in low-wage jobs. The recent increase of the German minimum wage to 12 euros in October 2022 is likely

to have a similar effect on gender inequality in principle. However, the simultaneous increase in the upper earnings threshold of marginal employment (from 450 euros per month to 520 euros per month) makes marginal employment more attractive, especially for women (Blömer and Consiglio 2022). The increase of this threshold thus potentially counteracts the reduction of gender inequality due to the minimum wage.

Overall, the minimum wage is an important measure from an equality policy perspective because it limits the disadvantages that women face as a result of their clear overrepresentation in low-wage work. However, there are also clear limits to the minimum wage in this respect. One of these limitations results from the extent to which women are affected by the minimum wage on the one hand and the size of the gender pay gap on the other in eastern and western Germany. The gender pay gap is particularly high in the western German states, but the share of employees affected by the minimum wage is low there. The impact of the statutory minimum wage as an equality policy measure is also limited by the fact that the corresponding hourly wage adjustments take place below the low-wage threshold, while the gender pay gap results quite significantly from the fact that women are underrepresented in high-wage jobs. This also explains why the overall gender pay gap in Germany has narrowed only slowly despite the fact that the minimum wage has led to reductions of the gender gaps in hourly wages, monthly earnings and working hours in affected establishments.

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