

# Effects of the German minimum wage on earnings and working time using establishment data

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## Abstract

This study examines the effects of the introduction of a statutory minimum wage in Germany on hourly wages, monthly wages and paid working hours. We exploit a novel panel data set by linking the Structure of Earnings Survey (SES) 2014 and the Earnings Survey (ES) 2015 and apply a difference in differences approach at the establishment-level. The advantages and limitations of this approach are discussed in comparison to previous studies, which showed mixed results regarding minimum wage effects on earnings. The results indicate an effect of the introduction of the statutory minimum wage on hourly wages of about 13 percent. Due to negative effects on working time of about minus 6 percent, the effects on monthly gross earnings are smaller, but still amount to approximately 8 percent. The minimum wage has been particularly effective in raising monthly earnings of low-wage workers in part-time jobs and in eastern Germany. We hence provide new insights to the debate about the existence and size of minimum wage effects on earnings and working time and its political implications.

**Keywords:** Minimum wage, evaluation, hourly wages, earnings, working time

**JEL Classification:** J08, J30, J31

## 1 Introduction

The introduction of a general minimum wage in 2015 was a major change to the institutional framework of the labour market in Germany. It had a considerably larger impact on a range of outcomes than subsequent incremental adjustments of the minimum wage (Bruttel 2019; Caliendo et al. 2019; Mindestlohnkommission 2020). In view of the upcoming strong increase of the minimum wage to 12 Euro per hour in October 2022, the introduction of the minimum wage provides an important reference of how the minimum wage operates in the German labour market. The effects on hourly wages, monthly wages and working time have been a major focus of interest in previous evaluation studies, since these dimensions determine basically whether the reform helps increasing the incomes of low-wage earners and hence their welfare.

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There has been a lively debate about the size and relation of minimum wage effects on hourly wages, monthly wages and working hours based on different data sources and methodological approaches applied in the literature. The question about the scope of jobs that are still paid below the effective minimum wage is closely related to this debate since a higher compliance with the minimum wage goes along with higher wage effects. While previous research unanimously found a substantial positive impact of the minimum wage introduction on hourly wages, there have been diverging results regarding the impact on monthly wages. Studies based on the German Socio-Economic Panel (GSOEP) found that there were no increases in monthly wages for affected workers in the year 2015 and the effect was only weakly statistically significant for the year 2016 (Burauel et al. 2020a; Burauel et al. 2020b; Bachmann et al. 2020). They also showed that the moderate effects on monthly wages resulted from minimum wage induced reductions of contractual working time. However, other studies found significant positive minimum wage effects on monthly wages, using the Integrated Employment Biographies (IEB), which contain information on individual wages from administrative social security records (Bossler/Schank 2020; Dustmann et al. 2020). The IEB does not include information on working time or hourly wages on a regular basis and therefore does not allow evaluation of effects on these outcomes. Hence, to date, causal evidence on the minimum wage effects on working time has relied exclusively on the GSOEP. The Structure of Earnings Survey is the only other large dataset for Germany that provides joint information on hourly wages, monthly wages and working time. It has so far only been applied for descriptive analyses, showing wage increases of minimum wage workers and the number of jobs below the effective minimum wage (Bachmann et al. 2020; Dütsch et al. 2019; Mindestlohnkommission 2020), but attempts of causal evaluation based on the SES have not been made, mainly since its standard use is not as a panel data set.

This paper extends the existent research by examining the causal effects of the minimum wage introduction on hourly wages, monthly wages and working hours using the Structure of Earnings Survey (SES) 2014 and the Earnings Survey (ES) 2015, linking both to form a panel dataset. The data are gathered based on establishments' transmission of payroll accounting data. We discuss what can be learned from this employer perspective, compared to previous studies based on household survey data like the GSOEP, or administrative data like the IEB. Based on the finding of significant effects on monthly earnings, we conclude that the minimum wage can be an effective measure to improve the earnings situation of low-wage workers. In this regard, it has been particularly effective for low-wage workers in part-time jobs and those in eastern Germany. We hence provide new insights to the debate about the existence and size of minimum wage effects on earnings and working time and its political implications.

The applied methodology uses a difference-in-differences approach that compares changes in earnings and working time among jobs in establishments that were affected by the minimum wage, to those in establishments that were not affected. Affected establishments were identified as those that had at least one employee with an hourly wage below 8.50 Euros in the year 2014. Since high-wage jobs are unlikely to be affected by the minimum wage, jobs with earnings higher than 10 Euros were excluded from the sample in the main specification. Overall, the sample contains more than 70,000 jobs in approximately 6,500 establishments for the observed period (2014 to 2015), which allows us to obtain robust results for subgroups of jobs. Due to large differences in the bite of the minimum wage, the heterogeneity of effects could be expected to be particularly large between East and West Germany and by type of employment, which were analysed separately.

The remainder of the paper is structured as follows. Section 2 provides an overview of previous evidence. Section 3 introduces the data and describes the sample. Section 4 explicates the econometric approach to identify effects of the minimum wage. Section 5.1 presents descriptive results on the distribution and changes in earnings and working time. Section 5.2 presents the effects of the minimum wage and differentiates between East and West Germany and by type of employment. Section 6 concludes.

## 2 Previous Evidence

Descriptive evidence has shown that the development of hourly wages was clearly above average among low-wage jobs affected by the minimum wage introduction, but merely similar to the average wage development among jobs affected by the upratings of the minimum wage in 2017 and 2019 (Mindestlohnkommission 2020). Low-wage earners received above average increases of monthly wages too, but presumably because of reductions in working time, they were smaller compared to the increases in hourly wages. Despite these overall common tendencies, the respective findings differed markedly between establishment survey data (SES/ES) and employee survey data (GSOEP). Based on the GSOEP rather incremental, small adjustments of the distribution of low hourly wages were observed after the introduction of the minimum wage. In contrast, an immediate substantial shift to the value of the minimum wage and closely above was observed based on the SES/ES (e.g. Mindestlohnkommission 2020: 52). The latter observation has been denoted as the typical stylized fact of what minimum wages usually do to the distribution of hourly wages (Cengiz et al. 2019). Regarding monthly earnings, Himmelreicher (2020) finds above-average increases in lower deciles of the distribution of hourly wages between the years 2014 and 2018 and shows that the respective increases in monthly earnings were higher based on the SES than based on the GSOEP. In accordance with the differing findings on the development of low wages, the results on presumptive non-compliance with the minimum wage differed, too. Based on the GSOEP there were approximately 2,1 million employees (8,2 percent) with hourly wages below the minimum wage in the year 2015 and based on the SES/ES there were approximately 1 million jobs (2,8 percent) located below the then effective minimum wage of 8.50 Euros (Mindestlohnkommission 2018: 62ff.).

Because of these differing results, comparing employee survey-data to firm survey data has received particular attention in minimum wage research in Germany (Bachmann et al. 2020; Dütsch et al. 2019) and also in the UK (Fry/Ritchie 2012). For Germany one of the achievements of these comparisons was pointing out relevant differences in the survey methodologies. Most fundamentally, the GSOEP surveys persons and asks them about their employment situation, but also about a variety of other aspects of life, while the SES surveys establishments that primarily deliver data from their wage accounting systems. Establishments predominantly sent their wage and working time data automatically by their accounting software. It has been shown that differences in the observed sample composition of the two datasets cannot explain the differences in the share of employees/jobs below the minimum wage. Instead different types of measurement errors were assumed to be relevant for employers and employees, which potentially can explain the observed differences (Bachmann et al. 2020: 67ff.). Ultimately, it could however not be ascertained to what extent the respective measurement errors were present or which of the datasets comes closer to portraying the true distribution of low hourly wages. In detail, it has been assumed that information on hourly wages, which is calculated by dividing monthly wages through working time, are relatively imprecise in the GSOEP because working hours and monthly wages are measured for differing time periods (week/versus month) and because information provided by employees could be less reliable due to presumed problems of remembering exact values. Regarding the SES/ES on the other hand, it has been assumed that employers might have a tendency not to participate in the survey if they are non-compliant with the minimum wage, or not to disclose hourly wages below the minimum wage if they do participate in the survey (see section 3 for an assessment of these presumptions).

There are several data sources that allow examinations of monthly earnings in Germany, but for causal analysis of minimum wage effects on hourly wages and working time the GSOEP has been used almost exclusively up to date. For the identification of causal effects, the respective studies (Burauel et al. 2020a; Burauel et al. 2020b; Bachmann et al. 2020; Bachmann et al. 2022) use individual panel data and apply a difference in difference approach, comparing individuals with hourly wages below 8.50 Euros in 2014 a control group of employees with hourly wages in the range from 8.50 to 10 Euros. Because wage dynamic is generally different between these two groups, it is additionally adjusted for differences between the treatment and control group in the pre-treatment period. The studies show minimum wage effects in the very short-run, from 2014 to 2015, as well as in a two year period, from 2014 to 2016.

Burauel et al. (2020b) show an effect on hourly wages of approximately 4 percent on individuals affected by the minimum wage until 2015, which is significant at the 5 percent level. The effect is larger and more robust in the two-year period (until 2016) and amounts to approximately 6 percent then. The finding is in line with other available studies based on the GSOEP (Bachmann et al. 2020; Caliendo et al. 2017). Following the adjustment of the minimum wage to 8.84 Euros in 2017, no statistically significant effects on hourly wages were found (Bachmann et al. 2020; Bachmann et al. 2022).

Regarding causal effects on monthly wages previous studies used the GSOEP or IEB data and findings are more mixed. Burauel et al. (2020b) find no short-term (one year-period) effect of the minimum wage on monthly wages. The same is found in other studies based on the GSOEP (Bachmann et al. 2020; Caliendo et al. 2017). The presumed cause for this finding is that reductions in working time prevented increases in monthly earnings at least in the short run (see also Bonin et al. 2018 regarding effects on working time). In the two-year period Burauel et al. (2020b) find a (weakly statistically significant) minimum wage effect of approximately 6.6 percent on monthly wages, which is similarly large as the effect on hourly wages for this period.

Burauel et al. (2020a) found a significant negative effect on contracted working time of about minus 5 percent in the one-year period, but no significant effect on working time in the two year period. Interestingly, negative effects were only found regarding contractual working time, but not regarding actual working time. Bachmann et al. (2020) find similar results using the GSOEP and a treatment group at the individual level. They additionally conduct a difference-in-differences analysis at the regional level, which suggests that the minimum wage induced reductions of working time persisted up to the year 2017 and that the minimum wage has reduced actual working hours too.

Studies using IEB data, which contain information on monthly earnings from social security registers, apply a regional difference-in-differences approach and thus compare wage developments in regions with a higher or lower bite of the minimum wage. They find positive effects of the general minimum wage on monthly earnings. Bossler/Schank (2020) and Dustmann et al. (2020) find a significant, positive minimum wage effect on monthly wages ranging between 3 and 7 percent. The effects are largest at the 20th percentile of the distribution of monthly earnings and reach up to the 50th percentile (Bossler/Schank 2020: 14). The authors explain that the effect is small at the 10th percentile, because it is located at the upper earnings limit of marginal employment (jobs with maximum earnings of 450 Euros per month, which are exempt from taxes and social security contributions). They observe a rightward shift in distribution of low monthly earnings and an increase of the number of individuals exactly at the upper earnings threshold after the minimum wage has been introduced. The findings suggest that there are incentives to stay in marginal employment despite increases in hourly wages. These studies could however not analyse effects on working hours or hourly wages, since these characteristics are not included in the applied data.

Burauel et al. (2020a) and Burauel et al. (2020b) also examined heterogeneous minimum wage effects by type of employment. They find that the minimum wage had the highest positive impact on the hourly wages of marginal workers (15.5 percentage points). The effect on the hourly wages of full-time employed workers amounted to 7.8 percentage points and there was no significant effect on part-time workers. Despite the positive effects on hourly wages of full-time and marginal workers, no significant impact on monthly earnings was found. Regarding working time they report a significant and robust reduction in contractual working hours among employees who are subject to social security contributions and earned less than the minimum wage before the introduction. No significant effects on marginally employed workers were found, which presumably was mainly due to the low number of observations in this group.

### 3 Data and Sample Description

This study constructs a panel data set by linking the Structure of Earnings Survey (SES) of 2014 and the Earnings Survey (ES) of 2015 at the establishment level.<sup>2</sup> Based on these data, we examine the short-term impact of the introduction of a general minimum wage in Germany (for comprehensive information about these data see Statistisches Bundesamt 2016; 2017). The SES is a large mandatory survey among establishments that the Federal Statistical Office conducts every four years. It collects information on characteristics of the establishment and a fraction of the jobs within each covered establishment. The focus of the survey is earnings and hours of work. The ES 2015 is a special survey, which is mostly identical to the SES 2014 regarding its content and procedure but has a smaller sample size, and establishments' participation is nonmandatory. It was initiated with the specific aim of obtaining information on the impact of the minimum wage in the years following the introduction of the minimum wage.<sup>3</sup> 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 of 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 Firm Register (URS) of the Federal Statistical Office. In the second stage, a simple random selection of jobs is drawn within establishments. While all jobs are covered in small firms, the share of covered jobs decreases with firm size.

The minimum wage in Germany is subject to several exemptions for specific groups. It does not apply to self-employed persons, to persons under 18 years old without a vocational degree, individuals in vocational training, individuals in particular internships, long-term unemployed individuals in the first six months after taking up employment or, until 2017, employees in particular industries with sectoral minimum wages (Mindestlohnkommission 2020: 20). Consequently, individuals under the age of 18 and individuals in vocational training were excluded from the sample. Other exemptions could not be clearly delimited in the SES data and were therefore not excluded from the sample. We apply the same sample delineation as in previous descriptive minimum wage examinations based on the SES or ES (Mindestlohnkommission 2020; Bachmann et al. 2020; Dütsch et al. 2019; Dütsch/Himmelreicher 2020).

The SES/ES data have crucial advantages but also several limitations. They provide very reliable information on monthly earnings because firms usually transfer this information directly based on their accounting data. The SES/ES data also provide a relatively large sample of jobs and establishments, which allows differentiating analyses by subgroups. The main limitation of these data is that it usually has not a panel structure but it consists of repeated cross-sections with distinct samples. The years 2014 and 2015 are an exception to this, which is explained in detail in the next paragraph. Further, since the SES/ES is an establishment survey, concerns that employers may have the tendency not to disclose hourly wages below the effective minimum wage may be relevant for the quality of the generated data (Garnero et al. 2015). Generally, the SES/ES does not measure unpaid working time and is therefore not designed or expected to measure non-compliance with the minimum wage. Information from qualitative research, custom agencies imply that actual evasions of the minimum wage law are mainly related to unpaid and undocumented working time (Mindestlohnkommission 2020: 69).<sup>4</sup> Nevertheless, it is of interest that software tools for wage accounting usually indicate when wages and working hours result in an hourly wage that is below the minimum wage (Dütsch et al. 2019: 273). While such tools obviously help employers to comply with the minimum wage regarding hourly wages resulting from documented and paid working time, it is unknown how accurate working time documentation is and whether there is unpaid working time. Further, the supposed tendency not to disclose wages below the effective minimum wage, may find its way into survey responses both in the SES and the ES at specific instances, such as the reporting of working time for the survey when working time has not been properly documented, or the required random sampling of jobs within larger establishments for the survey, the implementation of which is left to the establishments.

2 Source: RDC of the Federal Statistical Office and Statistical Offices of the Federal States, DOI: 10.21242/62111.2014.00.00.1.1.1 and 10.21242/62112.2015.00.00.1.1.0.

3 The ES has been conducted for the years 2015 to 2017 and 2019.

4 It is also not measured in contractual working time in the GSOEP. While it is potentially measured by actual working time in the GSOEP, it is unknown if and how the respective actual working hours are remunerated.

The ES 2015 has been subject to one additional concern because, unlike the SES survey, participation in the ES was not mandatory. While the same sampling pool of establishments was contacted for the ES 2015 as for the SES 2014, the participation rate was much lower (12.8 percent), which caused the concern that participation in the survey might have been systematically avoided by establishments that were not compliant with the minimum wage after its introduction. Previous empirical evidence does not support this assumption. Most notably, the ascertained rates of jobs below the effective minimum wage do not differ much between the non-mandatory surveys of the years 2015-2017 and the mandatory Structural Earnings survey of the year 2018. Further, the Federal Statistical Office analysed the survey response for the ES 2015 based on the full sample of the SES 2014 and the subsample that participated in the ES 2015. They found that the probability of taking part in the survey declined with establishments' wage level (Frentzen/Günther 2017), which is confirmed by a relatively low mean hourly wage in the ES 2015 (Bachmann et al. 2022: 43). As a consequence, and in line with the aim of the survey to facilitate minimum wage research, the ES is better suited to examine low-wage employment than high-wage employment. Frentzen/Günther (2017) also found that the response rate was marginally lower for establishments that were affected by the minimum wage in the year 2014 than for establishments that were not affected. This is not necessarily a problem for the analysis of wage effects, since it makes the treatment group (of affected establishments) smaller, but does not necessarily distort wage changes within the treatment group. However, if there was systematically non-participation of establishments that were affected by the minimum wage law and did not react to it (non-compliance), it would lead to an overestimation of wage effects. In the so far most comprehensive examination of potential measurement errors Bachmann et al. (2020) concluded that both the SES/ES and the GSOEP presumably are affected by measurement errors that are likely to differ due to different issues in household/employee surveys and establishments surveys. Ultimately, it could not be clarified which data come closer to portraying the true distribution of low hourly wages in Germany.

For our analysis, we link the SES of 2014 and the ES of 2015 at the establishment level based on an identification number. Linkage is technically not possible for establishments in public service and establishments that exclusively employ marginal employees. Apart from these exceptions, all establishments that participated in the ES 2015 also participated in the SES 2014 and can be followed over time in the data. Information on wages and working time refers to a random sample of jobs within each establishment. It has to be emphasized that the panel structure of the data is given only at the establishment level but not at the level of individual jobs. This means that the composition of jobs within establishments of the treatment and control group can change over time. Wage changes therefore can reflect e.g. wage increases (or reductions) of workers that stayed at a firm, or entries of employees with specific wage levels, or exits of employees with specific wage levels.

**Tab 1:** Comparison of hourly wages in the cross-sectional sample and panel sample

	SES 2014		ES 2015
	Cross-section	Panel sample	Panel sample
Share of jobs below 8.50€	0.13	0.13	0.02
5th percentile	7.00	6.99	8.50
10th percentile	8.00	8.00	8.67
Median	14.31	14.32	15.00
Mean	17.04	16.91	18.12
Number of jobs	725,764.00	73,395.00	66,782.00

Notes: Percentiles, median and mean in Euros per hour.  
Sources: SES 2014, ES 2015, unweighted data, own calculations.

Due to the much smaller sample size of the ES 2015, linking both data sets greatly reduces the number of cases from the SES 2014, resulting in approximately 73,000 jobs in 6,594 establishments (see Table 1). A firm is categorized in the treatment group if it had at least one employee earning less than 8.50 Euros per hour in 2014 and in the control group if otherwise. Approximately 40.5 percent and 2,672 establishments in the sample, respectively, are affected by the minimum wage (see also Mindestlohnkommission 2020: 131; Ohlert 2021). Accordingly, the sample comprises the same 6,594 establishments in the ES 2015, but the number of jobs deviates somewhat from the data for the previous year due to job changes. Table 1 compares the unweighted wage distributions of the full sample and the panel sample of the SES 2014. It shows that there are no deviations in the lower part of the wage distribution, which suggests that the sample of the ES 2015 is not substantially biased regarding the distribution of low wages. Also the share of jobs below 8.50 remains the same. Compositional changes in the establishment sample over time are ruled out due to the balanced establishment panel. Due to the much smaller sample size of the ES 2015, linking both data sets greatly reduces the number of cases from the SES 2014, resulting in approximately 73,000 jobs in 6,594 establishments (see Table 1). A firm is categorized in the treatment group if it had at least one employee earning less than 8.50 Euros per hour in 2014 and in the control group if otherwise. Approximately 40.5 percent and 2,672 establishments in the sample, respectively, are affected by the minimum wage (see also Mindestlohnkommission 2020: 131; Ohlert 2021). Accordingly, the sample comprises the same 6,594 establishments in the ES 2015, but the number of jobs deviates somewhat from the data for the previous year due to job changes. Table 1 compares the unweighted wage distributions of the full sample and the panel sample of the SES 2014. It shows that there are no deviations in the lower part of the wage distribution, which suggests that the sample of the ES 2015 is not substantially biased regarding the distribution of low wages. Also the share of jobs below 8.50 remains the same. Compositional changes in the establishment sample over time are ruled out due to the balanced establishment panel.

## 4 Econometric Approach

To identify the effects of the introduction of the minimum wage, we apply a difference-in-differences estimation by dividing establishments into those affected by the minimum wage and those not affected. The outcomes of interest are individual hourly wages, monthly earnings and paid working time of job  $i$  in firm  $j$  and year  $t$  (see equation 1). Monthly earnings are defined as gross monthly earnings excluding overtime pay, and working time is defined as paid hours of work per month excluding paid overtime.<sup>5</sup> Hourly wages are calculated by dividing monthly earnings by paid working time per month. Log hourly wages are used in the multivariate analyses. The difference-in-differences approach compares the development of wages and working hours in establishments affected by the minimum wage introduction (treated) with that in establishments not affected (control) over time.

$$y_{ijt} = \text{treated}_j * \text{year2015}_t * \delta + \text{year2015}_t * \tau + \theta_j + x_{ijt} * \beta + \varepsilon_{ijt}$$

We include fixed firm effects ( $\theta_j$ ) in the models and thus estimate minimum wage effects based on changes within establishments between 2014 and 2015. Because establishment characteristics and employment structure may differ between establishments in the treatment and control groups, we control for several time variant establishment and job characteristics ( $x_{ijt}$ ). Establishment size is included with the categories “up to 10 employees” “11 to 100 employees” and “more than 100 employees”.<sup>6</sup> At the job level, we further include the highest educational degree, age and age-squared and the type of employment with the categories full-time, part time and marginal employment as well as a dummy for female gender because wages usually vary strongly between these categories. Due to the specific data structure, we cannot test the common trends assumption (CTA) regarding the outcome variables prior to the minimum wage introduction. Establishments can be linked only for the years 2014 and 2015.

5 Including overtime in paid working hours and earnings would not change hourly wages strongly. Overtime pay is slightly higher due to overtime surcharges. Unpaid overtime is not included in the data.

6 Furthermore, the presence of a collective bargaining agreement in the establishment as well as sector dummies were included in the specification. These variables are time invariant in our data and thus are dropped from the models due to the applied fixed effects estimation at the establishment level.

To alleviate this problem, we construct a weighted control group to achieve a similar level of the respective outcome variable in the treatment and control groups in 2014. We apply entropy balancing regarding the mean of the respective outcome variables for establishments in 2014 as described in (Hainmueller 2012; Hainmueller/Xu 2013). We estimate average effects of the minimum wage introduction on all jobs as well as on low-wage jobs by restricting the sample to low-wage jobs with hourly wages of up to 10 Euros per hour. The selected cut-off at 10 Euros considers that spill-over effects are likely closely above the minimum wage but become increasingly unlikely in higher wage regions (Cengiz et al. 2019). Heterogeneity of minimum wage effects is shown by conducting separate estimations for East and West Germany and by interacting treatment effects by type of employment.

The effects on different types of employment rely on jobs of the respective type in the two observed years. Since the data do not allow to follow individual jobs over time, the number of jobs and the specific persons holding these jobs within establishments may change over time. The implications of this are also discussed in section 6.

## 5 Results

### 5.1 Descriptive Results

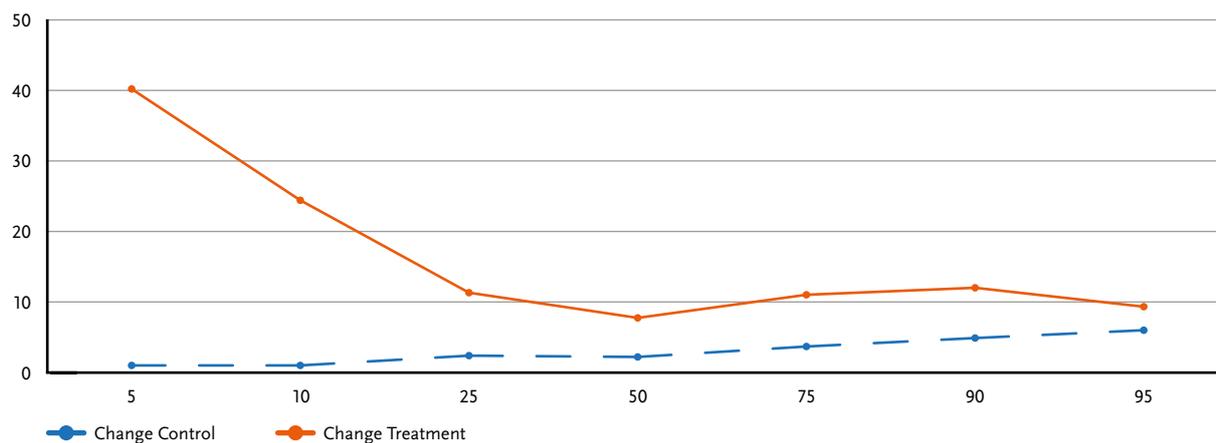
Between 2014 and 2015, hourly wages increased by 11.6 percent in establishments affected by the minimum wage and by 3.7 percent in other establishments, on average, in our sample (table 2). The difference in this change between the treatment and control groups therefore amounts to approximately 7 percentage points. While growth of hourly wages was clearly higher at the bottom of the distribution of affected establishments than among other establishments, it was also fairly high in the upper half of the wage distribution, where an impact of the minimum wage is rather unlikely (figure 1). In establishments that were not affected by the minimum wage, there was almost no growth of hourly wages at the 5th and 10th percentiles and a slightly higher wage growth at higher percentiles, which resembles the usual pattern of wage growth observed in the years prior to the minimum wage introduction (Burauel et al. 2018: 34).

**Tab 2:** Means and changes in outcome variables in treated and nontreated establishments

	Control			Treated		
	2014	2015	Change	2014	2015	Change
<b>Hourly wages</b>						
mean	19.0	19.7	3.7%	14.1	15.7	11.6%
<b>Monthly wages</b>						
mean	2933.1	3035.8	3.5%	1996.3	2236.0	12.0%
<b>Working time</b>						
mean	34.4	34.3	-0.2%	29.9	30.3	1.3%
Number of jobs	41,974.00	40,128.00		31,421.00	26,654.00	

Sources: SES 2014, ES 2015, unweighted data, own calculations.

Monthly wages increased by 12 percent in establishments affected by the minimum wage and by 3.5 percent in other establishments, on average (table 2). Monthly wage growth was thus approximately as high as the mean hourly wage growth. The difference between the treatment and control groups regarding monthly wage growth amounts to approximately 8.5 percentage points. A comparison of the changes across the distribution of monthly wages shows that the growth of monthly wages was highest at the 25th percentile, where the monthly wage increased from approximately 600 Euros to approximately 870 Euros (without figure). These descriptive findings suggest that the growth of monthly wages was higher for part-time workers who are liable to social security than for marginal workers and full-time workers with higher earnings (see also Himmelreicher 2020). For marginal workers, the growth of monthly wages is limited by definition due to the upper limit of earnings of 450 Euros in this employment form.



Notes: The y-axis shows changes in percent. The x-axis shows percentiles of the distribution of hourly wages.  
Sources: SES 2014, ES 2015, unweighted data, own calculations.

**Fig 1:** Changes in hourly wages in treated and nontreated establishments along the distribution

Working time increased by approximately 1 percent in establishments affected by the minimum wage and remained unchanged in other establishments on average (table 2). Hence, the difference between the treatment and control groups regarding changes in working time amounts to approximately 1 percentage point. In the treatment group, working time also increased most at the 25th percentile of the working time distribution, from approximately 17 hours per week to approximately 20 hours per week.

## 5.2 Results of Causal Analysis

### Main Results

The results from difference-in-differences regressions with control variables and weighted control groups show that the introduction of the minimum wage raised mean hourly wages by approximately 5.3 percent (table 3). The effect on the average wages of low-wage jobs is considerably larger, amounting to 13.2 percent. A fixed low-wage threshold of hourly wages lower than 10.05 Euro has been applied to include jobs with a round value of 10 Euro per hour. The actual low-wage thresholds reported by the Federal Statistical Office are close to 10 Euro in 2014 and 2015. While the overall minimum wage effect of approximately 5 percent is similar in size to the estimated effects in previous studies, the more relevant estimate of the impact on affected low-wage workers is more than twice as large. Previous studies based on the GSOEP conducted comparisons of workers who earned less than the minimum wage in 2014 to workers with earnings just above the minimum wage (Bachmann u.a. 2020; Burauel u.a. 2018; Caliendo u.a. 2017).<sup>7</sup> They found a positive effect of the minimum wage introduction on hourly wages amounting to approximately 6 percent. In contrast to the same studies (Bachmann et al. 2020; Burauel et al. 2018; Caliendo et al. 2017), we find significant positive effects of the minimum wage introduction on monthly wages. It amounts to approximately 3 percent, on average, and approximately 7.9 percent for low-wage jobs. These findings are therefore in line with those of studies based on the IEB, which found positive effects of approximately 3 to 7 percent on monthly wages.

Based on the SES/ES, we find negative effects of the minimum wage on working time of approximately minus 3 percent in total and approximately minus 5.6 percent for low-wage earners. Other studies found similar effects on working time of approximately -5 percent (Bachmann et al. 2020; Bonin et al. 2018; Caliendo et al. 2017; Bossler/Gerner 2019). In contrast to some of these studies, we find that the relative reductions in working time are smaller than the relative increases in hourly wages. It is also evident from firm surveys that the reduction in working time has been an important reaction to the minimum wage introduction (Mindestlohnkommission 2020: 133; Bellmann et al. 2016; Schmitt 2013). Our results confirm that in the short-term, working time adjustments have diminished increases in monthly earnings compared to the increases in hourly wages. However, they do not entirely offset the positive impact of the minimum wage introduction on monthly earnings.

<sup>7</sup> The coefficients of minimum wage effects are approximately 1 to 2 percentage points higher in models without entropy balancing than in models with entropy balancing. This applies to all models presented in the paper, with only minor variations.

**Tab 3:** Minimum wage effects on hourly wages, monthly wages and working time

	Average effect on all jobs	Average effect on low wage jobs
<b>Hourly wages</b>		
Year 2015	0.0316***	-0.00381
<b>Treatment 2015</b>	0.0534***	0.132***
Number of jobs	140,177	34,496
<b>Monthly wages</b>		
Year 2015	0.0165***	-0.0192
<b>Treatment 2015</b>	0.0301***	0.0788***
Number of jobs	140,177	34,496
<b>Working time</b>		
Year 2015	-0.00707**	-0.011
<b>Treatment 2015</b>	-0.0308***	-0.0575***
Number of jobs	140,177	34,496

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

Sources: SES 2014, ES 2015, unweighted data, own calculations.

There are distinct differences in the bite of the minimum wage between East Germany and West Germany. According to the SES, approximately 21 percent of employees in East Germany and approximately 9 percent of employees in West Germany had an hourly wage below 8.50 Euros in 2014 (Mindestlohnkommission 2020: 56). Accordingly, a larger impact of the minimum wage could be expected in East Germany.

Separate estimations for East and West Germany show that the effects of the minimum wage on wages and working time were indeed clearly larger in East Germany (see table 4). The effect on mean hourly wages amounted only to approximately 3.8 percent in West Germany and to approximately 9.0 percent in East Germany. The minimum wage introduction raised the mean wage of low-wage workers by approximately 10.8 percent in West Germany and by approximately 15.5 percent in East Germany.

Furthermore, the minimum wage led to increases in average monthly wages of approximately 1.7 percent in West Germany and approximately 5.2 percent in East Germany. The effects on the monthly wages of low-wage workers amounted to approximately 6.3 percent in West Germany and approximately 7.4 percent in East Germany. Since earnings are lower, on average, in East Germany than in West Germany, the observed minimum wage effects cause some convergence between the regions.

The impact of the minimum wage on working time also differs between East and West Germany. Working time decreased, on average, by approximately 2.5 percent in West Germany and by approximately 4.6 percent in East Germany due to the minimum wage. Among low-wage workers, the minimum wage led to a decrease in working time of approximately 5.0 percent in West Germany and approximately 7.0 percent in East Germany. Since contractual working time is, on average, higher in East Germany than in West Germany, the observed minimum wage effects cause some convergence in working time between the regions.

**Tab 4:** Minimum wage effects in East Germany and West Germany

	Average effect on all jobs		Average effect on low wage jobs	
	West Germany	East Germany	West Germany	East Germany
<b>Hourly wages</b>				
Year 2015	0.0291***	0.0351***	-0.00785*	0.011
<b>Treatment 2015</b>	0.0375***	0.0899***	0.108***	0.155***
Number of jobs	106,097	34,080	21,911	12,585
<b>Monthly wages</b>				
Year 2015	0.0160**	0.0237***	-0.024	0.0132
<b>Treatment 2015</b>	0.0170*	0.0521***	0.0625**	0.0743***
Number of jobs	106,097	34,080	21,911	12,585
<b>Working time</b>				
Year 2015	-0.00786**	-0.00262	-0.0114	-0.00845
<b>Treatment 2015</b>	-0.0253***	-0.0463***	-0.0501*	-0.0698***
Number of jobs	106,097	34,080	21,911	12,585

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

Sources: SES 2014, ES 2015, unweighted data, own calculations.

### Heterogeneous effects by type of employment

The effects of the minimum wage on the average hourly wages of different groups of workers are usually larger for groups with a higher bite of the minimum wage, i.e., groups with a higher share of affected workers. Additionally, workers may receive differential minimum wage effects by type of employment if there are differences by group a) in the distance to the minimum wage for affected workers, b) regarding differential spill-over effects on hourly wages above the minimum wage, or c) concerning remaining jobs below the minimum wage due to noncompliance or exceptions from the minimum wage. Table 5 shows that the bite of the minimum wage was higher for part-time workers and substantially higher for marginally employed workers than for full-time employees. Approximately 43 percent of marginal employment relationships received an hourly wage below 8.50 Euros in 2014. Additionally, average wages in employment relationships that were affected by the minimum wage were lower in marginal employment jobs than among part-time or full-time jobs. Hence, the impact of the minimum wage introduction could be expected to be the largest for marginal employment.

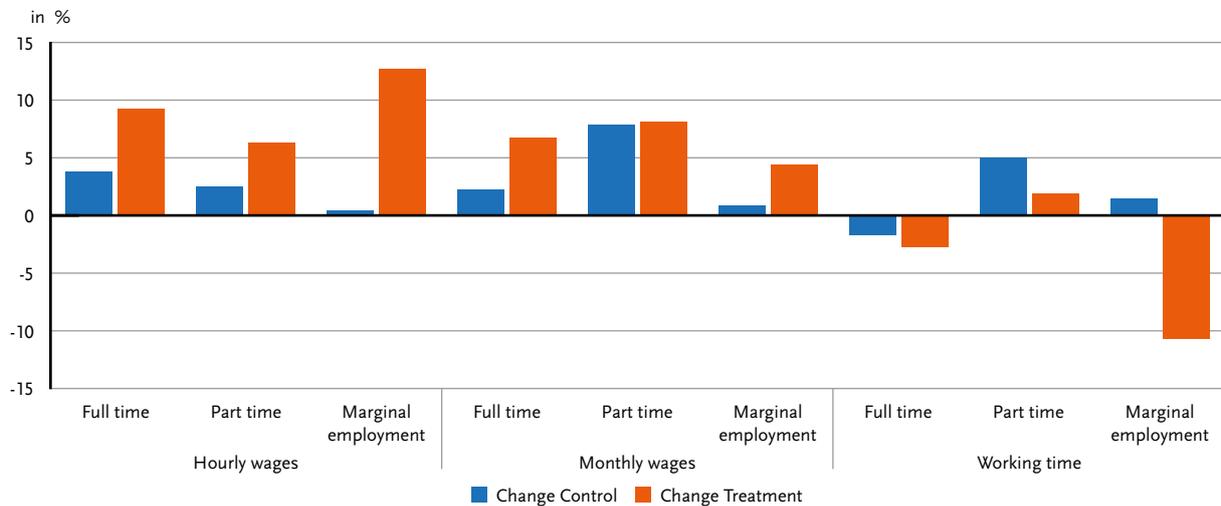
**Tab 5:** Distribution of hourly wages before the introduction of the minimum wage by type of employment

	Full-time 2014	Part-time 2014	Marginal employment 2014
Share of jobs below 8.50€	5.97	15.57	42.60
Mean wage below 8.50€	7.30	7.18	6.74
5th percentile	8.16	6.90	5.00
10th percentile	9.21	7.69	6.00
Median	16.42	12.98	8.83
Mean	19.19	14.72	9.19
Number of jobs	48,452	14,841	10,102

Sources: SES 2014, ES 2015, unweighted data, own calculations.

Notes: Percentiles, median and mean in Euros per hour.

According to the type of employment, specific working time adjustments can be expected. Reductions in working time are particularly likely to occur among marginal employees since their monthly gross earnings have to be below the administered threshold of 450 Euros, despite rising hourly wage rates. According to surveys on working time preferences, part-time workers in Germany wish to increase working hours, while full-time employees wish to reduce working hours (Harnisch et al. 2018). Therefore, the effects of the minimum wage on working time are likely to differ between part-time and full-time workers.



Sources: SES 2014, ES 2015, unweighted data, own calculations.

**Fig 2:** Changes in outcome variables in treated and nontreated establishments by type of employment

Figure 2 provides a descriptive overview of changes in the respective outcome variables in establishments that were affected by the introduction of the minimum wage compared to establishments that were not affected. In establishments affected by the minimum wage, growth of hourly wages was highest in marginally employed and somewhat larger in full-time employment than in part-time employment (figure 2). The wage growth of hourly wages was clearly lower for all three types of employment in establishments not affected by the minimum wage. Monthly wages increased to a similar extent among full-time jobs and part-time jobs in establishments affected by the minimum wage. However, in part-time employment, monthly wages also increased in establishments not affected by the minimum wage. In comparison, increases in monthly wages were smaller among marginal jobs and present only in establishments affected by the minimum wage. As noted in section 3 individual transitions between different types of employment cannot be tracked in the SES/ES data. Therefore minimum wage induced transitions from marginal employment to part-time employment, which occur by definition when the threshold of monthly earnings of 450 Euro is exceeded, are not captured in the changes reported here. Previous studies showed that the total number of transitions between marginal employment and regular employment rose in January 2015 compared to January 2014, from 52 thousand to 104 thousand, which was significantly higher than in previous years (Mindestlohnkommission 2020: 91 ff.).

According to the data of the IAB Labor Market Survey, 85 percent of the transitions from marginal employment to employment subject to social security contributions in 2015 were conversions within the same company (vom Berge et al. 2016). In addition, there was a decline in the share of marginally employed versus employees subject to social insurance contributions in the workforces of establishments, which was particularly pronounced in establishments of small and medium-sized enterprises (Pestel et al. 2020; Bonin et al. 2018).

Working hours decreased slightly in full-time employment and more so in establishments affected by the minimum wage. Working hours increased in part-time employment, but the increase was lower in establishments affected by the minimum wage than in unaffected establishments (figure 2). The working hours decreased most clearly among marginal employment in establishments affected by the minimum wage, by approximately 11 percent. This finding reflects that the minimum wage together with the statutory upper earnings limit of 450 Euros per month for marginal employment implies a de facto upper limit in working time.

Based on the microcensus, Wanger and Weber (2016) also found a decline in normal weekly working hours among exclusively marginally employed persons by approximately 5 percent in eastern Germany and by around 2.5 percent in western Germany in a comparison of the years 2014 and 2015. According to the same study, the distribution of weekly working hours indicates that the avoidance of exceeding the marginal earnings threshold was the most important reason for the reduction in working hours.

**Tab 6:** Minimum wage effects by type of employment

Panel A: Hourly Wages	Average effect on all jobs	Average effect on low wage jobs
Year 2015	0.0315***	-0.00373
<b>Treatment 2015</b>	<b>0.0427***</b>	<b>0.101***</b>
Full time	Reference	
Part time	-0.0940***	-0.0323***
Marginal employment	-0.315***	-0.108***
Full time x Treatment 2015	Reference	
Part time x Treatment 2015	0.00956	0.0265***
Marginal employment x Treatment 2015	0.0463***	0.0651***
Number of jobs	140,177	34,496

Panel B: Monthly Wages	Average effect on all jobs	Average effect on low wage jobs
Year 2015	0.0163***	-0.0195
<b>Treatment 2015</b>	<b>0.0185**</b>	<b>0.0476**</b>
Full time	Reference	
Part time	-0.578***	-0.509***
Marginal employment	-1.976***	-1.671***
Full time x Treatment 2015	Reference	
Part time x Treatment 2015	0.0310**	0.0682***
Marginal employment x Treatment 2015	0.0272	0.0373*
Number of jobs	140,177	34,496

Panel C: Working time	Average effect on all jobs	Average effect on low wage jobs
Year 2015	-0.00711**	-0.0113
<b>Treatment 2015</b>	<b>-0.0317***</b>	<b>-0.0574***</b>
Full time	Reference	
Part time	-0.491***	-0.478***
Marginal employment	-1.659***	-1.559***
Full time x Treatment 2015	Reference	
Part time x Treatment 2015	0.0253*	0.0430**
Marginal employment x Treatment 2015	-0.0238	-0.0301
Number of jobs	140,177	34,496

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

Sources: SES 2014, ES 2015, unweighted data, own calculations.

Estimates of the minimum wage effects on hourly wages by type of employment show that there is a similar positive impact of the minimum wage on full-time and part-time jobs amounting to approximately four percent, on average (see table 6, panel A).<sup>8</sup> There is a higher effect of approximately nine percent on the hourly wages in marginal employment, on average. The effects of the minimum wage are larger for each employment group if only low-wage workers are considered in the analysis. The positive effect on the hourly wages in low-wage jobs amounts to approximately 17 percent for marginally employed, approximately 13 percent in part-time and approximately 10 percent in full-time employment. These results, based on the SES, therefore clearly show higher effects of the minimum wage than previous studies based on the GSOEP for all three types of employment. Similar to the GSOEP studies, the effects on hourly wages are larger among marginally employed workers than among regular workers.

The minimum wage effect on the growth of monthly wages amounts to approximately 5 percent for low-wage full-time jobs, approximately 12 percent for low-wage part-time jobs and approximately 9 percent for low-wage marginal employment (see table 6, panel B). The respective effects on all jobs are smaller. In summary, increases in monthly wages due to the minimum wage introduction are significant but of different sizes for full-time workers, part-time workers and marginally employed workers. The relatively small effect on the working time of part-time workers explains the relatively large effect of the minimum wage on the monthly earnings of low-wage part-time workers.

The minimum wage caused an overall reduction in average working time in marginal jobs and full-time jobs (see table 6, panel C). The negative effect on the working time in all part-time jobs was, however, smaller and close to zero. The minimum wage-induced reduction in working time among low-wage earners amounts to approximately minus 6 percent in full-time jobs and marginal employment and to approximately minus 1 percent in part-time jobs.

## 6 Discussion and conclusions

This study is the first to present a causal evaluation of minimum wage effects on earnings and working time based on the SES 2014 and the ES 2015 and hence based on data provided by establishments. Previous studies have evaluated the minimum wage with respect to these outcomes using household survey data (Burauel et al. 2020a; Burauel et al. 2020b; Bachmann et al. 2020) or using administrative social security records (Bossler/Schank 2020; Dustmann et al. 2020). Alongside the GSOEP, the SES/ES is one of only two data sets in Germany that allow to calculate hourly wages on a regular basis, which makes it particularly relevant for minimum wage research. Based on these data it is possible to examine effects on hourly wages, monthly wages and working time, which are crucial in determining whether the minimum wage can increase the welfare of its recipients.

In summary, we find that the positive effects of the introduction of the statutory minimum wage on hourly wages from this study are substantially larger (approximately 13 percent) than those observed in previous studies based on the GSOEP (approximately 6 percent). The effect is smaller, however, than previous descriptive examinations based on the SES/ES have suggested (e.g. Mindestlohnkommission 2020: 48). The effects of the minimum wage introduction on monthly wages have been a topic of debate, with some studies finding no effects (in the short-run) and others finding a significantly positive impact. Regarding that matter, our results confirm a significant positive effect on the monthly wages of low-wage workers of approximately 8 percent. Similar to other studies, the effects on monthly wages are substantially smaller than the effects on hourly wages because of reductions in working hours due to the minimum wage introduction. According to our estimates, the working hours of low-wage earners decreased by approximately 6 percent due to the minimum wage. Hence, the effect on the monthly earnings of low-wage earners has been reduced but not offset by the reduction in working time.

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<sup>8</sup> The effect for full-time jobs is given by the coefficient "Treatment 2015" The effect for part-time and marginal jobs is given by the sum of the coefficients "Treatment 2015" and the respective interactions "Part-time x treatment" and "Full-time x treatment".

We further provide evidence on heterogeneous minimum wage effects by type of employment. The results show that hourly pay in low-wage part-time jobs and marginally employment could catch up compared to low-wage full-time jobs. Gains of monthly gross earnings were largest among part-time jobs and therefore are likely to have benefitted women more than men (see also Boll et al. 2017). The results also suggest that part-time employees and in particular marginally employed workers have benefitted from the minimum wage due to the possibility of receiving similar earnings with fewer hours of work. The possibility to differentiate results by type of employment based on a large number of observations is an advantage of the applied SES/ES data.

The overall finding of relatively high minimum wage effects on both hourly wages and monthly wages documents that employees actually received higher earnings due to the introduction of the minimum wage. Higher gross earnings are important to low-wage earners, even if they still depend on transfer payments due to low working hours or household needs (Bruckmeier/Bruttel 2021; Baumann/Bruttel 2020). The findings also underline that the minimum wage is a suitable policy tool to lower the risk of in-work poverty.

Differences of the results to those of other studies cannot be explained comprehensively, since the studies differ in several regards, such as the data and its underlying survey methods, the specific difference in differences approach, the level at which treatment and control groups are constructed (establishments rather than individuals or regions) and the surveyed population of jobs or employees respectively. Nevertheless, two sources of differences shall be briefly discussed in the following.

First, the approach in this study exploits a panel data structure at the establishment level, but not at the level of individual employees or jobs, while Burauel et al. (2020a;b) apply panel data on individuals and Bossler/Schank (2020) and Dustmann et al. (2021) follow developments within regions over time. We therefore did not track individuals over time, but instead observed the wages and working time of jobs that were present in minimum wage establishments (and non-minimum wage establishments) before and after the reform. This is particularly relevant for the analysis of marginal employees, who partly switched to regular part-time employment in accordance with exceeding the monthly earnings threshold of 450 Euros per month due to the minimum wage (Mindestlohnkommission 2020: 91; vom Berge et al. 2016; Pestel et al. 2020). Hence, we presumably underestimate minimum wage effects on the monthly earnings of marginal workers to some extent. Additionally, the effect on monthly earnings may be underestimated for part-time workers too, if former marginal employees enter the lower end of the monthly wage distribution of part-time workers due to the minimum wage. Further, negative effects on working time may be overestimated for marginal employees because workers who maintain or increase their working time cannot be tracked with the SES/ES if they become regular part-time workers.

Second, concerns about potentially biased survey participation and response behaviour by establishments have led to an exaggerated reluctance to apply the SES/ES data for causal evaluation, although it has been used widely for descriptive analyses. We have argued in this article that more can be learned from examining and interpreting these data carefully, with having in mind that these data is based on establishments' wage accounting. Establishments might document less paid working time than actually worked in practice. Thus, obtained minimum wage effects on hourly wages as well as negative effects on working time could be overestimated if the extent of jobs below the minimum wage were underestimated systematically after its introduction. However, this is not a specific issue of the ES 2015 data. Instead, in the presence of a minimum wage, this kind of measurement error in hourly wages is more likely in establishment and firm surveys, while other measurement errors are more likely in household surveys (Bachmann et al. 2020: 67ff.).

Starting from 2022 on the Earnings Surveys will provide enhanced research potential in several regards (Deutscher Bundestag 2020). The data then will be gathered monthly and result in a continuous panel structure. It will also be supplemented with the characteristic of nationality of job-holders and it will capture all jobs within establishments instead of merely a subsample. The enormous research potential of these data should be utilized to the fullest for minimum wage research, but also for other research topics such as the gender pay gap.

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