

Robots or Workers? Minimum Wage Effects on Routine Employment in Germany

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I Introduction

Minimum wages have become an important tool used by governments across the globe to protect low-wage workers and tackle wage inequality. Despite longstanding theoretical predictions of negative employment effects, empirical research has failed to find evidence that matches the theory (Manning, 2021). This raises the question of how the economy absorbs the higher labor costs without a corresponding drop in employment (Harasztosi and Lindner, 2019). A number of potential adjustment mechanisms exist. For example, firms can pass higher wage costs through to the consumer through increased prices, or to owners by reducing profits. An important, but largely underexplored, mechanism is substitution away from workers whose jobs are automatable.

A production task is performable either by capital or labor: intuitively a shock to the price of one increases the likelihood that the task will be allocated to another (Acemoglu and Restrepo, 2019). Consider a warehouse firm that needs to move boxes. This task can be performed by a robot or a worker. A robot requires the firm to raise capital to invest in the new technology, alongside the human capital required to maintain and operate it. Thus, the firm has assessed that it is more economical to allocate the task to workers. Significantly higher labor costs due to minimum wages could induce the firm to reassess its decision and invest in robot adoption.

I exploit the 2015 introduction of Germany's national minimum wage to investigate the extent to which minimum wage increases induce firms to substitute capital for labor by examining the effect for routine occupations. I combine administrative data provided by the Institute for Work Research (IAB) covering the years 2012-2016, with the occupational classification provided by Dengler et al. (2014). While routine classifications

*I am grateful to Didier Fouarge, Marie-Christine Fregin, Simon Janssen, Pelin Özgül, and Michael Stops for their valuable comments and advice. Funding for this study was provided by the German Ministry of Labour and Social Affairs on behalf of the Deutscher Bundestag as part of the ai:conomics project.

have predominantly been used to explain increasing job polarization through the automation of mid-wage work (Autor et al., 2003; Goos et al., 2014). There is an increasing focus on the relationship between automation and low-wage work (Aaronson and Phelan, 2024; Downey, 2021; Graetz et al., 2022). A significant portion (34% in 2014) of workers affected by the minimum wage are in routine occupations, suggesting substantial substitution potential among affected workers. To answer my research question, I employ two empirical approaches: an individual-level analysis to capture effects on workers, and an establishment-level analysis to detect firm-level compositional changes. Across both approaches I find no evidence of adverse employment outcomes or reductions in demand for routine labor.

At the individual level, I replicate the data construction and empirical strategy of Dustmann et al. (2022) and then introduce heterogeneity analysis distinguishing routine from non-routine workers among those exposed to the minimum wage. With this approach, I find no evidence of direct substitution or increased unemployment. Routine workers do not experience differential employment outcomes following the minimum wage introduction. However, the groups diverge on other margins. Non-routine workers see hourly wage growth roughly 1 percentage point higher than routine workers and experience larger improvements in establishment quality, measured by average employer wages and firm size. These differences appear to be driven by baseline characteristics: routine workers earned more and were already employed at better firms prior to the reform.

My individual-level results do not distinguish between no displacement and successful reabsorption because I track changes in employment. If firms substitute away from routine labor but displaced workers quickly find new jobs, individual-level analysis would detect no effect. To directly test whether firms adjust their labor composition, I examine establishment-level routine employment and wage bill shares in a balanced panel from 2012–2017. I find no relationship between minimum wage exposure and the share of employment in routine occupations. Since previous evidence suggests German workers adjust wages when facing economic challenges (Dustmann et al., 2014), routine workers might reduce wages to help firms weather difficult periods. However, I find no significant relationship between minimum wage exposure and routine workers' share of the wage bill. Taken together, these findings suggest no short-run effects of the minimum wage on capital labor substitution.

This study advances the literature on minimum wages and labor-capital substitution by shedding light on ambiguous theoretical predictions from the literature. In task-based models, Eckardt (2022) shows minimum wages reduce the factor inequality between low-skill wage and capital, reducing their share of income and employment. In this model, whether the displaced workers are able to reallocate depends on the extent to which the automation is cost-saving. Contrary to this, Downey (2021) argues that because partially-automated tasks require low-wage operators, higher minimum wages raise technology

adoption costs and may slow automation.

Most closely related to this study are empirical findings from the U.S., these show reduced employment in automation-exposed occupations linked to minimum wage increases (Aaronson and Phelan, 2019; Lordan and Neumark, 2018). I build on these papers in three key ways. First, the 2015 introduction of the minimum wage provides cleaner identification than the state-level minimum wage variation used in the U.S. studies, avoiding concerns about endogenous policy timing and cross-state spillovers. Second, the use of administrative data enables me to identify workers or establishments exposed to both automation and the minimum wage, whilst both papers are only able to examine the effects of aggregate employment shifts. Third, I examine individual and establishment-level outcomes, enabling me to detect effects both on aggregate employment and whether there were firm-level adjustments at the margin. In contrast to the U.S. evidence, I find no automation-induced employment or compositional changes within three years of the minimum wage introduction. Three possible explanations arise for this difference. First, Germany’s labor market regulations differ substantially from the U.S., which may suggest different adjustment margins are in use (Dauth et al., 2021). Second, my empirical approach does not allow me to capture longer term changes, effects may be delayed. Third, results from the U.S. may not capture actual minimum wage effects due to different identification strategies.

A related literature examines capital investment responses to minimum wages, with inconclusive and context-dependent results. Studies from Hungary and China find that minimum wages induce exposed firms to increase capital expenditure and reduce employment Harasztosi and Lindner (2019); Geng et al. (2022); Hau et al. (2020). In the United States, T. Gustafson and D. Kotter (2023) provide evidence that minimum wage increases lead firms in highly exposed industries (retail, gastronomy, and entertainment) to reduce their capital expenditure. Consistent with my findings of no employment or wage reductions in automation exposed occupations, Bossler et al. (2020) investigate the effect of the minimum wage increase on capital investment within Germany and find no effects. Taken together, the findings for Germany suggest firms adjust to the minimum wage across other margins rather than capital substitution.

My paper contributes to a broader literature on the impact of the minimum wage. Consistent with findings from the U.S. (Wolfson and Belman, 2019), the U.K. (Commission, 2019), Germany (Busch and Ochs, 2025) and other countries (Manning, 2021), I find that the introduction of a national minimum wage in Germany increased hourly and daily wages for individuals without affecting aggregate employment. I further expand the novel findings of Dustmann et al. (2022) on reallocation of workers to better establishments by analyzing the effects on a heterogeneous group of workers. I add to their findings by showing that the positive reallocation effects were concentrated among non-routine workers, who worked at smaller establishments and had lower pay at baseline

compared to routine workers. This further corroborates the view that the minimum wage induced smaller, lower paying firms to exit the market and that the employment outflows are absorbed by better, higher productive firms (Dustmann et al., 2022). This paper continues as follows: Section II provides a summary of the Institutional Setting; Section III provides an overview of the data used; Section IV reports on the results from the individual approach; Section V reports on the results from the establishment approach; and Section VI concludes.

II Institutional Setting

Prior to 2015, Germany had no national minimum wage. Only sector-specific minimum wages existed for a few industries, including electricians, roofers, and painters. Wages were traditionally set through collective bargaining between unions and employer associations, a process in steady decline (Addison et al., 2011). This, alongside rising wage inequality (Dustmann et al., 2009), prompted the German government to pass the Minimum Wage Law on July 3, 2014.

The minimum wage was set at €8.50/hr and came into effect on January 1, 2015. At introduction, almost 15% of workers earned below this threshold, implying around 4 million directly affected jobs (Destatis, 2016). With a minimum-to-median wage ratio of 0.48, the German minimum wage cut deeper than the U.S. federal minimum (0.36) but less than France (0.61) (Statistics, 2023). For comparison, the UK’s ratio at its 2000 introduction was 0.34. The limited pre-policy period and deep bite makes the German minimum wage introduction an ideal setting for event study and difference-in-difference analyses.

While the minimum wage was nationally binding, several groups were exempt: workers under 18, apprentices, interns, voluntary workers, and the long-term unemployed (Umkehrer and Berge, 2020). Temporary exemptions until December 2016 applied to hairdressing, meat processing, agriculture, and forestry, where lower union-negotiated wages were permitted—though these industries comprise only around 5% of employment. The minimum wage was subsequently raised to €8.84 in October 2017, €9.19 in January 2019, and €12.82 by January 2025 (MindestlohnKommission, n.d.).

There has now been over a decade of research on the minimum wage introduction and subsequent rises in Germany, finding that the strongest effect occurred in the immediate period after introduction (Dütsch et al., 2025; Mindestlohnkommission, 2023). Here, I outline some of the key facts known from the minimum wage introduction. First, wages rose for affected workers, with estimates ranging from 4-13% depending on data source (Burauel et al., 2018; Dustmann et al., 2022; Ohlert, 2025). Second, the large employment losses initially predicted (Mueller and Steiner, 2013) did not materialize, effects were small and concentrated among marginally employed workers (Caliendo et al., 2019; Dütsch et

al., 2025). Third, firm profitability declined, with some exit among highly affected and micro-businesses (Bossler et al., 2022; De Monte et al., 2022), and evidence suggesting worker reallocation to better establishments (Dustmann et al., 2022).

These findings establish that most firms could absorb the increased labor costs without large employment reductions. There are however still questions on the potential firm adjustment mechanisms, including capital substitution. Aside from Bossler and Gerner (2020), this has largely been overlooked in the literature so far. Further, to the best of my knowledge, no study has systematically looked at the relationship between routine workers and the introduction of the minimum wage in Germany.

III Data Overview

I base my analysis on a 50% sample of the Integrated Employment Biographies (IEB) covering years 2011-2017 provided by the Institute for Employment Research. The IEB is a dataset of all individuals in Germany with the following employment statuses: employment subject to social security (in the data since 1975), marginal part-time employment (in the data since 1999), benefit receipt according to the German Social Code III or II (SGB III since 1975, SGB II since 2005), officially registered as job-seeking at the German Federal Employment Agency or (planned) participation in programs of active labor market policies (in the data since 2000).¹ This provides me with a different sample compared to that used by Dustmann et al. (2022) who use a 50% sample of the Employment History (BeH) dataset, also provided by the IAB. The BeH dataset contains only individuals with employment subject to social security and marginal part-time employment, not benefit recipients or job-seekers. Differences in sample distributions are explored below.

The IEB data contains information on the working time status (i.e., part-time, full-time, or marginal employment), the establishment the workers works for, their wage information, industry and occupation, and a set of sociodemographic characteristics (e.g., age, gender, nationality and education). Also included in this data is information on working hours from 2011 through to 2014, allowing me to calculate precise hourly wages for the years before the introduction of the minimum wage. This can be used to precisely estimate the exposure of workers or firms to the minimum wage. A limitation in the working hours variable arises from employers being able to select from various reporting schemes, such as actual working hours, contractual or collectively agreed working hours, a variable full-time worker reference value, or an estimate. The chosen scheme for a specific job is not observable, resulting in significant inconsistencies in the raw data. To correct or this, I follow the imputation procedure of Dustmann et al. (2022) to create harmonized working hours information. After the imputation procedure, as reported in

¹The data I use is the same as, but a larger sample than, the commonly used Sample of Integrated Employment Biographies (SIAB).

Appendix A.1, working hours in the IEB closely follow the imputed hours in the BeH and those recorded in the two primary survey data sets in Germany: the Structure of Earnings Survey of the German Statistical Office (SES) and the German Socio-Economic Panel (SOEP).

The imputed working hours are then used to generate hourly wage information for workers in all pre-policy periods (2011-2014), dividing daily wages by the imputed working hour information. To estimate the effect of the minimum wage hike on hourly wages, I generate proxied hourly wages based on the average working hours information for each working time status. Average daily (including weekends) working hours for each working time status category are computed for 2013 (5.28 for full-time workers, 3.30 for part-time workers, and 1.18 for marginal workers).² This approach relies on the assumption that minimum wage changes don't meaningfully alter the number of hours people work within different employment categories. There is indeed no conclusive evidence that working hours were reduced directly after the introduction.³

A significant limitation with the data arises due to the implementation of an occupational code switch in 2010 in Germany. This resulted in large numbers of missing information in working time status and occupational variables for the years 2010-2012. I follow the procedure of Ludsteck (n.d.) to impute the working time status for the missing years. For the missing occupation codes, this is most significant in 2011 where fully 20% of employment spells are missing occupational data. The problem subsides significantly in the following year, with around 0.5% of missing occupational codes. To the best of my knowledge, there is no implementation procedure for the occupational codes.

Using this data, I construct a yearly panel and select all job spells referring to June 30. In case a worker has more than one job I take the main job spell, this is taken as the job with the highest wage. In the case of the same wage recorded for a job, I take the full-time job (or part time if the other job is marginal), if the job has the same working time status I take the job with spell with the longest duration. I drop spells for apprentices and where the worker is younger than 18 from the sample. I further focus on prime age workers and remove workers aged 60 and over giving me final panel of 110,735,212 person-year observations.

In an additional step, I combine the register data with a routine share measure generated by Dengler et al. (2014) at the 3-digit occupational level using to identify occupations which are susceptible to technological substitution. These scores are generated using the German classification of occupations 2010 and are split across five dimensions and two broad categories (routine and non-routine): interactive non-routine, analytical

²These values are taken from Dustmann et al. (2022), reflecting the average weekly hours worked divided by 7. Daily wages are constructed by dividing a recorded wage per employment spell by the total number of days in that employment spell, including weekends.

³Caliendo et al. (2017) and Patrick Buraueil et al. (2020) are unable to detect a significant effect of the minimum wage introduction on actual working hours.

non-routine, manual non-routine, manual routine and manual non-routine. The advantage of this measure is that it is developed specifically for Germany, avoiding the necessity to crosswalk scores designed for another labour market (Acemoglu and Autor, 2011). Furthermore, unlike other measures developed for Germany which are based on surveys (Spitz-Oener, 2006; Matthes et al., 2014), Dengler et al. (2014) operationalise their task-score based on the Berufenet expert occupation database. For the analyses, I split workers into two main groups: routine and non-routine based upon their main task type.

III.A *Who are the affected workers?*

Table A.2.1 provides descriptive evidence on who minimum wage workers are. Column 1 reports figures for workers earning more than €4.50 and less than or equal to €8.50 per hour, Column 2 reports the same statistics for those earning just above the threshold, i.e., more than €8.50, but less than or equal to €12.50. Finally, Column 3 reports statistics for those earning between €12.50 and €20.50. Below minimum wage workers are more likely to be in East Germany, a foreign national, female, have a lower education background and be under 24. They are also more likely to have been unemployed in the previous year, and work part time or marginal jobs. They are also overrepresented in transportation, accommodation and food sectors and are more likely to work in firms with under 20 employees. In the Appendix A.3, I compare the distribution of minimum wage workers to that of Dustmann et al. (2022). Across the wage distribution, younger workers and those with lower educational attainment are underrepresented in my dataset in comparison to the BeH. These distributional differences are not surprising as lower educated and younger workers are more likely to be unemployed (Busch and Ochs, 2025). In Appendix A.1, the fraction of the working population affected by the minimum wage is compared across the BeH, IEB, SOEP, and SES showing relatively similar figures across sample distributions.

A comparison between routine and non-routine workers in the affected group is shown in Table 2. This shows that routine workers are more likely to be male and work in full-time occupations, furthermore they earn higher hourly and daily wages and work in larger firms. Whilst there are more non-routine workers in the lowest wage bin, there is still considerable representation of routine workers suggesting that there are a number of workers whose tasks are substitutable that are exposed to the minimum wage.

IV Individual Approach

Following Dustmann et al. (2022), I begin the analysis at the individual level, outcomes (employment change and wage growth) are measured as changes over a two-year period (between $t - 2$ and t) along the distribution of wages in the baseline period $t - 2$. I describe the following using wage growth, but the same applies for other outcomes of

interest. Individuals are divided into 15 hourly wage bins with hourly wages measured at $t - 2$. As my hourly wages are derived from the working hours information supplied until 2014, I use two year differences to allow for two post-policy periods (2013–2015 and 2014–2016). The bins start at €4.50–€6.50, given a lower number of individuals in these wage bins, and then proceed in increments of €1 until €19.50–€20.50.

Individual wage growth $y_{it} - y_{i,t-2}$ of worker i between period $t - 2$ and t is regressed against a dummy variable $1[b_{k-1} < w_{i,t-2} \leq b_k]$ equal to 1 if worker i falls into wage bin k in $t - 2$:

$$y_{it} - y_{i,t-2} = \sum_k 1[b_{k-1} < w_{i,t-2} \leq b_k] \gamma_{kt} + \beta X_{i,t-2} + e_{it}. \quad (1)$$

The coefficient γ_{kt} measures the average two-year wage growth for four periods (2011–2013, 2012–2014, 2013–2015 and 2014–2016), conditional on a set of control variables $X_{i,t-2}$ measured at $t - 2$. The coefficient γ_{kt} for the post-policy periods (2013–2015 and 2014–2016) captures the effect of the minimum wage introduction on wage growth subject to two confounding factors: mean reversion and macroeconomic time effects. Workers earning less at $t - 2$ would typically expect to experience a higher wage growth than workers earning higher wages. Simultaneously, wages would be expected to grow anyway because the economy is growing. To eliminate these two effects, a second re-parametrized version of equation (1) is estimated:

$$\begin{aligned} y_{it} - y_{i,t-2} = & \sum_k 1[b_{k-1} < w_{i,t-2} \leq b_k] \gamma_{k,2013} \\ & + \sum_k 1[b_{k-1} < w_{i,t-2} \leq b_k] \delta_{kt} \\ & + \beta X_{i,t-2} + e_{it}. \end{aligned} \quad (2)$$

In this equation, workers' two-year wage growth is estimated relative to the growth in a baseline period (2011–2013). The coefficient $\delta_{kt} = \gamma_{kt} - \gamma_{k,2013}$ identifies the causal effect of the minimum wage on wage growth. The assumption is that mean reversion and macroeconomic time effects are largely stable over time. The validity of this assumption can be assessed by examining whether the estimates δ_{kt} for workers earning much higher wages (€12.50 and above) in the wage distribution are closer to 0 than those for affected workers. In practice, I divide workers into less aggregated wage bins. The lowest wage bin being those earning between €4.50–€8.50 at baseline. We could expect spillover effects to those earning a little above the affected level, therefore those earning €8.50–€12.50 are grouped together. Finally, I create a control group of those earning €12.50–€20.50.

To analyze the impact of the minimum wage on routine workers, I employ a triple difference approach, interacting the wage bin indicators with a routine worker dummy

$RT_{i,t-2}$, equal to 1 if the worker is classified as a routine worker at $t - 2$:

$$\begin{aligned}
y_{it} - y_{i,t-2} = & \sum_k 1[b_{k-1} < w_{i,t-2} \leq b_k] \gamma_{k,2013} \\
& + \sum_k 1[b_{k-1} < w_{i,t-2} \leq b_k] \delta_{kt} \\
& + \sum_k (1[b_{k-1} < w_{i,t-2} \leq b_k] \times RT_{i,t-2}) \delta_{kt}^{RT} \\
& + \beta X_{i,t-2} + RT_{i,t-2} + e_{it}.
\end{aligned} \tag{3}$$

In equation (3), δ_{kt} captures the minimum wage effect for non-routine workers, while δ_{kt}^{RT} identifies the differential effect for routine workers capturing how their response differs from non-routine workers in the same wage bin and time period. Both approaches control for secular trends in automation by using workers higher in the wage distribution as the control group. Since both treatment and control groups within each sample (routine or non-routine) are similarly exposed to automation-related trends such as cheaper capital or increasing digitization, the estimates isolate the causal effect of the minimum wage from these confounding factors.

IV.A Addressing Limitations

A significant limitation with the individual approach arises from the occupational code switch in 2010, discussed above. Workers are divided into routine or non-routine based on their occupational code and in the main analysis the baseline period is 2011–2013. However, 2011 has one fifth of its occupational codes missing. I take two approaches to tackle this limitation. First, I follow the same empirical strategy as above but change the baseline period to 2012–2014. This assumes that parallel trends hold for both routine and non-routine workers. This has the advantage that I am able to use the reported working hours information to identify below minimum wage workers. However, the 2012–2014 period could potentially capture anticipation effects and bias the estimates downwards.

Second, to address the concern of limited pre-policy periods and potential anticipation effects, I also study one-year differences in outcomes. Workers are assigned into wage bins based on their wages at $t - 1$ and changes in outcomes are measured as of June 30th in years t and $t - 1$. A limitation with this approach is that a trade off must be made as the working hours are only observed from 2010–2014, thus providing only 1 post-policy period if using the imputed hourly wage at baseline. Thus, for this second approach, I use the proxied hourly wages (i.e., daily wages divided by average working hours information) to assign workers into baseline wage bins. This allows me to generate two pre-policy periods (2012–2013, 2013–2014) and two post-policy periods (2014–2015, 2015–2016). I compare the sample characteristics of workers in proxied hourly wage bins

against the imputed wage bins in Appendix A.2. Most importantly, the proxied bins seem to over-represent full-time and part-time workers, relative to marginal workers. Given that the minimum wage effects are predominantly concentrated among marginal workers, any results from this exercise may be biased upwards.

IV.B *Individual Approach - Employment Results*

I begin by examining the effect of the minimum wage on employment. Figure 1 provides an initial indication of the effect. The finding suggests that employment outcomes for individuals earning more than €7.50 per hour are negative following the introduction of the minimum wage. While this is a potentially interesting finding, it is likely that these differences are more driven by sampling issues with the IEB dataset. This is corroborated when comparing my figure to that of Dustmann et al. (2022) in Appendix A.4. The pattern of the graph is similar, but the differences compared to the 2011–2013 baseline for workers up the wage distribution disappear. Furthermore, the differences between the wage bins appear to be consistent across the wage distribution across the two graphs. Finally, across both graphs minimal deviations from the zero line suggest negligible effects of the minimum wage hike on employment prospects for below minimum wage workers.

I report on the difference-in-difference estimates for the post-policy periods on employment in Table 3. Consistent with Figure 1, Panel A Column 1 reports a slightly positive effect for all workers of 0.6 percentage points. Appendix A.5 reports on the differences with Dustmann et al. (2022), showing a similar effect of 0.8 percentage points. The findings for the different models, reported in Panel B and Panel C, are consistent. The 2012–2014 baseline provides estimates of 0.4 percentage points. The 2012–2013 baseline with one year differences and proxied wage bins provides estimates of 0.6 percentage points for the 2014–2015 period and 1.2 percentage points for the 2015–2016 post-policy period, suggesting a combined positive effect of 1.8 percentage points.

Turning to differential effects on non-routine and routine workers, Column 3 reports on the triple difference estimates using the 2011–2013 baseline period. I find that routine workers experienced a 1.1 percentage point lower growth rate in employment probabilities in the 2014–2016 period relative to the 2011–2013 baseline period. However, the estimates for the 2013–2015 and 2012–2014 periods are also negative relative to the 2011–2013 baseline period violating the parallel trend assumption.

In Panel B, I adjust the baseline period and the differential effects disappears with no significant difference between routine and non-routine workers detected. Moving to the 1-year differences with proxied hourly wage bins, I find that the differential effect becomes positive at 0.9 percentage points. Taken together, I find no robust and meaningful relationship between the minimum wage hike and the employment outcomes of routine workers.

In the next step, I provide point estimates for the employment effects weighted by working time status. I assign 1 to full-time workers, 0.5 to part-time, 0.2 to marginal and 0 to non-employment. The effects are slightly larger using this outcome, I find a positive effect of 1.8 percentage points. Comparing this to Dustmann et al. (2022), they find slightly larger estimates of 2.3 percentage points. This result suggests that the minimum wage induced some workers to upgrade their employment from part-time or marginal to full-time, consistent with the higher daily wage effects. This result is robust to different model specifications, as shown in Panel B and Panel C. Moving to the effect on routine workers, I see a similar pattern to the overall employment effects with a negative result for the 2011–2013 baseline period eliminated by shifting the baseline and moving to 1-year differences with proxied wage bins.

IV.C *Individual Approach - Wage Results*

Next, I turn to the wage effects of the minimum wage introduction. Figure 2 provides an initial visual assessment of the parallel trends assumption. In this figure, two-year proxied hourly wage growth is plotted separately for the 2012–2014 and 2014–2016 periods relative to the 2011–2013 baseline, obtained from Equation (2). Hourly wage outcomes are generated as daily wages divided by the average number of hours worked in each working time status category (i.e. full-time, part-time, marginal). As expected, this shows a positive effect of the policy. Workers earning below the minimum wage at $t - 2$ in both post-policy periods experience significantly higher wage growth compared to the pre-policy period. This is not true for wage bins higher up in the distribution, indicating stable macroeconomic conditions during the period of study and supporting the validity of the parallel trends assumption. This shows that the minimum wage causally raised wages for workers earning below the minimum wage at $t-2$.

Table 5 reports difference-in-differences estimates comparing workers earning below the minimum wage (€4.50–€8.50) to those earning well above it (€12.50–€20.50). Panel A reports results using the 2011–2013 baseline period. Column 1 reports results from Equation (2) showing that workers in the treatment group experienced 4.2 percentage points higher hourly wage growth in the 2014–2016 period relative to the 2011–2013 baseline. I also see a similar growth in the 2013–2015 initial post policy period of 3.9 percentage points, suggesting that a large proportion of the wage growth occurred in 2015. The small pre-policy difference of 0.6 percentage points in 2012–2014 provides further support for the parallel trends assumption.

The key findings and comparison of point estimates between my data construction and those of Dustmann et al. (2022) are summarized in Appendix A.4 and Appendix A.5. Reassuringly, I find similar results for hourly wages. Comparing the figures, both figures show similar levels of wage growth for below minimum wage workers. Turning to the

point estimates, Dustmann et al. (2022) find a 0.8 percentage points higher effect. This may be due to a higher representation of low skilled, young and marginally employed workers in the BeH compared to the IEB sample (see Appendix A.5).

Next, I turn to the effect of the minimum wage on routine workers. Column 2 reports the baseline estimate for non-routine workers, showing similar wage growth compared to the entire sample of 4.3 percentage points in the 2014–2016 period, compared to the 2011–2013 baseline wage growth. Column 3 reports the triple difference effects, showing that routine workers experienced a 1.2 percentage point lower wage growth than other workers equating to an hourly wage growth of about 3.1 percentage points due to the minimum wage. Reassuringly, I am unable to detect similar differences in the 2012–2014 or 2011–2013 period, providing support for the parallel trends assumption.

To address concerns relating to the missing occupational codes at baseline, Panel B reports the results with a 2012–2014 baseline. As is expected, I again detect a differential of just over 1 percentage point. Panel C reports on the results with proxied hourly wage bins and 1-year differences, again I detect a post-policy differential this time finding a differential of around 1.5 percentage points.

Turning to daily wages, I report on effects in Table 6. Consistent with the results provided by Dustmann et al. (2022), I find a slightly larger effect at the daily wage level of 7 percentage points. The larger growth in daily wage results is most likely driven by workers re-allocating from marginal and part-time to full time employment, a finding that is confirmed below. Again, the differential between routine and non-routine workers is detected. This differential is slightly larger, at 2.6 percentage points using the two-year differences 2011–2013 baseline model. The robustness of this result is confirmed in Panels B and C.

What could be driving these differences in wage growth? Two factors seem most likely to be driving this. To investigate this, I rely on the sample distributions shown in Table 2. First, routine workers are more likely to earn higher daily and hourly wages at baseline compared to non-routine workers. This suggests that the bite is lower for routine than non-routine workers, employers simply provide them with a wage boost to comply with the minimum wage increase while the wage premium for being a routine workers is diminished. Secondly, routine workers are more likely to be in full-time employment in baseline periods. Thus, there are fewer opportunities for routine workers to upgrade their working time status to full-time.

IV.D *Individual Approach - Reallocation results*

Next, I turn to the effects of the minimum wage on potential worker reallocation. Specifically, I investigate whether the minimum wage induced workers to move to higher quality establishments. Change in establishment quality is measured as the difference in outcomes

between the workers current establishment measured at $t - 2$ and the same outcomes in the establishment the workers was recorded at on June 30th at $t - 2$. Therefore, the outcomes are compared for both firms at $t - 2$. This eliminates the possibility that the outcomes for the establishments recorded at time t are not effected by the minimum wage. To assess the effect of the occupational code switch, I apply the one-year differences with proxied wage bins model. This measures outcomes at $t - 1$, therefore I only report on the results for the 2014–2015 post-policy period.

Figure 3 provides an initial indication of the effect of the minimum wage hike on a number of characteristics that can be extracted using the IEB data sample: average daily wage, size, wage premium, high-skilled employment share, full-time employment share, and marginal employment share. Across the six graphs, I see fairly consistent pattern: the minimum wage introduction induced below minimum wage workers to reallocate to higher quality establishments. Following the hike, minimum wage workers were more likely to work in establishments that on average paid their workers more, were larger, had a higher share of high-skill and full-time workers and a lower share of marginal employment. As demonstrated in Appendix A.4, these findings are broadly similar to those in Dustmann et al. (2022).

I report on the corresponding difference-in-difference estimates in Table 7. This reiterates the story above. For the two-year differences with 2011–2013 baseline model, I see that workers reallocated to firms that paid there workers on average 1.5 percentage points per day more. The average wage premium is obtained from an individual-level wage regression that controls for workers’ demographic characteristics (age, sex, education, and German citizenship) as well as their working time status as a measure for establishment quality. This shows a slightly lower growth of 0.5 percentage points when accounting for the same worker type. This difference can be explained by increases in other metrics, overall, workers reallocated to establishments with more high-skilled and full-time workers and fewer marginal workers. These effects are largely robust to the 1-year differences, 2012–2013 baseline period with proxied hourly wage bins, with the exception of high-skilled employment share which changes sign.

Turning to the difference between routine and non-routine workers, Column 3 reports the routine differential. Across models a consistent story appears. In general, routine workers have a smaller reallocation effect, these effects are most clearly seen with the average daily wage, wage premium and establishment size. As demonstrated in Table 2, routine workers already worked at larger firms, and on average had higher daily and hourly wages. This could indicate that firms hiring routine workers were better at baseline. Furthermore, these results do not imply workers substitution between establishments.

V Establishment Approach

The above analysis suggests no adverse effects for routine workers following the introduction of the minimum wage. However, the key insight of Dustmann et al. (2022) is that the minimum wage induces workers to reallocate from one establishment to another. Establishments hit by the minimum wage could substitute labor for capital, but the substituted labor is able to reallocate to other establishments with no detectable short-term harm to their wage or employment prospects. To investigate whether establishments may be substituting routine labor for capital, I track establishment outcomes.

For this approach, I draw a stratified 25% sample of establishments recorded in the BeH in 2014. Then, using this sample I create a Linked Employer-Employee Panel from 2012-2017, these data contain information on all employees recorded in those establishments on June 30th in each year. For all employment spells linked to the establishment I apply the working time status and hourly wage imputations as described in the individual approach. This allows me to accurately measure establishment exposure to the minimum wage using working hours. To allow for clean identification of within-firm effects, I remove firms that are not observed in the whole period thus eliminating any confounders from differential firm entry and exit.

At the establishment level, I closely follow the empirical strategy of Dustmann et al. (2022) deployed to investigate effects at the regional level. First, I generate a gap measure commonly used in the literature (e.g., Card and Krueger 1994; Draca, Machin, and Van Reenen 2011):

$$\text{GAP}_{et} = \frac{\sum_{i \in e} h_{it} \max\{0, MW - w_{it}\}}{\sum_{i \in e} h_{it} w_{it}}$$

where h_{it} represents worker i 's weekly hours in establishment e , MW denotes the minimum wage, and w_{it} is the worker's hourly wage. This metric captures both the proportion of workers earning below the minimum wage and the size of their wage shortfall. When multiplied by 100, it shows the percentage wage increase needed to raise all workers in the establishment to the minimum wage threshold. The gap measure is averaged for firms over three pre-policy years from 2012-2014 to create a time stable gap measure for each establishment. To eliminate the effect of outliers, I winsorize the gap measure at the 95th percentile.

Table 8 reports on the 2014 sample distribution for establishments in my sample. In Column 1, I report averages for all establishments, showing an average gap of 10%. In Columns 2 and 3 I split the sample into below and above median gap, showing the those below the median have all workers earning above minimum wage whilst those above the median have a gap of 20%. Correspondingly, above median gap establishments have lower wage bills and fewer employees. Whilst those below the median gap have slightly

more routine workers, on average above median firms still employ a substantial share of routine workers with 39%. They also have smaller shares of full-time and a greater share of marginal workers.

I then use event-study style regressions to relate my outcome measures to exposure to the minimum wage in the following specification:

$$Y_{et} = \sum_{t \neq 2014} \beta_t (\overline{GAP}_e \times \text{Year}_t) + \alpha_e + \delta_o + \theta_s + \epsilon_{et} \quad (4)$$

where Y_{et} represents establishment outcomes (routine workers' share of the wage bill and workforce).⁴ The coefficients β_t identify the dynamic treatment effects in each year relative to the 2014 baseline. The specification includes establishment fixed effects (α_e), industry fixed effects (δ_o), and state fixed effects (θ_s), with establishment size as a time-varying control. An advantage of this approach compared to the individual approach is that it allows me to add an additional year. As firm investments in technology may take time to come into effect, we may not expect to immediate substitution. Therefore, I am able to capture any lagged effects of the minimum wage up to 3 years after implementation.

V.A *Establishment-level Results*

Figure 4a presents the event study estimates obtained from 4 for both the share of the workforce that is employed in routine occupations and their share of the wage bill. In the years up to 2014, I detect a small negative differential effect for affected establishments compared to 2014, indicating some potential anticipation effects. Following the introduction of the minimum wage policy, I see the positive trend continues, routine workers make up a higher share of total employment and the wage bill in the years following 2014. In Table 9 I report on difference-in-difference estimators comparing outcomes for establishments before and after the minimum wage. This shows that the routine share of the workforce increased by 1 percent point, whilst the routine share of the wage bill was slightly lower at 0.7 percent point. Taken together, these results show that there is no evidence of substitution at the establishment level even up to 3 years after the minimum wage. As shown in the appendix, it appears that establishments rather adjusted by reducing their reliance on marginal workers. As routine workers are less likely to be marginal workers, this most likely explains their increasing share of the wage and employment bill, rather than reallocation to capital inputs.

⁴In the appendix, I report on the outcomes for total employment and wage effects, as well as employment outcomes for full-time, part-time and marginal workers showing an overall increase in wages and decrease in employment at effected establishments, driven by marginal workers.

VI Conclusion

Minimum wages have become a common tool deployed by policy makers, contrary to predictions of large job losses employment effects have been largely elusive. This paper investigates an avenue through which firms can absorb higher wage costs relating to minimum wages: factor allocation. Intuitively, if there is a rise in the cost of labor firms may be incentivized to allocate tasks to capital which is now comparatively cheaper. I use register data provided by the IAB linked to routine occupation classifications. I employ two empirical approaches to investigate whether the 2015 introduction of Germany’s national minimum wage affected workers in routine occupations differently. The first approach tracks individual workers, while the second examines establishment-level compositional changes.

At the individual level, I track employment and wage outcomes for workers earning below the minimum wage at baseline, distinguishing between those in routine and non-routine occupations. Routine workers exposed to the minimum wage experienced similar employment outcomes to non-routine workers. Both groups saw modest improvements in employment probabilities, with no evidence of differential job losses among routine workers whose tasks are more susceptible to automation. However, the groups diverged on wage growth. Routine workers experienced hourly wage growth of around 3 percentage points, approximately 1 percentage point lower than non-routine workers. This differential appears driven by baseline characteristics rather than substitution: routine workers already earned higher wages and worked in larger, better-paying establishments prior to the reform, leaving less room for wage increases and upgrades in employment status.

Both groups experienced reallocation to higher quality establishments following the minimum wage introduction. Workers moved to firms with higher average wages, larger size, and better workforce composition. However, these reallocation effects were stronger for non-routine workers, consistent with lower baseline establishment quality. Importantly, these differences in reallocation patterns do not suggest substitution. Rather, they reflect pre-existing differences in the types of establishments employing routine versus non-routine workers.

The individual-level analysis cannot distinguish between no displacement and successful reabsorption of displaced workers. If firms substituted away from routine labor but workers quickly found new jobs, individual outcomes would show no effect. To directly test whether firms adjusted their labor composition, I examine establishment-level outcomes in a balanced panel from 2012-2017. I find no relationship between minimum wage exposure and the share of employment or wage bill accounted for by routine workers. If anything, routine workers’ share of both employment and wages increased slightly at affected establishments. These establishment-level results hold even three years after implementation, suggesting no delayed substitution effects.

These findings contrast with U.S. evidence linking minimum wages to reduced automation-exposed employment. Two explanations seem plausible. First, different identification strategies may account for the divergence. The clean shock from Germany’s national introduction avoids endogeneity concerns inherent in state-level variation, where policy timing may correlate with local economic conditions or where cross-state spillovers complicate inference. Second, Germany’s distinct labor market institutions may lead firms to adjust along different margins.

The results suggest that, at least in the short run, German firms did not respond to higher labor costs by substituting routine workers with capital. Whether automation effects emerge over longer horizons, or whether institutional features genuinely constrain this adjustment channel, remains an open question for future research

VII References

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VIII Figures

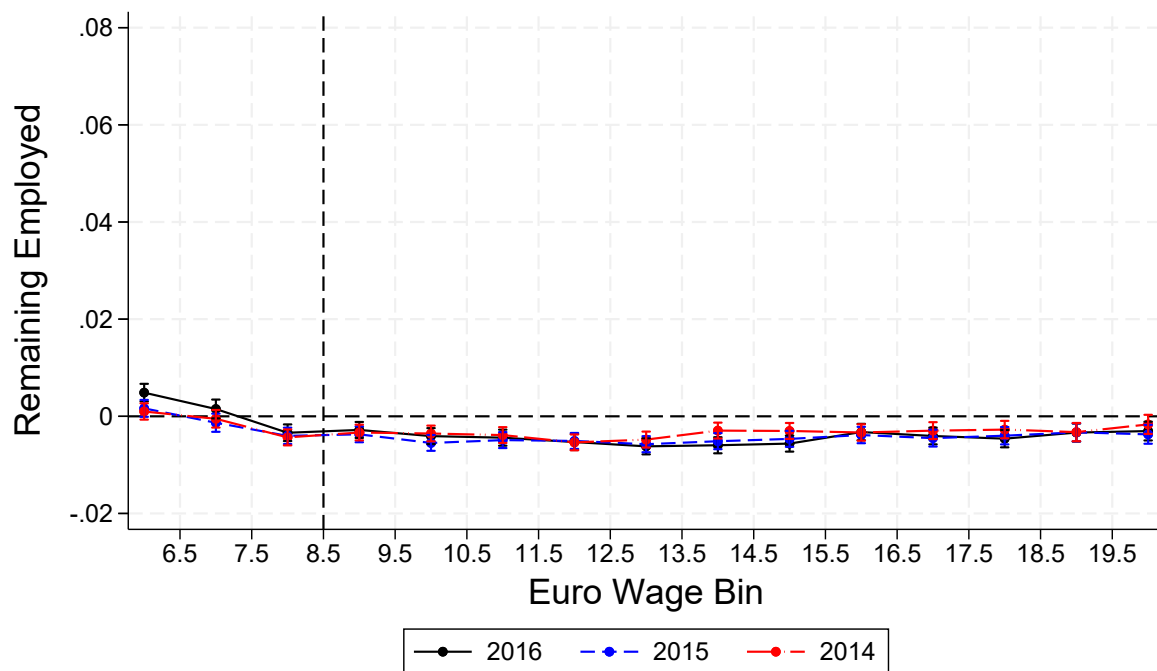


Figure 1: Employment Probability in year t relative to 2011-2013 baseline period

Notes: This figure plots two-year employment probability changes across hourly wage bins for the 2012–2014 and 2014–2016 periods relative to the 2011–2013 baseline relative to the 2011–2013 baseline period, obtained from Equation (2). Workers are assigned to bins based on their hourly wage at $t - 2$. The sample includes prime-age workers (18–59) from the IEB administrative data. Controls include age, gender, education, nationality, working time status, industry, and region.

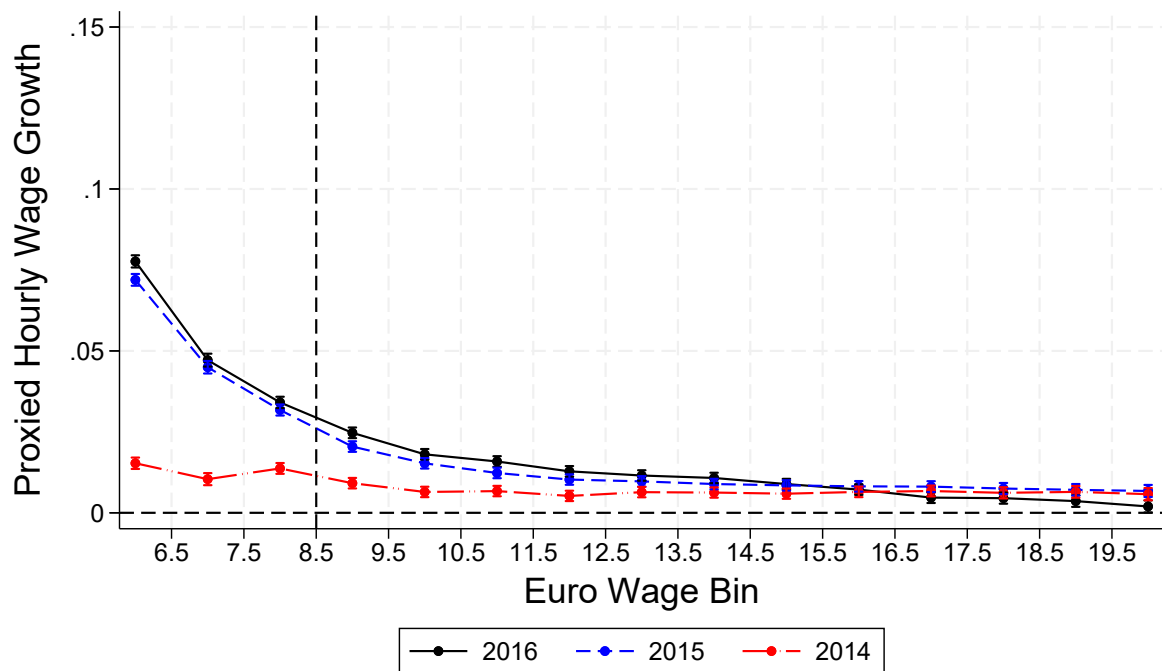
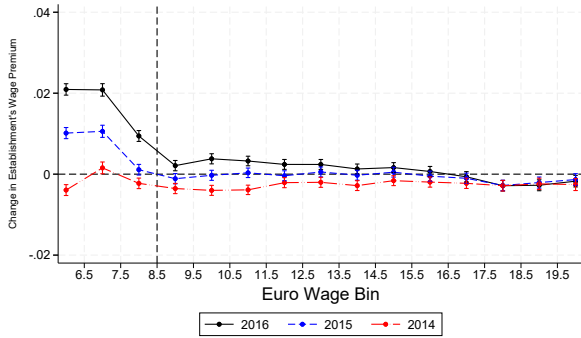
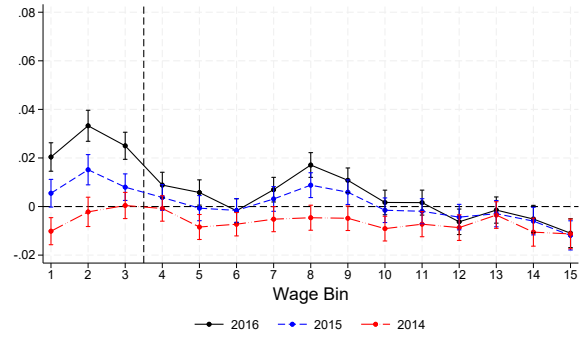


Figure 2: Two Year hourly wage growth relative to 2011-2013 baseline period

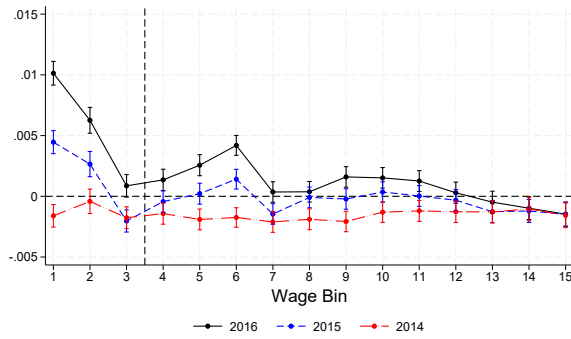
Notes: This figure plots two-year proxied hourly wage growth across hourly wage bins for the 2012–2014 and 2014–2016 periods relative to the 2011–2013 baseline, obtained from Equation (2). Hourly wages are proxied by dividing daily wages by average working hours for each working time status category (5.28 hours for full-time, 3.30 for part-time, 1.18 for marginal). Workers earning below €8.50/hr at $t - 2$ experience significantly higher wage growth in post-policy periods, while workers higher in the distribution show no deviation from zero, supporting the parallel trends assumption. Controls include age, gender, education, nationality, working time status, industry, and region.



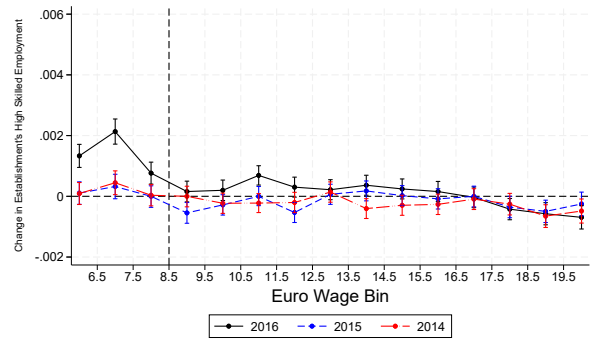
(a) Average Daily Wage



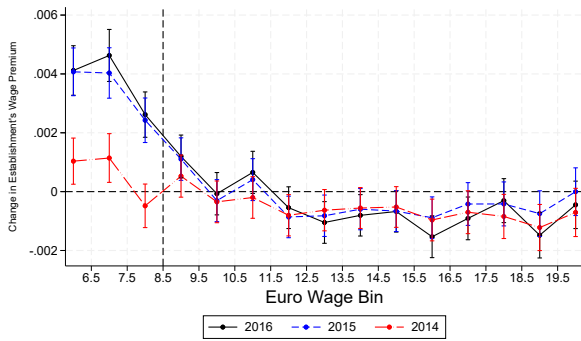
(b) Establishment Size



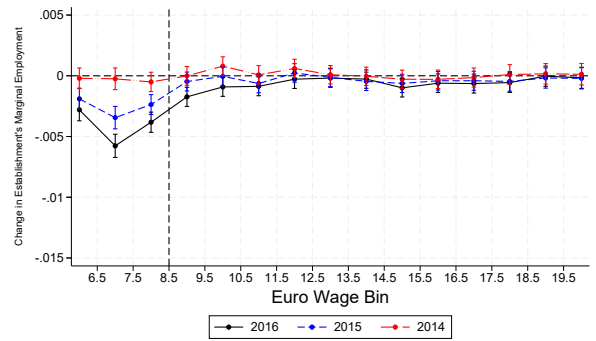
(c) Wage Premium



(d) High-Skilled Employment Share



(e) Full-Time Employment Share



(f) Marginal Employment Share

Figure 3: Reallocation Effects of the Minimum Wage

Notes: These figures plot changes in establishment quality measures for workers across hourly wage bins relative to the 2011–2013 baseline, obtained from Equation (2). Establishment quality is measured as the difference in outcomes between the worker's establishment at t and at $t - 2$, with both outcomes measured at $t - 2$ to avoid contamination from minimum wage effects on establishments. Average daily wage is the log mean daily wage at the establishment. Wage premium is obtained from an individual-level wage regression controlling for demographics and working time status. High-skilled, full-time, and marginal employment shares are calculated at the establishment level. Controls include age, gender, education, nationality, working time status, industry, and region.

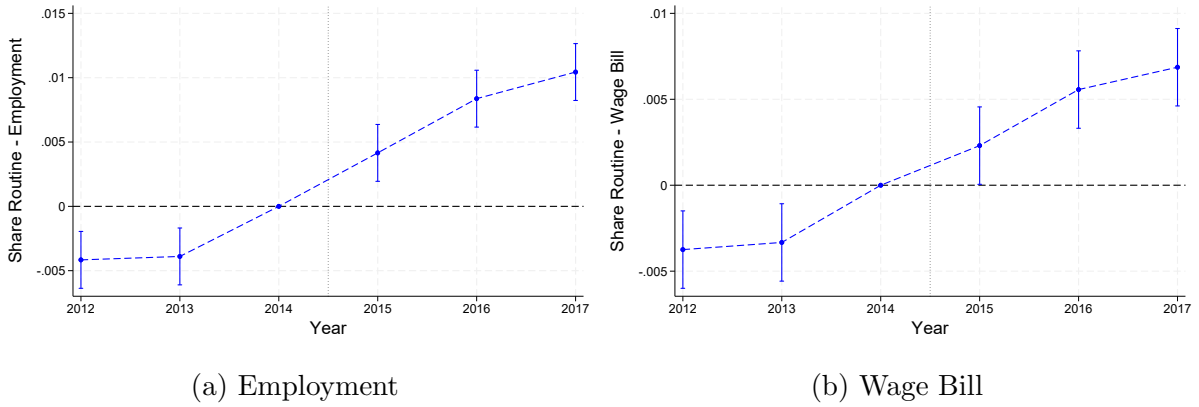


Figure 4: Routine Share of Employment and Wages

Notes: These figures plot event study estimates from Equation (4) for the share of establishment employment (left) and wage bill (right) accounted for by routine workers. The sample is a balanced panel of establishments observed in all years 2012–2017 from a stratified 25% sample of BeH establishments. The gap measure captures minimum wage exposure as the percentage wage increase needed to raise all workers to €8.50/hr, averaged over 2012–2014 and winsorized at the 95th percentile. Coefficients are relative to 2014. The specification includes establishment, industry, and state fixed effects, with establishment size as a time-varying control.

	$4.5 < W_{t-2}$ ≤ 8.5	$8.5 < W_{t-2}$ ≤ 12.50	$12.50 < W_{t-2}$ ≤ 20.50
East Germany	0.27	0.26	0.18
Non-German citizen	0.17	0.14	0.08
Women	0.66	0.57	0.47
By education			
Share low skilled	0.15	0.10	0.05
Share medium skilled	0.79	0.83	0.84
Share high skilled	0.06	0.07	0.11
By age			
Share less than 24	0.10	0.04	0.01
Share 24–44	0.47	0.51	0.52
Share 45–59	0.43	0.45	0.47
By unemployment and working time status			
Unemployed in previous year	0.78	0.87	0.94
Share full-time	0.33	0.56	0.72
Share part-time	0.27	0.26	0.25
Share marginally employed	0.40	0.18	0.03
By industry structure			
Agriculture; Mining	0.00	0.00	0.00
Manufacturing; Utilities; Waste	0.10	0.15	0.23
Construction; Retail; Wholesale	0.24	0.26	0.29
Transport; Hospitality; Food	0.22	0.14	0.09
Finance; IT; Real Estate	0.04	0.03	0.04
Professional Services	0.21	0.21	0.11
Public Services; Education; Health	0.11	0.16	0.20
Arts; Entertainment; Other	0.07	0.04	0.03
By establishment size			
1–4 employees	0.16	0.11	0.05
5–19 employees	0.30	0.27	0.22
20–49 employees	0.18	0.19	0.18
50+ employees	0.36	0.43	0.55
Number of observations	1,136,212	1,897,692	3,361,060

Table 1: Which Individuals Are Heavily Affected by the Minimum Wage?

Notes: This table reports sample shares by worker and establishment characteristics across three hourly wage bins in 2014. Column 1 includes workers earning between €4.50 and €8.50/hr (below minimum wage), Column 2 includes those earning €8.50–€12.50/hr (just above), and Column 3 includes those earning €12.50–€20.50/hr (control group). Hourly wages are imputed following the procedure of Dustmann et al. (2022). The sample includes prime-age workers (18–59) from the IEB administrative data, excluding apprentices.

	Non-Routine	Routine
East Germany	0.26	0.28
Non-German citizen	0.81	0.85
Women	0.70	0.59
By education		
Share low skilled	0.16	0.13
Share medium skilled	0.78	0.80
Share high skilled	0.06	0.07
By age		
Share less than 24	0.11	0.09
Share 24–44	0.46	0.48
Share 45–59	0.42	0.43
By unemployment and working time status		
Unemployed in previous year	0.22	0.22
Share full-time	0.28	0.44
Share part-time	0.29	0.23
Share marginally employed	0.44	0.33
By industry structure		
Agriculture; Mining	0.00	0.00
Manufacturing; Utilities; Waste	0.06	0.18
Construction; Retail; Wholesale	0.22	0.26
Transport; Hospitality; Food	0.29	0.09
Finance; IT; Real Estate	0.02	0.06
Professional Services	0.18	0.27
Public Services; Education; Health	0.12	0.10
Arts; Entertainment; Other	0.09	0.03
By establishment size		
1–4 employees	0.15	0.20
5–19 employees	0.32	0.27
20–49 employees	0.19	0.14
50+ employees	0.34	0.39
Wage results		
Daily wage	23.44	28.33
Imputed hourly wage	6.91	6.98
Number of observations	751,540	384,469
Share of wage bin	0.66	0.34

Table 2: Comparison of Routine and Non-Routine Workers Earning $4.5 < W_{t-2} \leq 8.5$
Notes: This table compares characteristics of routine and non-routine workers among those earning below the minimum wage (€4.50–€8.50/hr) in 2014. Routine classification is based on the occupational task measure from Dengler et al. (2014) at the 3-digit occupation level using the German classification of occupations 2010. Routine workers are more likely to be male, work full-time, earn higher daily wages, and work in larger establishments. Daily wages are in euros; hourly wages are imputed following Dustmann et al. (2022).

Table 3: Minimum Wage Effects on Employment

	All	Non-Routine	Routine DDD
Panel A: 2011-13 Baseline			
2014 to 2016	0.006 (0.0007)	0.008 (0.0010)	-0.011 (0.0015)
2013 to 2015	0.004 (0.0006)	0.006 (0.0009)	-0.011 (0.0014)
2012 to 2014	0.002 (0.0005)	0.005 (0.0007)	-0.011 (0.0012)
2011 to 2013	-0.148 (0.0033)	-0.151 (0.0035)	-0.009 (0.0013)
Panel B: 2012-14 Baseline			
2014 to 2016	0.004 (0.0007)	0.003 (0.0008)	-0.001 (0.0014)
2013 to 2015	0.001 (0.0006)	0.001 (0.0007)	-0.000 (0.0012)
2012 to 2014	-0.151 (0.0039)	-0.147 (0.0039)	-0.020 (0.0011)
Panel C: 1-Year Differences (2012-13 Baseline)			
2015 to 2016	0.012 (0.0009)	0.008 (0.0010)	0.009 (0.0013)
2014 to 2015	0.006 (0.0007)	0.004 (0.0008)	0.004 (0.0013)
2013 to 2014	0.006 (0.0006)	0.004 (0.0007)	0.005 (0.0011)
2012 to 2014	-0.121 (0.0017)	-0.116 (0.0017)	-0.021 (0.0011)

Notes: This table reports difference-in-differences estimates of minimum wage effects on employment probability, comparing workers earning €4.50–€8.50/hr (treatment) to those earning €12.50–€20.50/hr (control) at baseline. Column 1 reports effects for all workers from Equation (2). Column 2 reports effects for non-routine workers. Column 3 reports the triple-difference estimate for routine workers from Equation (3), capturing how their response differs from non-routine workers. Panel A uses 2011–2013 as the baseline with two-year differences. Panel B shifts the baseline to 2012–2014 to address missing occupational codes in 2011. Panel C uses one-year differences with proxied hourly wage bins (daily wages divided by average working hours by employment status). Controls include age, gender, education, nationality, working time status, industry, and region. Standard errors in parentheses.

Table 4: Minimum Wage Effects on Employment Full-Time Equivalent

	All	Non-Routine	Routine DDD
Panel A: 2011-13 Baseline			
2014 to 2016	0.018 (0.0008)	0.019 (0.0011)	-0.013 (0.0013)
2013 to 2015	0.014 (0.0006)	0.015 (0.0007)	-0.011 (0.0012)
2012 to 2014	0.006 (0.0005)	0.007 (0.0008)	-0.011 (0.0011)
2011 to 2013	-0.217 (0.0038)	-0.219 (0.0040)	-0.014 (0.0010)
Panel B: 2012-14 Baseline			
2014 to 2016	0.011 (0.0007)	0.012 (0.0011)	-0.001 (0.0012)
2013 to 2015	0.008 (0.0005)	0.008 (0.0006)	0.000 (0.0010)
2012 to 2014	0.213 (0.0042)	-0.208 (0.0043)	-0.025 (0.0010)
Panel C: 1-Year Differences (2012-13 Baseline)			
2015 to 2016	0.017 (0.0009)	0.013 (0.0010)	0.008 (0.0011)
2014 to 2015	0.012 (0.0006)	0.009 (0.0007)	0.007 (0.0011)
2013 to 2014	0.008 (0.0007)	0.006 (0.0007)	0.007 (0.0010)
2012 to 2014	-0.171 (0.0026)	-0.164 (0.0027)	-0.029 (0.0010)

Notes: This table reports difference-in-differences estimates of minimum wage effects on full-time equivalent (FTE) employment, comparing workers earning €4.50–€8.50/hr (treatment) to those earning €12.50–€20.50/hr (control) at baseline. FTE is constructed by assigning weights of 1 to full-time, 0.5 to part-time, 0.2 to marginal employment, and 0 to non-employment. Column 1 reports effects for all workers. Column 2 reports effects for non-routine workers. Column 3 reports the triple-difference estimate for routine workers. Positive effects indicate workers upgraded from part-time or marginal to full-time employment. Panel structure and controls follow Table 3. Standard errors in parentheses.

Table 5: Minimum Wage Effects on Hourly Wages

	All	Non-Routine	Routine DDD
Panel A: 2011-13 Baseline			
2014 to 2016	0.042 (0.0022)	0.043 (0.0023)	-0.012 (0.0018)
2013 to 2015	0.039 (0.0019)	0.040 (0.0019)	-0.013 (0.0016)
2012 to 2014	0.006 (0.0007)	0.002 (0.0010)	0.001 (0.0016)
2011 to 2013	0.118 (0.0032)	0.118 (0.0033)	0.005 (0.0016)
Panel B: 2012-14 Baseline			
2014 to 2016	0.036 (0.0021)	0.041 (0.0025)	-0.013 (0.0021)
2013 to 2015	0.033 (0.0019)	0.038 (0.0021)	-0.014 (0.0018)
2012 to 2014	0.128 (0.0038)	0.124 (0.0038)	0.007 (0.0016)
Panel C: 1-Year Differences (2012-13 Baseline)			
2015 to 2016	0.031 (0.0012)	0.032 (0.0013)	-0.004 (0.0015)
2014 to 2015	0.062 (0.0022)	0.068 (0.0024)	-0.015 (0.0017)
2013 to 2014	0.014 (0.0007)	0.017 (0.0008)	-0.009 (0.0013)
2012 to 2014	0.110 (0.0020)	0.110 (0.0019)	-0.004 (0.0014)

Notes: This table reports difference-in-differences estimates of minimum wage effects on log hourly wage growth, comparing workers earning €4.50–€8.50/hr (treatment) to those earning €12.50–€20.50/hr (control) at baseline. Hourly wages are proxied by dividing daily wages by average working hours for each working time status category. Column 1 reports effects for all workers. Column 2 reports effects for non-routine workers. Column 3 reports the triple-difference estimate for routine workers, showing approximately 1 percentage point lower wage growth than non-routine workers. The differential is driven by routine workers' higher baseline wages and greater full-time employment shares. Panel structure and controls follow Table 3. Standard errors in parentheses.

Table 6: Minimum Wage Effects on Daily Wages

	All	Non-Routine	Routine DDD
Panel A: 2011-13 Baseline			
2014 to 2016	0.070 (0.0024)	0.076 (0.0027)	-0.026 (0.0026)
2013 to 2015	0.060 (0.0021)	0.066 (0.0022)	-0.024 (0.0022)
2012 to 2014	0.007 (0.0010)	0.006 (0.0014)	-0.004 (0.0020)
2011 to 2013	0.002 (0.0048)	-0.007 (0.0053)	0.012 (0.0020)
Panel B: 2012-14 Baseline			
2014 to 2016	0.063 (0.0020)	0.070 (0.0024)	-0.022 (0.0025)
2013 to 2015	0.053 (0.0018)	0.060 (0.0020)	-0.019 (0.0020)
2012 to 2014	0.013 (0.0056)	0.007 (0.0058)	0.008 (0.0017)
Panel C: 1-Year Differences (2012-13 Baseline)			
2014 to 2016	0.064 (0.0016)	0.042 (0.0017)	-0.007 (0.0018)
2013 to 2015	0.073 (0.0025)	0.080 (0.0027)	-0.015 (0.0021)
2012 to 2014	0.016 (0.0009)	0.020 (0.0011)	0.005 (0.0022)

Notes: This table reports difference-in-differences estimates of minimum wage effects on log daily wage growth, comparing workers earning €4.50–€8.50/hr (treatment) to those earning €12.50–€20.50/hr (control) at baseline. Daily wage effects (7 percentage points) exceed hourly wage effects (4.2 percentage points), reflecting workers' reallocation from marginal and part-time to full-time employment. Column 1 reports effects for all workers. Column 2 reports effects for non-routine workers. Column 3 reports the triple-difference estimate for routine workers, showing a larger differential (2.6 percentage points) than for hourly wages due to fewer opportunities for working time upgrades among routine workers who were more likely full-time at baseline. Panel structure and controls follow Table 3. Standard errors in parentheses.

Table 7: Reallocation to higher-quality establishments: individual approach

	All	Non-Routine	DDD
Panel A - 2011–2013 Baseline (2-year differences)			
Average daily wage	0.015 (0.0009)	0.017 (0.0010)	-0.005 (0.0020)
Average wage premium	0.005 (0.0005)	0.006 (0.0005)	-0.004 (0.0010)
Establishment Size	0.013 (0.00458)	0.007 (0.0061)	-0.017 (0.0108)
High-skilled employment share	0.001 (0.0002)	0.001 (0.0002)	-0.001 (0.0005)
Full-Time employment share	0.004 (0.0006)	0.003 (0.0007)	-0.001 (0.0010)
Marginal employment share	-0.003 (0.0004)	0.000 (0.0006)	-0.001 (0.0011)
Panel B - 2011–2013 Baseline (1-year differences)			
Average daily wage	0.011 (0.0010)	0.005 (0.0014)	-0.007 (0.0018)
Average wage premium	0.005 (0.0005)	-0.0001 (0.0009)	-0.009 (0.0001)
Establishment Size	0.015 (0.0043)	0.014 (0.0063)	-0.030 (0.0073)
High-skilled employment share	-0.001 (0.0002)	-0.002 (0.0005)	-0.001 (0.0005)
Full-Time employment share	0.002 (0.0005)	0.004 (0.0007)	0.003 (0.0009)
Marginal employment share	-0.003 (0.0004)	-0.003 (0.0005)	-0.001 (0.0006)

Notes: This table reports difference-in-differences estimates of minimum wage effects on worker reallocation to higher-quality establishments, comparing workers earning €4.50–€8.50/hr (treatment) to those earning €12.50–€20.50/hr (control) at baseline. Establishment quality is measured as the change in outcomes between the worker’s establishment at t and $t - 2$, with both outcomes measured at $t - 2$ to avoid contamination. Average daily wage is the log mean daily wage. Wage premium is from an individual-level regression controlling for demographics and working time status. Column 1 reports effects for all workers. Column 2 reports effects for non-routine workers. Column 3 reports the triple-difference estimate for routine workers, showing smaller reallocation effects consistent with their higher baseline establishment quality. Panel A uses two-year differences; Panel B uses one-year differences with proxied wage bins for the 2014–2015 post-policy period. Standard errors in parentheses.

	All	Below Median	Above Median
Mean gap	0.10	0.00	0.20
Daily wage bill	969.62	1,552.28	386.96
Total employees	11.85	15.27	8.42
By routine occupations			
Share of employment	0.45	0.50	0.39
Share of wage bill	0.44	0.49	0.40
By employment type			
Full-time	0.52	0.65	0.39
Part-time	0.24	0.23	0.26
Marginal	0.24	0.13	0.35
By industry structure			
Agriculture; Mining	0.02	0.02	0.02
Manufacturing; Utilities; Waste	0.12	0.15	0.09
Construction; Retail; Wholesale	0.30	0.32	0.28
Transport; Hospitality; Food	0.11	0.06	0.16
Finance; IT; Real Estate	0.07	0.09	0.06
Professional Services	0.14	0.15	0.14
Public Services; Education; Health	0.18	0.18	0.17
Arts; Entertainment; Other	0.07	0.05	0.09
Number of observations	840,192	420,096	420,096

Table 8: Establishments by Wage Gap

Notes: This table reports establishment characteristics by minimum wage exposure in 2014. The gap measure captures the percentage wage increase needed to raise all workers to the €8.50/hr minimum wage, calculated as $GAP = \sum_i h_i \max\{0, MW - w_i\} / \sum_i h_i w_i$ where h_i is weekly hours and w_i is hourly wage. The gap is averaged over 2012–2014 and winsorized at the 95th percentile. Column 1 reports averages for all establishments. Columns 2 and 3 split the sample at the median gap. Above-median establishments have smaller wage bills, fewer employees, higher marginal employment shares, and lower routine employment shares, though routine workers still comprise 39% of employment. The sample is a stratified 25% sample of establishments from the BeH observed in all years 2012–2017.

Table 9: Minimum Wage Effects on Routine Share: Establishment Approach

	Employment	Wage Bill
Post \times GAP	0.010 (0.0007)	0.007 (0.0007)
Observations	5,036,940	5,036,940

Notes: This table reports difference-in-differences estimates from Equation (4) for the effect of minimum wage exposure on the share of establishment employment (Column 1) and wage bill (Column 2) accounted for by routine workers. The gap measure captures pre-policy minimum wage exposure, averaged over 2012–2014 and winsorized at the 95th percentile. Post is an indicator for years 2015–2017. The sample is a balanced panel of establishments observed in all years 2012–2017 from a stratified 25% sample of BeH establishments. Specifications include establishment, industry, and state fixed effects, with establishment size as a time-varying control. Positive coefficients indicate routine workers' share increased slightly at affected establishments, providing no evidence of capital-labor substitution up to three years post-implementation. Standard errors in parentheses.

Appendix

A.1 Working Hours Imputation Comparison between BeH, IEB, GSOEP, and SES

	IEB	BEH	SES	SOEP
<i>Full-time</i>				
All	5.0	4.4	4.4	5.4
Men	3.6	3.0	3.3	4.2
Women	8.0	7.4	6.6	7.9
<i>Part-time</i>				
All	10.7	13.1	9.9	18.0
Men	15.7	20.7	15.3	22.9
Women	9.6	11.5	8.8	17.2
<i>Marginal</i>				
All	39.1	47.4	39.7	53.4
Men	39.5	48.8	39.7	60.8
Women	39.0	46.7	39.7	50.9

Table A.1.1: Fraction Affected by the Minimum Wage According to Structure of Earnings Survey (SES), SOEP, BEH and IEB in 2014

	IEB	BEH	SES	SOEP
<i>Full-time</i>				
All	39.2	38.8	39.1	39.2
Men	39.3	38.9	39.1	39.4
Women	39.0	38.5	39.0	38.4
<i>Part-time</i>				
All	24.3	24.2	23.9	23.6
Men	25.2	25.1	23.8	24.5
Women	24.0	24.0	23.9	23.5
<i>Marginal</i>				
All	8.7	9.8	8.2	11.6
Men	8.6	9.8	8.0	14.1
Women	8.7	9.8	8.2	10.7

Table A.1.2: Average Weekly Hours in the IEB, in the BEH, in the Structure of Earnings Survey (SES) and the German Socioeconomic Panel (GSOEP) in 2014

	Imputed Hourly Wages	Proxied Hourly Waages
East Germany	0.27	0.23
Non-German citizen	0.17	0.17
Women	0.66	0.68
By education		
Share low skilled	0.15	0.14
Share medium skilled	0.79	0.77
Share high skilled	0.06	0.09
By age		
Share less than 24	0.10	0.10
Share 24–44	0.47	0.48
Share 45–59	0.43	0.42
By unemployment and working time status		
Unemployed in previous year	0.78	
Share full-time	0.33	0.32
Share part-time	0.27	0.34
Share marginally employed	0.40	0.34
By industry structure		
Agriculture, mining	0.00	0.02
Manufacturing etc	0.10	0.08
Construction etc	0.24	0.20
Transportation etc	0.22	0.20
Information etc	0.04	0.04
Professional etc	0.21	0.20
Public etc	0.11	0.17
Arts etc	0.07	0.08
By establishment size		
1–4 employees	0.16	0.20
5–19 employees	0.30	0.30
20–49 employees	0.18	0.15
50+ employees	0.36	0.35
Number of observations	1,136,212	1,204,118

Table A.2.1: Comparison between imputed and proxied hourly wages for the affected wage bin

A.2 Comparison Results - Tables

A.3 Comparison of Sample Distributions

	4.5 < W_{t-2} ≤ 8.5		
	Original	Replication	Difference
East Germany	0.30	0.27	-0.03
Non-German citizen	0.14	0.17	+0.03
Women	0.66	0.66	0.00
By education			
Share low skilled	0.23	0.15	-0.08
Share medium skilled	0.70	0.79	+0.09
Share high skilled	0.07	0.06	-0.01
By age			
Share less than 24	0.17	0.10	-0.07
Share 24–44	0.44	0.47	+0.03
Share 45–59	0.39	0.43	+0.04
By unemployment and working time status			
Unemployed in previous year	0.22	0.22	0.00
Share full-time	0.31	0.33	+0.02
Share part-time	0.28	0.27	-0.01
Share marginally employed	0.42	0.40	-0.02
By industry structure			
Agriculture, mining	0.00	0.00	0.00
Manufacturing etc	0.10	0.10	0.00
Construction etc	0.24	0.24	0.00
Transportation etc	0.23	0.22	-0.01
Information etc	0.04	0.04	0.00
Professional etc	0.21	0.21	0.00
Public etc	0.11	0.11	0.00
Arts etc	0.08	0.07	-0.01
By establishment size			
1–4 employees	0.22	0.16	-0.06
5–19 employees	0.31	0.30	-0.01
20–49 employees	0.17	0.18	+0.01
50+ employees	0.30	0.36	+0.06
Number of observations	1,107,304	1,136,212	+28,908

Table A.3.1: Caption

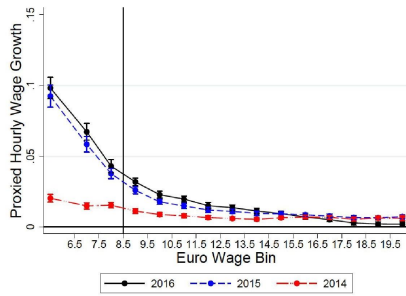
	12.50 < W_{t-2} ≤ 20.50		
	Original	Replication	Difference
East Germany	0.17	0.18	+0.01
Non-German citizen	0.07	0.08	+0.01
Women	0.48	0.47	-0.01
By education			
Share low skilled	0.08	0.05	-0.03
Share medium skilled	0.83	0.84	+0.01
Share high skilled	0.10	0.11	+0.01
By age			
Share less than 24	0.08	0.01	-0.07
Share 24–44	0.51	0.52	+0.01
Share 45–59	0.42	0.47	+0.05
By unemployment and working time status			
Unemployed in previous year	0.06	0.06	0.00
Share full-time	0.72	0.72	0.00
Share part-time	0.25	0.25	0.00
Share marginally employed	0.03	0.03	0.00
By industry structure			
Agriculture, mining	0.00	0.00	0.00
Manufacturing etc	0.23	0.23	0.00
Construction etc	0.29	0.29	0.00
Transportation etc	0.09	0.09	0.00
Information etc	0.04	0.04	0.00
Professional etc	0.11	0.11	0.00
Public etc	0.21	0.20	-0.01
Arts etc	0.03	0.03	0.00
By establishment size			
1–4 employees	0.07	0.05	-0.02
5–19 employees	0.22	0.22	0.00
20–49 employees	0.18	0.18	0.00
50+ employees	0.53	0.55	+0.02
Number of observations	3,791,061	3,361,060	-430,001

Table A.3.2: Caption

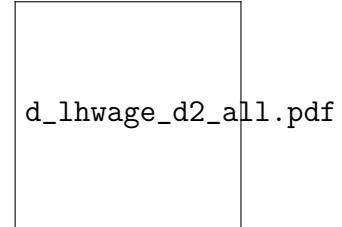
	8.5 < W_{t-2} ≤ 12.50		
	Original	Replication	Difference
East Germany	0.27	0.26	-0.01
Non-German citizen	0.12	0.14	+0.02
Women	0.57	0.57	0.00
By education			
Share low skilled	0.15	0.10	-0.05
Share medium skilled	0.79	0.83	+0.04
Share high skilled	0.07	0.07	0.00
By age			
Share less than 24	0.13	0.04	-0.09
Share 24–44	0.48	0.51	+0.03
Share 45–59	0.39	0.45	+0.06
By unemployment and working time status			
Unemployed in previous year	0.15	0.13	-0.02
Share full-time	0.57	0.56	-0.01
Share part-time	0.27	0.26	-0.01
Share marginally employed	0.17	0.18	+0.01
By industry structure			
Agriculture, mining	0.00	0.00	0.00
Manufacturing etc	0.15	0.15	0.00
Construction etc	0.26	0.26	0.00
Transportation etc	0.14	0.14	0.00
Information etc	0.03	0.03	0.00
Professional etc	0.21	0.21	0.00
Public etc	0.17	0.16	-0.01
Arts etc	0.04	0.04	0.00
By establishment size			
1–4 employees	0.14	0.11	-0.03
5–19 employees	0.28	0.27	-0.01
20–49 employees	0.18	0.19	+0.01
50+ employees	0.40	0.43	+0.03
Number of observations	2,170,353	1,897,692	-272,661

Table A.3.3: Caption

A.4 Comparison Results - Figures

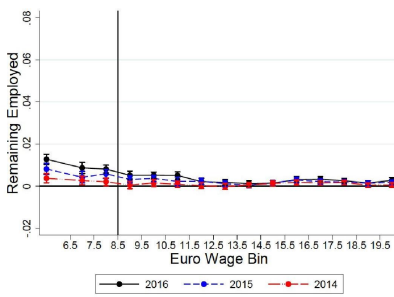


(a) Original estimates

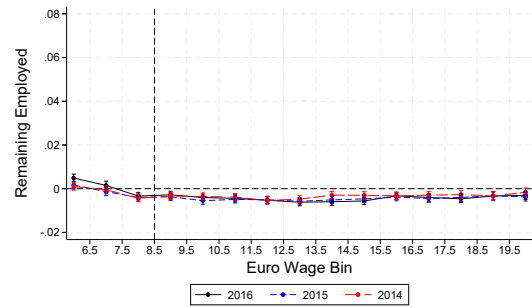


(b) Own Reconstruction

Figure A.4.1: Wage Effects of the Minimum Wage: Individual Approach

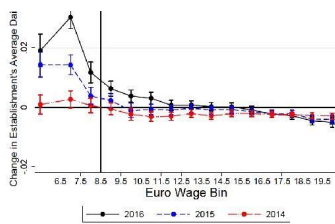


(a) Original estimates

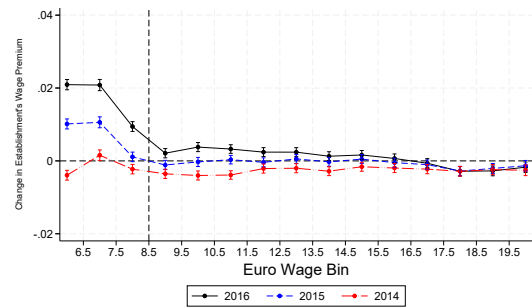


(b) Own Reconstruction

Figure A.4.2: Employment Effects of the Minimum Wage: Individual Approach

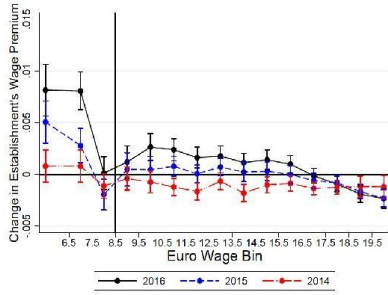


(a) Original estimates

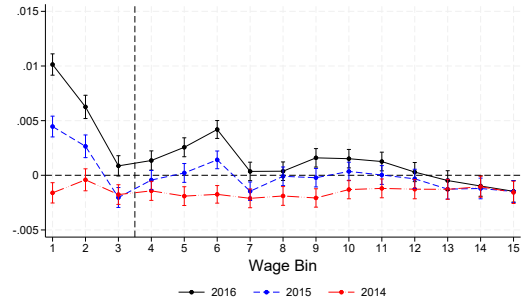


(b) Own Reconstruction

Figure A.4.3: Establishment's Average Daily Wage

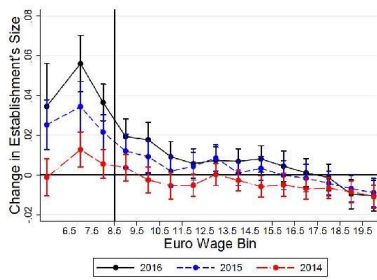


(a) Original estimates from Dustmann et al. (2022)

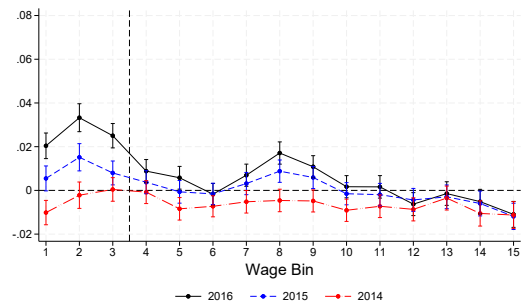


(b) Own Reconstruction

Figure A.4.4: Establishment's Wage Premium

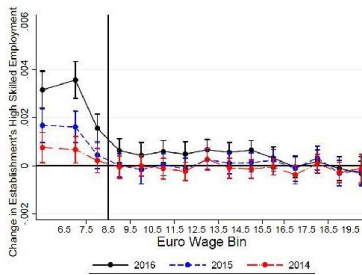


(a) Original estimates from Dustmann et al. (2022)

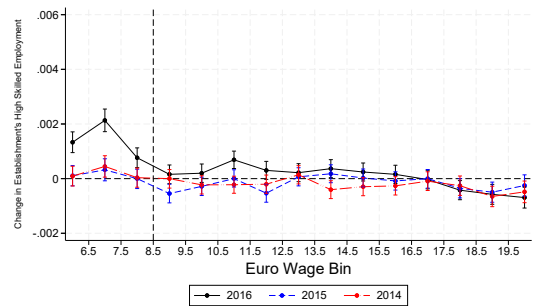


(b) Own Reconstruction

Figure A.4.5: Establishment Size



(a) Original estimates from Dustmann et al. (2022)



(b) Own Reconstruction

Figure A.4.6: Establishment's High-Skilled Employment Share

A.5 Comparison Results - Tables

A.6 Establishment Results - Employment and Wage results

Table A.5.1: Comparison of effects of minimum wage on wages and employment

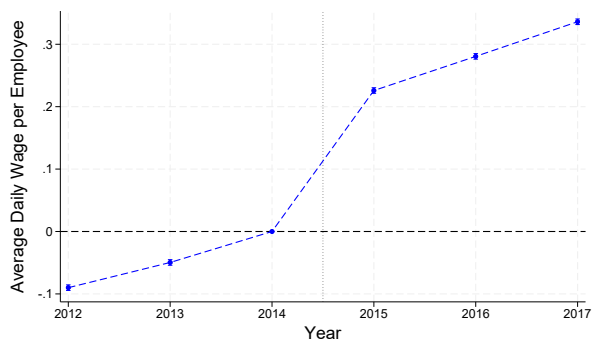
	BEH	IEB
Panel A - Hourly Wage Effects		
2014 to 2016	0.054 (0.0019)	0.042 (0.0022)
2012 to 2014	0.009 (0.0005)	0.006 (0.0007)
Panel B - Daily Wage Effects		
2014 to 2016	0.093 (0.0020)	0.070 (0.0024)
2012 to 2014	0.011 (0.0009)	0.006 (0.001)
Panel C - Employment Effects		
2014 to 2016	0.008 (0.0008)	0.006 (0.0006)
2012 to 2014	0.006 (0.0005)	0.002 (0.0005)
Panel D - Employment Effects Full-Time Equivalent		
2014 to 2016	0.023 (0.0008)	0.018 (0.0008)
2012 to 2014	0.006 (0.0005)	0.006 (0.0005)

Standard errors in parentheses

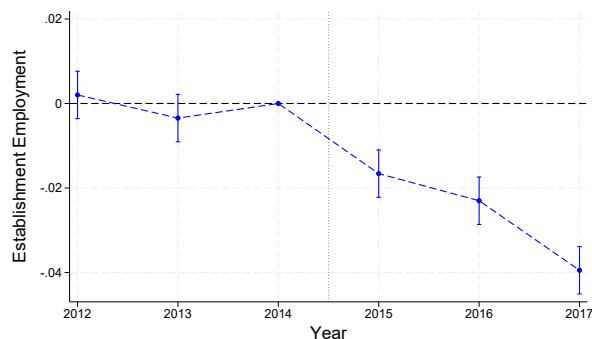
Table A.5.2: Comparison of effects of minimum wage on reallocation to higher quality establishments

	BEH	IEB
<i>Average daily wage</i>		
2014 to 2016	0.018 (0.0011)	0.015 (0.0009)
<i>Average wage premium</i>		
2014 to 2016	0.004 (0.0019)	0.005 (0.0005)
<i>Establishment Size</i>		
2014 to 2016	0.038 (0.0039)	0.013 (0.00458)
<i>High-skilled employment share</i>		
2014 to 2016	0.002 (0.0002)	0.001 (0.0002)
<i>Full-Time employment share</i>		
2014 to 2016	0.007 (0.0005)	0.004 (0.0006)
<i>Marginal employment share</i>		
2014 to 2016	-0.006 (0.0004)	-0.003 (0.0004)

Standard errors in parentheses
 * p < 0.05, ** p < 0.01, *** p < 0.001



(a) Average Daily Wage per Employee



(b) Employment

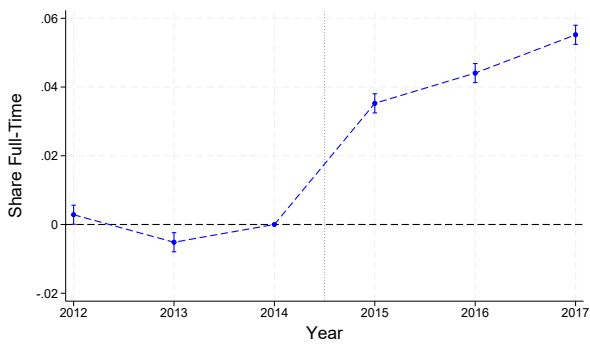
Figure A.6.1: Wage and Employment Effects of the Minimum Wage - Establishment Approach

Table A.5.3: The Effects of the Minimum Wage on Wages and Employment: Individual Approach (Original Estimates and All Employment)

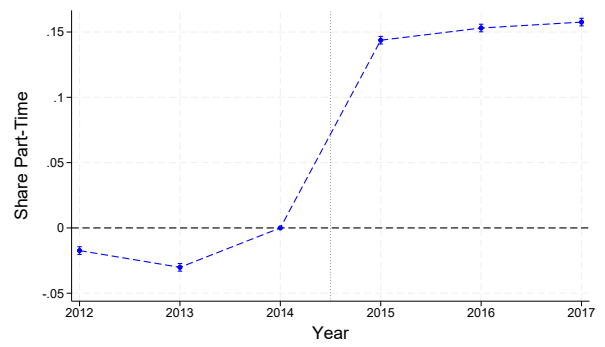
	IEB	Non-Routine	Routine	DDD
<i>Average daily wage</i>				
2015 to 2016	0.14 (0.0009)	0.017 (0.0012)	0.010 (0.0015)	-0.008 (0.0019)
2014 to 2015	0.008 (0.0009)	0.011 (0.0010)	0.005 (0.0014)	-0.007 (0.0018)
<i>Average wage premium</i>				
2015 to 2016	0.003 (0.0005)	0.005 (0.0006)	0.001 (0.0009)	-0.008 (0.0011)
2014 to 2015	0.002 (0.0005)	0.005 (0.0005)	-0.0001 (0.0009)	-0.009 (0.0001)
<i>Establishment Size</i>				
2015 to 2016	0.005 (0.0040)	0.015 (0.0040)	-0.006 (0.0074)	-0.020 (0.0082)
2014 to 2015	0.002 (0.0038)	0.015 (0.0043)	-0.014 (0.0063)	-0.030 (0.0073)
<i>High-skilled employment share</i>				
2015 to 2016	0.000 (0.0002)	0.000 (0.0003)	0.000 (0.0004)	-0.001 (0.0005)
2014 to 2015	-0.001 (0.0003)	-0.001 (0.0002)	-0.002 (0.0005)	-0.001 (0.0005)
<i>Full-Time employment share</i>				
2015 to 2016	0.007 (0.0004)	0.006 (0.0005)	0.008 (0.0007)	0.003 (0.0009)
2014 to 2015	0.003 (0.0004)	0.002 (0.0005)	0.004 (0.0007)	0.003 (0.0009)
<i>Marginal employment share</i>				
2015 to 2016 -	0.005 (0.0006)	-0.005 (0.0007)	-0.004 (0.0010)	-0.000 (0.0011)
2014 to 2015	-0.003 (0.0004)	-0.003 (0.0004)	-0.003 (0.0005)	-0.001 (0.0006)

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001



(a) Share of Full-Time Employees



(b) Share of Part-Time Employees

Figure A.6.2: Full- and Part-Time Share of Employment