Reallocation Effects of the Minimum Wage

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Abstract

We investigate the wage, employment and reallocation effects of the introduction of a nationwide minimum wage in Germany that affected 15% of all employees. Based on identification designs that exploit variation in exposure across individuals and local areas, we find that the minimum wage raised wages, but did not lower employment. It also led to the reallocation of low-wage workers from smaller to larger, from lower- to higher-paying, and from less- to more-productive establishments. This worker upgrading accounts for up to 17% of the wage increase induced by the minimum wage. Moreover, at the regional level, average establishment quality increased in more affected areas in the years following the introduction of the minimum wage.

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1 Introduction

Despite being one of the most controversial labor market policies, the popularity of the minimum wage is rising. Many U.S. states have recently increased the minimum wage, and some have passed legislation that foresees increases of up to $15/hour.[1] Similarly, many European countries have enacted or plan substantial increases in the minimum wage.[2] A prime example of these trends can be found in Germany. Against the backdrop of falling wages at the bottom of the wage distribution and the dwindling importance of trade unions, the German government introduced a national minimum wage in January 2015 for the first time in the history of the country. Set at 8.50 EUR per hour, it cuts deep into the wage distribution, with 15% of workers earning an hourly wage below 8.50 EUR six months before the minimum wage came into effect. Moreover, despite the large variation in wage levels across local areas, the minimum wage is set at a uniform national level. As a result, it was much more binding in some areas than in others, with more than one in three workers being affected in the most exposed areas. The introduction of the minimum wage at 8.50 EUR was viewed critically by many economists (e.g., Sachverständigenrat 2013; Der Spiegel 2013; FAZ 2013; Die Welt 2013), with two early studies predicting up to 900,000 job losses because of the nationwide minimum wage (Knabe, Schönherr, and Thum 2014; Müller and Steiner 2013).

[1] California, Connecticut, Florida, Illinois, Maryland, Massachusetts, New Jersey, and New York have all passed legislation to eventually increase minimum wages to $15/hour. On January 1 2021, there were 27 cities and counties in the United States where the minimum wage reached or surpassed $15 per hour. By the end of 2021, 13 additional cities and counties will have met or exceeded a $15 minimum wage; see Lathrope (2020) for details.

[2] In 2019, Italy's former coalition government led by Prime Minister Giuseppe Conte had announced plans to introduce a nationwide minimum wage. In the same year, the Polish government announced its plans to increase the minimum wage by *73%* by 2023. The former chancellor of the United Kingdom, Sajid Javid, declared in 2019 that he sought to raise the minimum wage to two-thirds of median earnings within five years, which would have made it the highest wage floor in the developed world.

In this paper, we examine the labor market effects of this first-time introduction of the minimum wage, drawing on high-quality register data and exploiting variation in exposure across workers and local areas. As a first step, we investigate the wage and employment effects of the policy by comparing workers who earned less than the minimum wage (treated group) and those who earned considerably more and should therefore be largely unaffected (control group) before and after its introduction. While being similar to empirical strategies used by Linnemann (1982), Currie and Fallick (1996) and Clemens and Wither (2019), we introduce two important extensions. First, whereas previous studies relied on survey data, we leverage rich and high-quality administrative data on hourly wages, which addresses measurement issues and improves the precision of our estimates. Second, we carefully deal with the potential problems with the research design. As emphasized by Ashenfelter and Card (1982), low-wage workers typically experience higher wage growth but are less likely to remain employed than high-wage workers, irrespective of the minimum wage policy, for example due to mean reversion. Our research design therefore contrasts wage *growth* and employment *changes* in periods before the introduction of the minimum wage with those after its introduction, both for low- and high-wage workers. We find that the minimum wage significantly increased wages of low-wage workers, relative to wages of high-wage workers located further up the wage distribution. At the same time, there is no indication that it lowered the employment prospects of low-wage workers. Findings from an analysis that exploits variation in the exposure to the minimum wage across 401 local areas (similar to Card 1992) corroborate our findings from the individual-level analysis: the minimum wage boosted wages but did not reduce employment in heavily affected, relative to less affected, areas. Our findings therefore do not confirm the fears of many economists that the minimum wage would cause substantial job losses. Rather, our findings

support the idea that the minimum wage helped to reduce wage inequality without reducing employment, both across individuals and across local areas.

In the second part of the paper, we address the question of how the labor market absorbs wage increases induced by the minimum wage. The hypothesis that we put forward and directly test is that the minimum wage improves the average quality of establishments that operate in the market, by reallocating workers from smaller, lower-paying establishments to larger, higher-paying ones. The idea that a minimum wage affects the allocation of workers between establishments is not new. For example, the introduction of the very first minimum wage in modern times in the 1890s in New Zealand was motivated by helping "worthwhile companies" that employ "working-class breadwinners" against "sweatshops" that gained market shares by undercutting those "worthwhile" companies (Nordlund 1997). The minimum wage, according to advocates of the policy, sought to reverse these trends. The reallocation of workers to better establishments, and hence an improvement in the quality of establishments in the economy, is also the core idea behind the "Swedish model" of centralized bargaining: higher wages, it is argued, will drive low-performing establishments out of the market (e.g., Agell and Lommerud 1993; Edin and Topel 1997; Erixon 2017). Yet, no empirical evidence exists to date that such minimum-wage induced reallocation effects are present in the labor market.

We present evidence consistent with reallocation at both the individual and regional level. Most importantly, at the individual level, we show that low-wage workers, but not high-wage workers, are more likely to upgrade to "better" establishments after the introduction of the minimum wage. This "upgrading" takes different forms. First, the minimum wage induces low-wage workers to move to establishments that pay a higher daily wage on average. This effect is quantitatively important and can account for around 17% of the overall increase in daily wages that low-wage workers experience following the introduction of the minimum wage. The improvement in average daily wages primarily reflects a movement to establishments that offer more full-time jobs, but also a movement to establishments that pay a higher wage premium to

the same type of worker. Second, we find that the minimum wage induces low-wage workers to move to larger and more stable establishments with a lower churning rate. Low-wage workers further reallocate to establishments that poach a larger share of workers from other establishments—that is, establishments that workers consider as superior based on their revealed preferences (Sorkin 2018; Bagger and Lentz 2018)—in response to the minimum wage. Even though our main data source does not include direct measures of establishment productivity, our findings further highlight that the minimum wage induced a reallocation of low-wage workers to establishments that are predicted to have higher revenues per worker based on, for example, their industry affiliation, size, and the wage they pay to their full-time workers. In sum, given that the minimum wage policy did not lower employment, our findings suggest that minimum wages increased allocational efficiency of workers.

We provide further evidence in support of worker reallocation based on our regional approach. Specifically, we show that in the years following the introduction of the minimum wage, small businesses with less than three employees are more likely to exit the market, and that average establishment size increased, in local areas more exposed to the minimum wage. Moreover, we find that the minimum wage increased the establishment wage premium, measured as a fixed establishment effect in an AKM-style wage regression estimated using only prepolicy data, in more- relative to less-exposed local areas, suggesting a compositional shift toward higher-paying establishments. Consistent with these findings, we further show that the minimum wage induced an increase in the average predicted productivity of establishments in more- relative to less-exposed areas, once again driven by the reallocation of workers toward more-productive establishments.

We provide several pieces of evidence that the findings highlighted above reflect the causal impact of the minimum wage, rather than macroeconomic shifts in the economy. First, both individual and regional effects of the minimum wage emerge exactly when the policy was introduced. Second, the impact of the minimum wage is concentrated among low-wage workers at the bottom of the wage distribution who are most affected by it. Trajectories of high-wage workers, in contrast, barely change in response to the minimum wage, underscoring that the overall macroeconomic environment was stable around its introduction. Third, our results from the individual-level approach are robust to controlling in a flexible manner for individual and regional characteristics, such as the local unemployment rate.

In the final step of the analysis, we provide suggestive evidence on the potential mechanisms underlying the reallocation effects, focusing on models of monopsonistic competition in the labor market. Building on Card et al. (2018), we set up a simple yet insightful model (discussed in detail in Online Appendix D) where nonpecuniary preferences towards a workplace—such as distance to home—give establishments the power to set wages. Importantly, in this set-up, establishments are heterogenous in terms of their marginal costs of producing one unit of output. Whereas a single market wage (for the same type of worker) would prevail in a fully competitive labor market, wages are increasing in firms' efficiency levels under monopsonistic competition. We show that in this environment, a minimum wage will drive the least-efficient firms out of the market. According to the model, workers in these firms are at least partially absorbed by more-efficient—and hence larger and higher-paying—firms that raise their wages and expand employment in response to the minimum wage. Yet, our model also highlights that not all minimum wage workers are necessarily better off after the minimum wage policy, as workers who reallocate to a more-efficient establishment may trade off higher wages with lower

utility from nonpecuniary job characteristics. In line with this idea, we find that commuting time—an important nonpecuniary job characteristic—increases for low-wage workers following the introduction of the minimum wage. Even though there may be some minimum wage workers who lose out because of the policy despite earning a higher wage, our model also emphasizes that workers will on average be better off after the introduction of the minimum wage, provided that the minimum wage does not lower employment. Overall, our empirical findings therefore suggest, if viewed through the lens of our model, that the minimum wage improved the welfare of workers on average.

Our paper relates to several strands of literature. First, we contribute to the large empirical literature that examines the effects of minimum wage increases on employment and wages (see e.g. Card and Krueger 1995; Neumark and Wascher 2010), by exploiting a first-time introduction of a minimum wage that cuts deep into the wage distribution and that was persistent as the minimum wage has been increased twice above the inflation rate after its introduction (similarly to Harasztosi and Lindner 2019). Both the sharp bite and the high persistence of the minimum wage, combined with exceptionally high-quality administrative data on the universe of workers and establishments, allow us to investigate reallocation responses, which is not possible in the context of minor, temporary minimum wage shocks.

Second, our paper puts a new spin on the recent findings by Luca and Luca (2018) and Chava, Oettl and Singh (2019) suggesting that increases in the minimum wage in the U.S. drove small, distressed businesses out of the market. Our theoretical model illustrates, and our empirical findings corroborate, that increased exits of small businesses following a minimum wage hike may not necessarily be a reason for concern but may instead reflect the upgrading of workers from less- to more-efficient establishments.

Third, our paper is related to the large theoretical literature on how low-wage labor markets react to minimum wage shocks. Economists have long argued whether low-wage labor markets are best characterized as highly competitive, implying that the minimum wage will cause displacement of workers (e.g., Stigler 1946), or whether firms' behavior is inconsistent with competitive labor markets, implying limited employment effects of the minimum wage (e.g., Lester 1960). Williamson (1968) was the first to formalize the idea that a minimum wage may drive small businesses that use more labor-intensive technologies out of the market. More recently, Acemoglu (2001), Bhaskar, Manning, and To (2002), Flinn (2006), Berger, Herkenhoff, and Mongey (2019), and Mayneris, Poncet, and Zhang (2018), among others, show that in the presence of search frictions, product market frictions, or monopsonistic competition, minimum wage policies may have limited employment effects. Instead they may improve establishment quality and ultimately aggregate total factor productivity, by shifting workers from less-efficient to more-efficient establishments.[3] Our paper provides, for the first time in the literature, direct empirical support of this prediction. While we acknowledge that search frictions or product market frictions may drive the reallocation of workers toward more efficient establishments, we show that monopsonistic competition in the labor market, due to the presence of nonpecuniary job characteristics, provides a natural explanation behind the worker upgrading that we observe.

Fourth, our paper contributes to the macroeconomic literature on re- and misallocation of resources across firms. One strand of this literature has documented large shifts in reallocation over the business cycle (e.g., Davis and Haltiwanger 1992; Moscarini and Postel-Vinay 2012). Reallocation also plays a key role in understanding productivity growth (e.g., Foster,

[3] Aaronson et al. (2018) make a related point and argue that a minimum wage policy induces less-efficient and more-labor-intensive firms to exit the market and more-efficient and more-capital-intensive firms to enter.

Haltiwanger and Syverson 2008). Another strand of this literature highlights that the misallocation of resources (such as labor) can be induced by policies such as state ownership and size restrictions (Hsieh and Klenow 2009), firm-level taxes or subsidies (Restuccia and Rogerson 2008), or state taxes (Fajgelbaum et al. 2018). Our paper is one of the few that exploit an exogenous shock or policy (in our case, the introduction of a minimum wage) to directly investigate the reallocation of workers across establishments, without relying on the structure of a model.

Finally, our paper complements recent papers that evaluate the labor market effects of Germany's minimum wage policy. By exploiting variation in the exposure to the minimum wage both across individuals and districts, combined with high-quality register data, we provide the cleanest evidence to date that the minimum wage raised wages, but did not reduce employment. We would like to stress that the absence of a negative employment effect of the minimum wage based on our individual and regional approaches is consistent with a recent finding by Bossler and Gerner (2020) that the German minimum wage slightly reduced employment in low-wage establishments heavily exposed to the minimum wage relative to high-wage, less-exposed establishments. Our findings suggests that the small negative employment effects uncovered by Bossler and Gerner (2020) at the establishment level in part capture the reallocation of (low-wage) workers from low- to high-wage establishments.[4] While other studies have investigated the impact of Germany's minimum wage policy on outcomes such as product prices (Link 2019), welfare dependency (Schmitz 2019), and within-plant productivity increases (Bossler et al. 2020), our paper is the first to highlight the reallocation effects of minimum wage policies.

[4] Exploiting variation in the exposure to the minimum wage solely across local areas, Caliendo et al. (2018) and Ahlfeldt, Roth, and Seidel (2018) conclude that the minimum wage policy led to spatial wage convergence without reducing employment in low-wage relative to high-wage areas.

2 Background and Data

2.1 The Minimum Wage Policy and Macroeconomic Environment

Recent Trends in Wage Inequality. Germany experienced a dramatic increase in wage inequality throughout the 1990s and 2000s (see e.g., Dustmann, Ludsteck, and Schönberg 2009; Antonczyk, Fitzenberger, and Sommerfeld 2010; Card, Heining, and Kline 2013). While real wages increased between 1995 and 2010 by more than 10% at the 90th percentile, they remained roughly constant at the median and declined by more than 10% at the 10th percentile (Kügler, Schönberg, and Schreiner 2018). Wage inequality started to decline after 2010, in the years immediately preceding the introduction of the minimum wage, although this trend went unnoticed among academics and policy makers until after the minimum wage was implemented. While up until the mid-1990's union wages, negotiated between trade unions and employer federations at the sectoral level and varying by worker skill and experience, acted as wage floors, the share of workers covered and protected by union agreements (either at the sectoral or firm level) decreased steadily, from nearly 80% in 1995 to about 55% in 2015 (Kügler, Schönberg, and Schreiner 2018). Against this backdrop of rising wage inequality and the dwindling importance of trade unions, the German government introduced a nationwide minimum wage of 8.50 Euro per hour.[5]

The Minimum Wage Policy. The Minimum Wage Law was passed by the German Parliament on July 3rd 2014, with the minimum wage coming into effect on January 1st 2015. It was subsequently raised to 8.84 EUR in October 2017, and to 9.19 EUR in January 2019. At the time of the initial introduction of the minimum wage, almost 15 percent of workers in Germany

[5] Minimum wages specific to certain industries, including construction, painting and varnishing, waste management, and nursing care, have been in place before that date – the earliest was introduced in 1997.

earned an hourly wage of less than 8.50 EUR, implying that around 4 million jobs were directly affected (Destatis 2016). With a ratio of 0.48 between the minimum and median wage in 2015, the German minimum wage did not cut as deep into the wage distribution as the French minimum wage (with minimum wage-to-median ratio of 0.61) but was considerably more binding than the federal minimum wage in the United States (minimum wage-to-median ratio of 0.36; OECD Economic Indicators 2016).

Workers younger than 18 years old, apprentices, interns, and voluntary workers, as well as the long-term unemployed were exempted from the minimum wage (see Umkehrer and vom Berge 2020 for an evaluation of the exemption for the long-term unemployed). Temporary exemptions also existed in the hairdressing and meat industries and in agriculture and forestry where until December 31, 2016, firms were allowed to pay the lower union wage agreed between trade unions and employer federations. These industries comprise only a relatively small fraction of total employment (5%).

Who are the Minimum Wage Workers? Table I provides some descriptive evidence on the characteristics of minimum wage workers (i.e., workers who in 2013 earned an hourly wage of less than 8.50 EUR; see Online Appendix A.2 for more details). Minimum wage workers are, compared to workers who earn more than 12.50 EUR per hour, more likely to reside in East Germany, of immigrant origin, female, low-skilled, and younger than 24 years; they are also more likely to have been unemployed in the past year, less likely to be employed full-time, and more likely to be marginally employed (i.e., working few hours and earning less than 450 EUR per month). Minimum wage workers are furthermore overrepresented in small establishments with up to four employees and in the transportation, accommodation, and food services sector.

Preliminary Descriptive Evidence: The Hourly Wage Distribution Before and After the Introduction of the Minimum Wage. A report by the German Minimum Wage Commission (2018) studies in detail the impact of the minimum wage hike on the hourly wage distribution in Germany (see Online Appendix A.1 for details). The report highlights that the number of jobs below 8.50 EUR decreased immediately after the introduction of the minimum wage, a trend that was accompanied by an increase in the number of jobs at or slightly above the minimum wage of 8.50 EUR of roughly equal size. These findings thus provide some first evidence that the overall job losses due to the minimum wage were limited. In line with existing evidence (e.g., Autor, Manning, and Smith 2016; Brochu et al. 2015; Cengiz et al. 2019), the findings by the German Minimum Wage Commission (2018) further suggest spillover effects of the minimum wage on jobs paying up to 11 EUR, but not beyond.

Although wage inequality has started to decline even before the introduction of the minimum wage in 2015, the evidence of the German Minimum Wage Commission suggests that the minimum wage helped to further reduce wage inequality. In line with this evidence, Bossler and Schank (2020) conclude that the introduction of the minimum wage can account for about half of the recent decrease in wage inequality.

The Macroeconomic Environment. Our empirical findings have to be interpreted within the particular macroeconomic context during which the minimum wage policy was introduced. The German economy was characterized by robust economic growth in the years surrounding the implementation of the minimum wage policy. Between 2011 and 2016, nominal GDP grew by 20% (see panel (a) of Figure I), while unemployment fell from 7.1% in 2011 to 6.1% in 2016

(panel b). The stock of employed workers steadily increased from 41.58 million in 2011 to 43.64 million in 2016 (panel c).

2.2 Data and Sample Selection

We base our analysis on individual-level German administrative records taken from source data of the Federal Employment Agency's Statistics Department and processed for research purposes (vom Berge et al. 2016a; vom Berge et al. 2016b). These data comprise not only all workers covered by the social security system, but also "marginal workers" who earn no more than 450 EUR per month and are therefore exempt from social security contributions. The data contain information on a monthly basis on the worker's employment status (i.e., employment vs un- or nonemployment), her full-time status (i.e., full- vs part-time and marginal employment), the establishment the worker works for, and a number of socio-demographic characteristics such as age, gender, nationality, education, place of residence and work, and the industry of employment.

To this first data source, we merge information on earnings and hours worked from the Employee Histories of the Institute for Employment Research in Nuremberg (*Beschäftigtenhistorik (BeH)*). The BeH contains information on both earnings and working hours (the latter only from 2011 to 2014) for each job at least once per year, along with its start and end dates. While roughly 6% of earnings in the BeH are top-coded at the upper limits for compulsory social insurance, this does not affect our analysis as the minimum wage does not affect wages this high up in the wage distribution.[6]

[6] When we calculate establishment fixed effects from an AKM-type regression, we stochastically impute the censored part of the wage distribution similarly to Dustmann, Ludsteck, and Schönberg (2009) and Card, Heining, and Kline (2013); see Online Appendix B.3 for details.

An important advantage of our data source compared to existing studies on the minimum wage in Germany is that we observe working hours until 2014, allowing us to calculate precise hourly wages for the years prior to the introduction of the minimum wage and therefore to obtain reliable measures for how a single worker or a local area are affected by its introduction.[7] Unfortunately, information on working hours is not available after the introduction of the minimum wage in 2015.[8] To study the impact of the minimum wage on hourly wages, we therefore proxy hourly wages as the daily wage divided by the average number of working hours in each full-time status category.[9] This approximation assumes that actual hours worked within each full-time status category are not significantly affected by the minimum wage, an assumption that is in line with the empirical evidence from other data sources.[10]

A drawback of the data on working hours is that some employers report actual working hours while others report contractual working time instead. We compute a harmonized measure for working hours following an imputation procedure described in detail in Online Appendix B1. After the imputation, weekly working hours in the BeH closely follow those from the Structure of Earnings Survey of the German Statistical Office and the German Socio-Economic Panel, the two main survey data sets available in Germany. We further impute missing values in the worker's full- vs part-time status using the procedure described in Online Appendix B2. Missing

[7] Both vom Berge et al. (2014) and Doerr and Fitzenberger (2016) emphasize that lack of information on working hours may lead to a downward bias in the impact of the introduction of the minimum wage on employment and wages and could therefore be one reason why some existing studies have failed to detect perceptible employment and wage effects of the minimum wage.

[8] Since we do not have access to hourly wage data postreform we cannot apply the distribution-based approach as in Cengiz et al. (2019) and Harasztosi and Lindner (2019).

[9] Average daily (including weekends) working hours for each full-time status category are computed for the year 2013 (5.28 for full-time workers, 3.30 for part-time workers, and 1.18 for marginal workers).

[10] Caliendo et al. (2017) estimate that actual hours dropped by 3.1% (*p*-value:.06) in the year after the minimum wage was introduced (2015 vs 2014), an effect that is not statistically different from the placebo estimate for the 2013 vs 2014 prepolicy period which suggests a drop of 1.8% (*p*-value: .22). Burauel et al. (2020) find a 2.5% reduction of actual hours, an effect that is not statistically significant.

values in the education variable are imputed using the imputation procedure suggested by Fitzenberger, Osikominu, and Völter (2005).

Our empirical analysis focuses on the years 2011 to 2016 due to a sharp break in how several key variables are coded between 2010 and 2011 (for example, the worker's full- vs part-time status and her education). We create a yearly panel and select all job spells referring to June 30th. In case an individual holds more than one job, we keep her main job, defined as the job with the highest daily wage or, in case of multiple jobs with identical wages, the full-time job (or part-time job if the other job is a marginal job). We drop job spells in apprenticeship training and where the worker is younger than 18 from our sample. We further focus on prime-age workers and exclude job spells of workers close to retirement (i.e., workers aged 60 and older). As demonstrated in Online Appendix A.11, our findings are robust to alternative sample restrictions. We refer to this sample as the "full sample". We use this sample to compute various measures of establishment quality, such as the establishment's employment size, average wage or a fixed effect obtained from a regression that includes worker fixed effects in addition to establishment fixed effects (see Online Appendix B.3 for details).[11]

Our analysis involves two main empirical approaches. The first empirical approach compares the career trajectories of workers who earned less than the minimum wage prior to its introduction with the career trajectories of workers who earned a wage higher than the minimum wage, similar to Currie and Fallick (1996) and Clemens and Wither (2019). To implement this approach, we select all individuals from the full sample who earned an hourly wage between 4.50 and 20.50 EUR (as of June 30th) at least once between 2011 to 2014. We follow these

[11] Establishment fixed effects are available only for establishments which employ at least one full-time employee and belong to the largest connected set. Rather than dropping establishments with missing fixed effects, we replace missing values with predicted values obtained from a regression of establishment fixed effects on establishment characteristics such as size and industry affiliation; see Online Appendix B.5 for details.

individuals over the entire 2011 to 2016 period, even if they earn more than 20.50 EUR per hour. We then draw a 50% random sample of individuals.[12]

Our second approach compares local areas that, due to their lower wage levels prior to the introduction of the minimum wage, were heavily affected by the minimum wage with areas that were largely unaffected by the minimum wage. To implement this approach, we collapse the full sample to the local district (there are 401 districts in Germany) and year level.[13]

3 Labor Market Effects of the Minimum Wage: Individual Approach

3.1 Method

Our data allows us to follow workers over time. The key idea of the individual approach is to compare individuals' changes in outcomes, such as wage growth, changes in the employment probability, or changes in establishment quality, over two-year windows (between $t-2$ and t) along the distribution of wages in the baseline period $t-2$.[14] We describe our approach here with wage growth as the dependent variable, but the same arguments apply for other outcome variables. We assign workers to 15 small (typically 1 EUR) wage bins *k* (where the first wage bin *k = 1* refers to hourly wages between 4.50 and 6.50 EUR, the second wage bin to hourly wages between 6.50 and 7.50 EUR, …, and the 15th wage bin to hourly wages between 19.50 and 20.50 EUR) based on their hourly wages in $(t-2)$.[15] We then regress individual wage growth $y_{it} - y_{it-2}$ of worker *i* between periods *t-2* and *t* on indicator variables $1[b_{k-1} <$

[12] Rules for data privacy and data parsimony require us to avoid working with full populations of individual-level microdata and confine our analysis to samples when possible.
[13] There are 401 districts ("Kreise") in Germany with on average 207,000 inhabitants.
[14] In Online Appendix A.8. we also study one-year (as opposed to two-year) changes in outcomes before and after the introduction of the minimum wage.
[15] We pool individuals earning between 4.50 EUR and 6.50 EUR together into one bin since few individuals fall into this group.

$w_{it-2} \leq b_k]$ equal to 1 if worker *i* falls into wage bin k in *t - 2* (where $b_0 = 4.50, b_1 = 6.50, b_2 = 7.50, \ldots, b_{15} = 20.50$):

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

In this equation, the coefficients γ_{kt} simply measure average wage growth between *t - 2* and *t* of workers in wage bin k in the baseline period conditional on a vector of individual baseline characteristics $X_{i,t-2}$ measured at *t - 2*. We allow wage growth by baseline wage bin to differ across four periods: two prepolicy periods (2011 vs 2013; 2012 vs 2014) and two postpolicy periods (2013 vs 2015; 2014 vs 2016). In the two postpolicy periods, the coefficients γ_{kt} capture the effect of the minimum wage along the wage bin distribution k on two-year wage growth, subject to two potential confounding factors: mean reversion and macroeconomic time effects. We would typically expect workers who earn a low wage in *t-2* to experience a higher wage growth than workers who earn a high wage in *t-2* because of mean reversion. At the same time, wages are likely to grow over a two-year period simply because the economy is growing. To eliminate mean reversion and macroeconomic time effects, we estimate in a second step a reparameterized version of equation (1):

$$y_{it} - y_{it-2} = \sum_k (1[b_{k-1} < w_{it-2} \leq b_k]\gamma_{k2013} + 1[b_{k-1} < w_{it-2} \leq b_k]\delta_{kt}) + \beta X_{i,t-2} + e_{it} \quad (2)$$

where the coefficients $\delta_{kt} = (\gamma_{kt} - \gamma_{k2013})$ now trace out, for each initial (prepolicy) wage bin k, workers' two-year wage growth in the post-policy years *relative* to two-year wage growth in the 2011 vs 2013 prepolicy period, given by coefficients γ_{k2013}. The coefficients δ_{kt} identify the causal impact of the minimum wage on wage growth under the assumption that mean reversion and macroeconomic time effects are stable over time. We can assess the plausibility of the

assumption of stable macroeconomic time effects by investigating whether estimates for δ_{kt} are close to zero for wage bins considerably higher than the minimum wage of 8.50 EUR per hour (e.g., 12.50 EUR per hour and up). We find this to be the case for most outcomes.

To nevertheless account for the possibility that macroeconomic time effects in the postpolicy periods are different from those in the 2011 vs 2013 prepolicy period, we construct difference-in-differences estimates. We subtract δ_{kt} coefficients averaged over wage bins high up in the wage distribution—which are unaffected by the minimum wage and hence capture changes in the macroeconomic environment—from δ_{kt} coefficients averaged over wage bins below the minimum wages. These difference-in-differences estimates eliminate any possible changes in the macroeconomic environment between the post- and prepolicy periods under the assumption that these changes affect all wage bins in the same way.

In practice, we divide workers into three groups based on their location in the wage distribution at baseline. The first group are workers who earn a wage below the minimum wage prior to its introduction (i.e., workers in wage bins (4.5,6.5], (6.5,7.5] and (7.5,8.5]. These are the workers who should be primarily affected by the minimum wage policy and we refer to this group as the "treated group" accordingly. The minimum wage may also spill over to workers who earn more than but close to the minimum wage before its introduction (i.e., workers in wage bins (8.5,9.5], (9.5,10.5], and (10.5,11.5], (11.5,12.5]) — "the partially treated group". The third group comprises all workers higher up in the initial wage distribution (i.e., workers in wage bins (12.5,13.5] and higher), which we refer to as the "control group". We then average δ_{kt} coefficients over the eight highest-wage bins (weighted by bin size) in the control group and subtract them from the δ_{kt} coefficients averaged over the three lowest-wage bins in the treated group. These corrected estimates are for most outcomes very similar to the noncorrected

estimates for δ_{kt}, suggesting that macroeconomic conditions were stable during the period under consideration, in line with the evidence presented in Section 2.1.

To summarize, the key identifying assumptions behind the difference-in-differences estimates are that (i) the mean reversion effect for each wage bin remains constant over time, and (ii) macroeconomic time effects do not vary across wage bins. While we cannot test these assumptions directly, there are several pieces of evidence that support them. First, as highlighted above, coefficient estimates of δ_{kt} are close to zero for wage bins beyond 12.50 EUR per hour (see for example Figures 2 and 3). Second, even though coefficient estimates for the 2012 vs 2014 prepolicy period (δ_{k2014}) are sometimes statistically significant (which is not surprising given our large sample size), they are substantially smaller in magnitude than for the 2013 vs 2015 and 2014 vs 2016 postpolicy periods for wage bins below the minimum wage for all outcomes. Hence, the effects of the minimum wage on wage bins below the minimum emerge exactly when the minimum wage is introduced, supporting a causal interpretation of our findings. Third, controlling for the local unemployment rate interacted with wage bins in equation (2)—thus allowing for local macroeconomic conditions to differentially impact wage bins over time—barely changes our estimates (see Table VI). Fourth, the wage, employment, and reallocation effects of the minimum wage are similar in districts with stable and declining unemployment rates between 2010 and 2016 (see Online Appendix A.6) and districts more and less exposed to the minimum wage (see Online Appendix A.7), further underscoring that our estimated effects reflect causal effects of the minimum wage, and not changing macroeconomic conditions.

3.2 Wage and Employment Effects of the Minimum Wage

Wage Effects. Panel (a) of Figure II provides a first indication that the minimum wage increased wages for low-wage workers. In the figure, we plot the two-year "proxied hourly wage growth" separately for the years 2011 vs 2013 to 2014 vs 2016, obtained from regression equation (1), where we proxy hourly wages as daily wages divided by the average number of working hours in each full-time status category (i.e., full-time, part-time, and marginal employment, see Section 2.2). As expected, workers with wages at baseline (in t - 2) below the minimum wage experience substantially higher hourly wage growth than workers earning wages above the minimum wage at baseline even before the minimum wage was introduced (18-30% vs 5-10%). Yet, Panel (a) of Figure II clearly highlights that the minimum wage did indeed raise hourly wages for low-wage workers: hourly wage growth in wage bins below the minimum wage is considerably larger in the 2013 vs 2015 and 2014 vs 2016 postpolicy periods than in the 2011 vs 2013 and 2012 vs 2014 prepolicy periods. This is not true for wage bins higher up in the distribution.

We investigate this in more detail in Panel (b) of Figure II, where we plot two-year hourly wage growth by wage bin separately for the 2012 vs 2014 prepolicy period and the two postpolicy periods *relative to* the 2011 vs 2013 prepolicy period, obtained from regression equation (2). In line with the figure in panel (a), the figure in panel (b) highlights that hourly wage growth in the postpolicy periods considerably surpasses hourly wage growth over the 2011 to 2013 period for wage bins below the hourly minimum wage of 8.50 EUR, by about 10% for workers in the lowest-wage bin. Postpolicy hourly wage growth also exceeds prepolicy (2011 vs 2013) hourly wage growth for wage bins slightly above the minimum wage, up to 12.50 EUR, in line with spillover effects of the minimum wage to higher-wage bins. In contrast, for wage bins

higher than 12.50 EUR, hourly wage growth in the 2013-2015 and 2014-2016 periods is not higher than over the 2011-2013 period (i.e., coefficient estimates are close to zero), suggesting that macroeconomic conditions were largely stable during our study period. This pattern suggests that the minimum wage indeed causally raised wages for workers who earned a wage below the minimum wage at baseline, with some possible spillover effects to workers who earned a wage just above the minimum wage. This causal interpretation of our findings is further corroborated by the "placebo" estimates for the years 2012 vs 2014 that, although statistically significant, are much smaller in magnitude than for the postpolicy periods. The wage effects of the minimum wage therefore emerge exactly in the year when the minimum wage came into effect.

We summarize our key findings in panel (a) of Table II, where we report in the first three columns estimates based on regression equation (2), but for more aggregated wage bins: [4.50, 8.50), [8.50, 12.50), and [12.50, 20.50). The table shows that workers directly exposed to the minimum wage—that is, workers who earned a wage of less than 8.50 EUR per hour at baseline (the "treated" group)—experience a 6.0% higher hourly wage growth over the 2014 to 2016 postpolicy period than over the 2011 to 2013 prepolicy period (26.6% vs 19.9%). Hourly wage growth of workers earning slightly above the minimum wage at baseline—between 8.50 and 12.50 EUR per hour (the "partially treated group")—is 2.1% higher in the postpolicy than in the prepolicy period (13.1% vs 11.8%). In contrast, postpolicy wage growth is very close to prepolicy wage growth for workers earning more than 12.50 EUR per hour at baseline (the "control group"). To net out possible macroeconomic time effects, columns (4) and (5) of Table II report difference-in-differences estimates that compare the excess wage growth (in the 2014 vs 2016 postpolicy period relative to the 2011 vs 2013 prepolicy period) for the two lower wage bins ((4.50, 8.50] and (8.50, 12.50]) to the excess wage growth for the highest wage bin ((12.50,

20.50]). This corresponds to the differences in estimates in columns (1) and (2), and columns (1) and (3). Since hourly wage growth in the upper parts of the wage distribution between 2011 and 2013 was very similar to that between 2014 and 2016, the difference-in-differences estimates are close to the estimates based on regression equation (2), reported in the first two columns. Reassuringly, in line with our findings in Figure II, estimates are considerably smaller in magnitude in the placebo period 2012 to 2014, supporting the view that the estimates in Table II reflect the causal impact of the minimum wage on wages, rather than changes in macroeconomic conditions.

In Panel (b) of Table II, we use the change in daily wages, unadjusted for the worker's full-time status in period *t*, as the dependent variable. The findings suggest that the minimum wage had a stronger impact on daily wages than on hourly wages of minimum wage workers (9.3% vs 5.4% according to the difference-in-differences estimates in column (4)). This suggests that the minimum wage induced some minimum wage workers to move from marginal or part-time employment to full-time employment, a finding that we confirm below.

Employment Effects. Our findings in Figure II and Table II indicate that the introduction of the minimum wage in 2015 pushed up wages for workers at the lower end of the wage distribution. We now investigate how the minimum wage affected their employment prospects. Recall that the individual approach focuses on workers who were employed at the baseline period. In a first step, we compare the probabilities that workers remain employed in period *t* along workers' hourly wage distribution in *t - 2*, separately for two prepolicy and two postpolicy periods (panel (a) in Figure III).[16] Reported estimates refer to coefficients γ_{wt} in regression equation (1). The graph highlights that workers at the bottom of the wage distribution have a lower probability of

[16] To be precise, our dependent variable is equal to -1 if a worker employed in *t - 2* is no longer employed in *t*, and 0 otherwise.

remaining employed than workers higher up the wage distribution even in the prepolicy periods, in line with less stable employment relationships for low-wage workers. According to the green dot-dashed 2011 vs 2013 prepolicy line, about 23% of workers in the 6.50-7.50 EUR wage bin are no longer employed in period *t*, compared to 13% of workers in the 19.50-20.50 EUR wage bin. At the same time, the relationship between the probability of remaining employed and the worker's baseline wage appears to be similar in the pre- and postpolicy periods, suggesting that the minimum wage had no discernable negative impact on the employment prospects of low-wage workers.

Panel (b) of Figure III provides a more detailed investigation. The figure shows the probability of remaining employed in year *t* by worker's wage bin in *t - 2* for one prepolicy period and two postpolicy periods *relative to* the 2011 to 2013 period, where estimates are obtained from regression equation (2). The figure suggests that workers directly exposed to the minimum wage—that is, workers who earn less than 8.50 EUR per hour at baseline—are slightly more likely to remain employed after (i.e., in 2015 and 2016), relative to before (i.e., in 2013) the introduction of the minimum wage. In contrast, employment prospects of workers earning more than 12.50 EUR per hour at baseline are similar in the postpolicy periods and the 2011 to 2013 prepolicy period. Coefficient estimates for the placebo period 2012 to 2014 are also close to zero, confirming once more that macroeconomic conditions have been largely stable over our study period.

We report the corresponding estimates based on regression equation (2) averaged over three aggregated wage bins and difference-in-differences estimates in panel (c) of Table II. Both sets of estimates suggest that the minimum wage increased the probability that a worker who earned less than the minimum wage in period *t - 2* remains employed in period *t* by about 1

percentage point. Point estimates are larger in magnitude (about 2.5 percentage points) when we use changes in full-time equivalents, where we assign 1 to full-time employment, 0.5 to part-time employment, 0.2 to marginal employment, and 0 to nonemployment, as the dependent variable (panel (d)). This is in line with our finding that the minimum wage raised daily wages more than hourly wages (panels (a) and (b)) and suggests that some minimum wage workers in marginal employment or part-time work switched to full-time work.

The employment estimates in panels (c) and (d) rule out the possibility that the minimum wage reduced employment prospects of workers who were employed at baseline. The absence of a displacement effect of the minimum wage implies that its positive wage effect for low-wage workers is not driven by a policy-induced change in the selection of workers into work. The small positive employment effects are consistent with the idea that employment has become a more attractive option for low-wage workers. Our findings based on the individual approach therefore show that the minimum wage raised wages for minimum-wage workers, without lowering their employment prospects. In consequence, the minimum wage policy reduced wage inequality, as intended.

3.3 Reallocation Effects of the Minimum Wage

We now turn to investigating the potential role of worker reallocation in explaining these findings. Specifically, we investigate whether the minimum wage increased upward mobility from small or lower-paying establishments to larger or higher-paying establishments among workers directly affected by it. We measure the change in establishment quality over a two-year period as $q_{j(i,t)}^{l=t-2} - q_{j(i,t-2)}^{l=t-2}$, where $q_{j(i,t)}^{l}$ denote the time l characteristics of establishment j at which worker i is employed in year t. That is, the "quality" of the establishment refers to the baseline period $(t-2)$ in both periods. This way, any changes in establishment quality induced

by the minimum wage reflect compositional changes only, rather than improvements in quality over time (possibly caused by the minimum wage itself) within the same establishment. By construction, this measure of establishment quality is zero for workers who remain employed at their baseline establishment. A drawback of this measure is that it is defined only for establishments that existed in both *t - 2* and *t*. In the subsequent analysis, we therefore drop workers who move to establishments that entered the market after *t - 2* from our sample. Panel (d) in Table V illustrates that the minimum wage did not have a clear-cut impact on the probability that a worker moves to a newly founded establishment, so that this sample restriction is unlikely to affect our findings.

Establishments' Average Daily Wage. In panel (a) of Figure IV, we use the establishment's average daily wage (in logs) as a measure for establishment quality. We plot the change in average daily wage ($q_{j(i,t)i}^{l=t-2} - q_{j(i,t-2)i}^{l=t-2}$) along the workers' wage distribution at baseline (in *t - 2*) relative to changes over the 2011 vs 2013 prepolicy period. Estimates refer to the coefficients δ_{kt} in regression equation (2), and account for possible effects of mean reversion. The figure clearly illustrates that minimum wage workers experience an improvement in establishment quality, measured as the change in the establishment's average daily wage, in the postpolicy periods (2013 vs 2015 and 2014 vs 2016) relative to the 2011 vs 2013 prepolicy years. This effect fades out for workers higher up the wage distribution and turns to nearly zero for workers earning more than 12.50 EUR per hour at baseline. A similar improvement in establishment quality for minimum wage workers is not observed in the 2012 vs 2014 prepolicy period (relative to the 2011 vs 2013 period), which supports the hypothesis that the improvement in establishment quality is caused by the minimum wage. The corresponding difference-in-differences estimates

in Table III (panel (b)) confirm these findings: minimum wage workers reallocate to establishments that pay 1.8% higher average daily wages in response to the minimum wage.

To put these estimates into perspective, recall that minimum wage workers experienced an excess daily wage growth of 9.3% in the 2014 vs 2016 postpolicy period (panel (b) of Table II, repeated for convenience in panel (a) of Table III). In Online Appendix A.9, we show that low-wage workers who between 2011 and 2013 switched to an establishment with a 10% higher average daily wage experienced a 7.5% increase in their individual daily wages. This association increases to 8.7% for minimum wage workers who upgrade to establishments that pay higher average daily wages than their previous establishment, a group of workers that is particularly relevant in our context. Assuming that a similar association between average establishment and individual wages holds for those workers who switch establishments because of the minimum wage hike, our estimate of 0.018 implies that between 14.5% (0.018×0.75/0.093) and 17.2% (0.018×0.87/0.093) of the overall daily wage increase can be attributed to reallocation. The remaining 83-85% of the individual daily wage growth induced by the minimum wage occurs within establishments, in compliance with the minimum wage law.[17]

Average Establishment Characteristics versus Establishment Wage Premium. The reallocation of minimum wage workers to establishments that pay higher daily wages could reflect a switch to (i) establishments that offer more full-time and fewer part-time (or marginal) jobs, (ii) establishments that employ a more skilled workforce, or (iii) establishments that pay higher hourly wages to the same worker type. We investigate the importance of each of these in

[17] It is worth highlighting that the reallocation of minimum wage workers to higher-paying establishments does not necessarily *cause* higher individual daily wage growth. For example, suppose a worker earns 6.50 EUR per hour at her baseline establishment and then reallocates, because of the minimum wage, to an establishment where she would earn 7.50 EUR per hour in the absence of the minimum wage policy. In response to the minimum wage policy, both her previous and new establishment pay her 8.50 EUR per hour, in compliance with the policy. Nevertheless, in this example, 50% of the (hourly) wage increase takes place through reallocation and 50% through changes in establishments' wage setting behavior.

the remaining panels of Figure IV and in panels (a) and (b) of Figure V. The findings in panel (b) of Figure IV suggest that the improvement in the establishments' average daily wage is partly driven by workers moving to establishments that employ a higher share of high-skilled workers (i.e., workers with a university degree). The difference-in-differences estimates presented in panel (a) of Table IV indicate that the minimum wage induced an improvement in the establishments' employment share of high-skilled workers by 0.2 percentage points or, as the average share of high-skilled workers in the establishments is 6.9%, by 2.9%.

The findings in panels (c) and (d) of Figure IV further highlight that the improvement in the establishment's average daily wage is partially driven by workers moving to establishments that generally employ more full-time workers and fewer marginally employed workers. The corresponding difference-in-differences estimates presented in panels (b) and (c) of Table IV reveal that minimum wage workers experienced through reallocation an increase in the establishment's full-time employment share of 0.7 percentage points (3%), and a decline in the establishments' marginal employment share of 0.6 percentage points (2%) in response to the minimum wage.

Panels (a) and (b) of Figure V illustrate that the minimum wage also induced some upgrading of minimum wage workers to establishments that pay higher hourly wages to the same worker type. In panel (a), we use the establishments' wage premium, calculated as the average daily wage residual in the establishment obtained from an individual-level wage regression that controls for workers' demographic characteristics (age, sex, education, and German citizenship) as well as their full-time, part-time, and marginal employment status as a measure for establishment quality. The pattern is the same as when we use the establishments' average daily wage as a quality measure: low-wage workers, but not workers higher up the wage distribution,

are more likely to move to establishments that pay a higher wage premium even before the introduction of the minimum wage. The magnitude of this effect is, however, smaller than for the establishments' average daily wage (0.4% vs 1.8%; see panels (b) and (d) of Table III. Using the establishments' fixed effect as a measure for establishment quality produces coefficient estimates that are very similar in magnitude to those when the establishment wage premium is used as a measure for establishment quality (compare panels (a) and (b) of Figure V and panels (d) and (e) of Table III).[18]

To put these estimates into perspective, recall that minimum wage workers experienced an excess hourly wage growth of 5.4% in the 2014 vs the 2016 postpolicy period (see column (4) of panel (a) in Table II, repeated for convenience in Panel (c) of Table III). In Online Appendices A.9 and A.10 we show that among prepolicy low-wage workers who switch establishments, a 10% increase in the establishment's wage premium or fixed effect is associated with an increase in individual hourly wages of 6.1% and 8.0%, respectively. These associations increase to 7.0% and 11.3% when we focus on minimum wage workers who upgrade to establishments with higher wage premia or fixed effects. Assuming that similar relationships hold for minimum wage workers induced to reallocate because of the minimum wage, our estimates imply that between 4.3% and 5.1% of the overall hourly wage increase caused by the minimum wage can be attributed to the reallocation of minimum wage workers to establishments that pay a higher wage premium to their workers; and between 5.0% to 7.1% can be attributed to the reallocation of minimum wage workers to establishments that pay higher establishment fixed effects.

[18] We estimated AKM establishment wage premia over seven-year rolling windows including only years prior to the introduction of the minimum wage on a sample of full-time workers (see Online Appendices B.3 and B.5 for details).

Contrasting the reallocation estimates for establishments' average daily wages (1.8%) and establishments' wage premiums (0.3%), we further find that about 83% ((1 - $\frac{0.3\%}{1.8\%}$) ×100) of the increase in the establishment's average daily wage is due to workers moving to establishments that offer more full-time jobs and employ more skilled workers, while the remaining 17% reflect an increase in the wage premium that establishments pay to the same worker type.

Alternative measures of establishment quality. The findings in the remaining panels of Figure V and Table IV further corroborate our finding that the minimum wage induced low-wage workers to reallocate to establishments of higher quality. Motivated by models of heterogeneous establishments such as Melitz (2003) (or our model of monopsonistic competition outlined in Online Appendix D) that predict that more-productive establishments employ more workers, we use establishment size as a measure for establishment quality in panel (c) of Figure V (panel (d) of Table IV). The results suggest that the minimum wage induces low-wage workers to reallocate to larger establishments. The difference-in-differences estimate reported in panel (d) of Table IV indicates that, relative to the prepolicy period, establishment size (measured prior to the introduction of the minimum wage) increases by 3.8% for minimum wage workers (relative to workers higher up the wage distribution) in the postpolicy period.

The findings in panel (d) of Figure V (panel (e) of Table IV) further show that low-wage workers move to establishments characterized by generally more-stable employment relationships in response to the minimum wage, as measured by the (inverse of) the establishment's churning rate. The churning rate is the combined number of workers who leave and join the establishment, divided by the number of employees at baseline. The churning rate as a measure of (inverse) establishment quality is motivated by equilibrium models with search

frictions (e.g., Burdett and Mortensen, 1998; Cahuc, Postel-Vinay and Robin, 2006). These models predict that more-productive, larger establishments set higher wages and have both lower separation and hiring rates in equilibrium. These results highlight that the increase in job stability following a minimum wage hike documented in the previous literature (e.g., Cardoso and Portugal 2006; Brochu and Green 2013; Dube, Lester, and Reich 2016) may in part be driven by reallocation of workers towards more-stable establishments.

The reallocation of low-wage workers toward higher-paying establishments after the introduction of the minimum wage might simply reflect a shift toward establishments with less desirable nonwage amenities.[19] In panel (e) of Figure V (panel (f) of Table IV), we use the establishment's poaching index as a parsimonious measure for establishment quality that does not only reflect the establishment wage premium, but also workers' preferences over nonwage amenities, as suggested by Bagger and Lentz (2018) (see Online Appendix B.5 for a detailed description of how the poaching index is computed). The poaching index captures the share of new hires whom the establishment recruits directly from other establishments, as opposed to new hires who join the establishment from unemployment. A higher poaching index indicates a higher establishment quality, as establishments are able to "steal" workers from other establishments only if they offer a superior job in terms of both wages and nonwage amenities. Our findings for the poaching index further corroborate our previous findings that the minimum wage induced an upgrading of low-wage workers to higher-quality establishments.

Our final measure for establishment quality is the establishment's productivity, computed as the (log of) total revenues divided by the number of employees in the establishment (panel (f) of Figure V and panel (g) of Table IV). While our main data source does not include information

[19] Hashimoto (1982) provides a classic analysis on the impact of the minimum wage on nonwage benefits, while Clemens, Kahn, and Meer (2018) and Phelan (2019) present more recent evidence.

on the total revenues, we use results derived from the IAB Establishment Panel survey to compute a measure of predicted productivity (see Online Appendix B.4 for details).[20] The results show a clear upgrading of minimum wage workers to establishments with a higher productivity. The difference-in-differences estimate in panel (g) of Table IV indicates that for minimum wage workers (relative to workers higher up the wage distribution) predicted productivity (measured prior to the introduction of the minimum wage) increases by 1.3% in the postpolicy period (relative to the prepolicy period).

Worker Reallocation Within versus Between Local Areas and Industries. The upgrading of low-wage workers to establishments that pay higher average daily wages may occur within or between districts. We investigate this in panel (a) of Table V, where we display difference-in-differences and placebo estimates using the change in the worker's average daily wage in the district where the establishment is located as the dependent variable. Estimates are close to zero, indicating that the minimum wage-induced reallocation of workers to establishments that pay higher daily wages is not driven by workers relocating to districts where daily wages are generally higher. Instead, the upgrading takes place almost entirely within districts.

In panel (b) of the table, we repeat the analysis using the change in the worker's average daily wage in the three-digit industry as the dependent variable. While the coefficient estimate is positive, it is considerably smaller in magnitude than the coefficient estimate for establishments' average daily wages. Minimum wage workers experience an increase in the industry-specific average daily wage of 0.64% following the introduction of the minimum wage, compared to an increase in the average daily wage in the establishment of 1.8% (panel (b) of Table III). Thus,

[20] In line with the findings by Lochner and Schulz (2020), we find that establishment size, wages, and establishment fixed effects, among other establishment characteristics, are strong predictors for establishment productivity.

roughly two-thirds of the upgrading of low-wage workers to establishments that pay higher daily wages occurs within industries, and one-third between industries.

The findings in panel (c) of Table V further show that the minimum wage had little impact on the probability that minimum wage workers switch establishments. Therefore, the upgrading of minimum wage workers to better establishments in response to the introduction of the minimum wage arises chiefly because of movements to better establishments conditional on switching establishments, rather than because of a higher probability of switching establishments. The findings in panel (d) of Table V further highlight that the minimum wage had no impact on the probability that low-wage workers reallocate to newly founded establishments; neither is there any indication that minimum wage workers move to industries that were temporarily exempt from the minimum wage policy (panel (e) of Table V; see Online Appendix A.11 for more details). At the same time, the minimum wage appears to have slightly increased the probability that low-wage workers hold more than one job (panel (f) of Table V).

Robustness. In Table VI, we probe the robustness of our results to the inclusion of various control variables, focusing on employment, (proxied) hourly wage growth, and four measures of establishment quality (the establishment's average daily wage, establishment size, the poaching index, and predicted establishment productivity). In column (1), we report difference-in-differences estimates based on equation (2) without any control variables. In columns (2) to (4), we successively add individual-level demographic control variables and industry and location fixed effects (referring to the baseline period), respectively. Estimates in column (5) correspond to our baseline specification that controls for those three sets of control variables jointly. In column (6), we include the local unemployment rate interacted with wage bins as additional controls, to account for the possibility that the (local) business cycle differentially affects

workers along the wage distribution. In all specifications, estimated effects are very similar to those in our baseline specification, providing additional reassurance that they are driven by the minimum wage, rather than business cycle effects that vary across workers located in different wage bins.

Heterogeneous Effects of the Minimum Wage. Online Appendices A.6 and A.7 highlight that the wage, employment, and reallocation effects of the minimum wage are roughly similar in districts with stable and declining unemployment rates, and in districts heavily and barely exposed to the minimum wage. The positive effects of the minimum wage that we uncover are therefore not restricted to workers in prospering areas. The findings described in Online Appendix A.16 further show that the minimum wage did not lead to displacement effects for any of the subgroups of low-wage workers that we considered, even though it substantially increased their hourly wages (we considered men vs women; East vs West Germans; workers in tradable and nontradable industries[21]; workers in specific industries such as retail and construction; and workers in food, cleaning, security, and logistics services (FCSL) occupations that are the target of domestic outsourcing (Goldschmidt and Schmieder 2017)). The reallocation effects of the minimum wage are more pronounced in the nontradable sector where product prices are set locally rather than nationally or internationally, as in the tradable sector. Reallocation effects are also particularly strong in FCSL occupations, suggesting that minimum wages can potentially reverse trends in domestic outsourcing, as the benefits of outsourcing to lower-wage establishments are more limited when minimum wages are higher.

[21] When classifying industries into nontradable and tradable, we follow Mian and Sufi (2014) and classify retail- and restaurant-related industries as nontradable, and industries listed in global trade data as tradable, as in their method 1. Our findings are similar when we classify industries as nontradable and tradable using their method 2.

4 Labor Market Effects of the Minimum Wage: Regional Approach

Our findings in the last section show that the minimum wage increased wages of low-wage workers without reducing their employment prospects. At the same time, the minimum wage induced low-wage workers to reallocate to establishments of higher quality. The minimum wage thereby helped to lower wage inequality, as intended, not only directly, but also indirectly, through reducing the degree of assortative matching between workers and establishments. The latter has been emphasized as an important driver of the increase in wage inequality (Card, Heining, and Kline 2016; Song, Price, Guvenen, Bloom, and von Wachter 2019).[22]

We now provide complementary evidence on the wage, employment, and reallocation effects of the minimum wage by exploiting variation in exposure to the minimum wage across local areas. An advantage of this regional analysis over the individual approach is that any wage, employment, and reallocation effects of the minimum wage will not be driven only by workers who were employed when the minimum wage was introduced and who were possibly partially shielded from potentially harmful effects of the policy, but also by workers who were not in employment prior to the introduction of the minimum wage. For example, if establishments primarily respond to the introduction of the minimum wage by reducing hiring of unemployed workers, without displacing their incumbent workforce, the regional approach will uncover negative employment effects that the individual approach would miss.

[22] We have directly investigated the link between the minimum wage and assortative matching between workers and establishments exploiting variation in the exposure to the minimum wage across districts, as described below. The findings in Online Appendix A.13 show that assortative matching, measured as the covariance between worker and establishment fixed effects, declined in districts more exposed to the minimum wage (relative to less-exposed districts) in the years following the introduction of the minimum wage.

4.1 Method

The Gap Measure. In our regional approach, we compute for each of the 401 districts a continuous measure for its exposure to the minimum wage that has often been used in the minimum wage literature (e.g., Card and Krueger 1994, and Draca, Machin and Van Reenen 2011):

$$\mathrm{GAP}_{\mathrm{rt}} = \frac{\sum_{i \in r} h_{it} \max\{0, MW - w_{it}\}}{\sum_{i \in r} h_{it} w_{it}}.$$

where h_{it} denotes the weekly hours worked of worker i (employed in district r), MW is the minimum wage, and w_{it} refers to her hourly wage. This measure does not only depend on the share of individuals in the district who earn less than the minimum wage, but also on how much a worker's wage is below the minimum wage. The measure (if multiplied by 100) reflects the percent wage increase necessary to bring all workers in the district up to the minimum wage.

We average the yearly gap measure over three prepolicy years (2011 to 2014) to obtain a time-constant gap measure for each district:

$$\overline{GAP_r} = \sum_{t=2011}^{2014} GAP_{\mathrm{rt}} \quad (3)$$

The gap measure, averaged across districts, equals 0.017, with a standard deviation of 0.01, implying that if hourly wages of all workers who previously earned less than the minimum wage would be brought up to the minimum wage, hourly wages in the district would increase by 1.7% on average. The gap measure is lowest in the district of Wolfsburg, the hometown of Volkswagen (0.002), and highest in the district of Mansfeld-Südharz, a rural district in East Germany (0.039). Figure VI shows a map of the 401 districts where darker colors indicate a stronger exposure to the minimum wage according to the average gap measure. The figure

highlights that districts in East and North Germany are more heavily affected by the minimum wage than districts in South Germany.

We then relate our continuous measure for the exposure of region *r* to the minimum wage given by equation (3) to outcomes in the district, such as the local (log) wage, local (log) employment or local establishment quality. Specifically, in a first step, we estimate event-study regressions of the following type:

$$Y_{rt} = \alpha_r + \zeta_t + \sum_{\tau=2011, \tau \neq 2014}^{2016} \gamma_\tau \, \overline{GAP}_r + \epsilon_{rt} \qquad (4)$$

where Y_{rt} denotes the outcome of interest, α_r are district fixed effects and ζ_t are year fixed effects. The coefficients γ_τ trace out how outcomes in districts more affected by the minimum wage evolve in comparison to districts less affected by the minimum wage, relative to the prepolicy year 2014. We present coefficient estimates for γ_τ in a figure, to best visualize the possible labor market effects of the minimum wage policy. For the postpolicy years $\tau > 2014$, coefficient estimates γ_τ in equation (4) yield causal estimates of the minimum wage policy under the assumption that outcomes in more- and less-affected districts would have developed at the same rate in the absence of the minimum wage policy.[23] This assumption can be partially assessed by investigating whether more- and less-exposed districts exhibit similar trends in outcome variables prior to the introduction of the minimum wage. This corresponds to the coefficient estimates γ_τ being statistically and economically indistinguishable from zero for the prepolicy years (i.e., for $\tau < 2014$). To deal with the possibility that highly and barely exposed districts evolved differentially prior to the introduction of the minimum wage, we first use our estimates of γ_τ for the prepolicy years 2011 to 2014 to fit a linear time trend. We then plot the

[23] Another important assumption for the validity of the empirical design is that there are no geographic spillovers. Our worker-level analysis suggests that most reallocation takes place within districts (see panel a, Table V) at least for previously employed individuals, which suggests that geographic spillovers are small.

deviations between the estimates of γ_τ and the linear time trend updated for the postpolicy years, thereby visualizing any trend breaks in outcomes at the time of the introduction of the minimum wage. We additionally report results from a continuous difference-in-differences regression that accounts for district-specific linear time trends:

$$Y_{rt} = \alpha_r + \zeta_t + \delta_{post}\overline{GAP_r} \times Post_t + \beta_r time_t + \epsilon_{rt}. \quad (5)$$

Here, $Post_t$ is an indicator variable equal to 1 for the postpolicy years (t = 2015, 2016), and $time_t$ is a linear time trend that is allowed to vary across districts. Both approaches rely on the assumption that any preexisting trends in outcomes between heavily and barely exposed regions have been linear and would have continued at the same rate in the absence of the introduction of the minimum wage. We further probe the robustness of our estimates by estimating regressions based on equation (5) that include fully flexible time effects interacted with local characteristics at baseline as additional regressors. We weight our regressions by average local employment over the 2011 to 2014 period, and cluster standard errors at the regional level to allow for an arbitrary correlation of error terms within regions over time.

While we report estimates that exploit variation in the exposure to the minimum wage across 401 districts below, the findings in Online Appendix A.12 highlight that our results continue to hold when we distinguish between 141 commuting zones instead (Kosfeld and Werner, 2012).[24]

[24] A commuting zone is a spatial unit with on average 589,000 inhabitants.

4.2 Wage and Employment Effects of the Minimum Wage

Wage Effects. Panel (a) of Figure VII provides a first visual impression of how wages in districts heavily affected by the minimum wage evolve relative to wages in districts less exposed to the minimum wage, where we plot the coefficient estimates for γ_τ from regression equation (4), using the (log) average wage in the district as the dependent variable. The figure suggests that districts more exposed to the minimum wage experienced similar wage growth compared to less exposed districts prior to the introduction of the minimum wage, over the 2011 to 2014 period. However, after the introduction of the minimum wage in 2015, wage growth in highly affected districts strongly picks up relative to wage growth in less affected districts. Thus, in line with results from the individual approach, these findings strongly suggest that the minimum wage pushed up wages. By year 2016, the coefficient estimate (γ_{2016}) approaches one, as we would expect under full compliance with the minimum wage law. In panel (a), we further display a linear time trend, calculated based on the 2011 to 2014 prepolicy years (the black solid line in the figure). Panel (b) then depicts the deviations between the coefficient estimates for γ_τ (the dashed blue line) and the linear trend (the solid black line). Since the trend line is basically a horizontal line at zero, deviations from the trend line evolve very similarly to the coefficient estimates for γ_τ. In sum, the figures in panels (a) and (b) show a very clear trend break in local wage growth starting in 2015, exactly the year in which the minimum wage was first introduced.

We provide additional estimates of the wage effects of the minimum wage in panel (a) of Table VII. In the first column, we display simple difference-in-differences estimates based on regression equation (5) but excluding linear district-specific time trends ($\beta_r time_t$). In column (2), we include district-specific linear time trends in the regression, as in regression equation (5). In columns (3) and (4), we add controls for district baseline characteristics interacted with a

linear time trend or with fully flexible year effects, rather than a district-specific linear time trend. All specifications clearly indicate that the minimum wage raised wages: A one-percentage point increase in the gap measure leads to an increase in average local wages by 0.685% to 0.798%, depending on the specification.

Employment Effects. Panels (c) and (d) of Figure VII and panel (b) in Table VII provide a corresponding analysis for the employment effects of the minimum wage. Panel (c) of Figure VII illustrates that local employment, measured as the number of workers employed in the district (in logs), fell at a nearly linear rate in more (relative to less) exposed districts throughout the entire 2011 to 2016 period.[25] Panel (d) depicts the deviations of the coefficient estimates γ_τ (the blue dashed line in panel (c)) from the linear trend (the black solid line in panel (c)), estimated for the prepolicy period 2011 to 2014 and updated for the postpolicy period. These deviations are all close to zero, suggesting that the minimum wage had no discernable impact on local employment, in line with our findings from the individual analysis.

We report corresponding difference-in-differences estimates based on variants of regression equation (5) in panel (b) of Table VII. In line with the evidence presented in the figure, the difference-in-differences estimates indicate that the minimum wage did not reduce local employment once we account for differential pretrends in various ways (columns (2) to (4)).[26] The estimate from our preferred specification in the second column implies that that we can reject the hypothesis that employment in the 10% most exposed districts (with a gap measure of 0.033) declined relative to the 10% least exposed districts (with a gap measure of 0.009) by more than 1.5% ((0.018-1.96×0.059)×(0.033-0.009)) at a 5% confidence level. Putting it differently,

[25] The slope implies that districts at the 10th percentile of the exposure measure experienced a 4% higher employment growth between 2011 and 2014 than districts at the 90th percentile.

[26] In Online Appendix A.14, we implement the "honest approach" to parallel trends proposed by Rambachan and Roth (2019) to probe the robustness of our finding of no minimum wage-induced disemployment effects to alternative assumptions about different trends in more- versus less-exposed districts.

the estimates for the local wage and employment responses to the minimum wage presented in panels (a) and (b) rule out an employment elasticity with respect to the wage that is larger (in absolute magnitude) than -0.14 at a 5% confidence level.[27] The absence of a negative employment effect not only at the individual level, but also at the regional level further suggests that employment prospects of unemployed workers are not substantially harmed by the introduction of the minimum wage.

4.3 Reallocation Effects of the Minimum Wage

The wage and employment effects from the regional approach confirm the findings from the individual approach: the introduction of the minimum wage raised wages but did not lower employment. The minimum wage thus did not only help to reduce wage inequality across individuals, but also across districts, without causing job losses among disadvantaged individuals or in disadvantaged districts. In a next step, we provide evidence that the upgrading of low-wage workers to better establishments induced by the minimum wage translated into an improvement in establishment quality in more relative to less exposed districts.

We first investigate whether the minimum wage decreased the number of establishments that are operating in the district. We find evidence in line with this hypothesis in panel (a) of Figure VIII. In the figure, we plot the deviations between the coefficient estimates γ_τ obtained from regression equation (4) and a linear time trend estimated for the prepolicy years 2011 to 2014 and updated for the postpolicy years, as in panels (b) and (d) of Figure VII. The figure is suggestive of a trend break around the introduction of the minimum wage and supports the view that a greater exposure to the minimum wage led to a decline in the number of establishments in the district. The corresponding regression estimate, presented in panel (c) of Table VII (column

[27] Dividing estimates in panel (b) by estimates in panel (a) provides us with an estimate of the employment elasticity with respect to the wage. We compute standard errors using the delta method (assuming zero covariance between the estimates).

(2)), indicates that the number of establishments declined by 0.45% ((0.033-0.009) ×0.188) in the 10% districts most hit by the minimum wage relative to the 10% districts least hit by the minimum wage. The decline in the number of very small businesses with no more than two employees is even more pronounced (0.65% ((0.033-0.009) ×0.271); panel (d) of Table VII and panel (b) of Figure VIII), in line with the hypothesis that the minimum wage drives some of the smallest establishments out of the market. We investigate establishment exit directly in panel (e) of Figure VIII. The figure provides clear evidence of increased exit of small businesses after the introduction of the minimum wage in districts heavily exposed to the minimum wage.

Since the minimum wage has little impact on overall local employment, the decline in the number of establishments induced by the minimum wage implies an increase in average establishment size in the district. Indeed, we find an increase by 0.36% in the 10% of districts most exposed relative to the 10% of districts least exposed to the minimum wage (panel (e) of Table VII and panel (c) of Figure VIII). Panels (d) and (f) of Figure VIII further highlight that the minimum wage increased the average establishment fixed effect, estimated using only prepolicy data, and predicted establishment productivity, measured at baseline in $t - 2$, in heavily exposed relative to barely exposed districts. To put these numbers in perspective, the average AKM establishment fixed effect in 2014 was about 19.4 percent higher in the 10% of districts least exposed to the minimum wage compared to the 10% of districts most exposed, meaning that the gap in AKM establishment fixed effects between the most- and least-exposed districts declined by 2.2% (0.43/19.4). It should be noted that as the establishment fixed effect and establishment productivity are measured at baseline, these effects purely capture compositional changes of establishments in the districts, driven by the reallocation of workers toward more-

productive and toward higher-paying establishments, and not within-establishment changes possibly induced by the minimum wage.

Establishment-level results. The finding that small businesses face an increased risk of exit following the introduction of the minimum wage suggests that some establishments lost out because of the minimum wage policy. In Online Appendix C, we investigate in more detail which establishments were the winners and losers of the policy, by exploiting variation in the exposure to the minimum wage across establishments, similarly to Draca, Machin, and Van Reenen (2011) and Harasztosi and Lindner (2019). We establish four sets of results. First, wages clearly increased in more- versus less-exposed establishments after the introduction of the minimum wage. Second, employment in more-exposed establishments slightly declined relative to employment in less-exposed establishments. Our wage and employment estimates combined imply a demand elasticity of -0.31 (unweighted) or -0.26 (weighted), estimates that are similar in magnitude to those found by Harasztosi and Lindner (2019) for Hungary or Bossler and Gerner (2020) for Germany. The small negative employment effect at the establishment level does not contradict the evidence on the absence of a disemployment effect at the regional or individual levels if low-wage workers reallocate from more-exposed (and hence low-paying) to less-exposed (and hence higher-paying) establishments in response to the minimum wage. Third, when breaking down the effects of the exposure to the minimum wage by establishment size, we find that very small establishments with up to four employees are more likely to exit the market following the minimum wage hike. Furthermore, whereas employment shrinks in establishments with up to 35 employees, employment in larger establishments expands in response to the minimum wage. Therefore, the findings from the establishment-level analysis further underscore

that the minimum wage drives some of the smallest businesses out of the market and reallocates workers from smaller to larger establishments.

5 Discussion

We now briefly sketch a simple model that provides a natural explanation of the three key findings: a minimum wage raises wages, does not lower employment, and induces a reallocation to larger, higher-paying firms.[28] We refer the reader to Online Appendix D for details and a formal analysis. While we focus here on a model of monopsonistic competition with heterogeneous firms, we acknowledge that search frictions in the labor market (Acemoglu 2001) or frictions in the product market (Luca and Luca 2018; Mayneris, Poncet, and Zhang 2018) may provide complementary explanations for our findings.

Building on Manning (2003), Bhaskar, Manning, and To (2002) and more recently Card et al. (2018), a worker in our set-up cares not only about wages but also about nonpecuniary aspects of the job, capturing for example commuting time, how well she gets along with her coworkers or boss, or her preferences for the working schedule the firm provides. While we assume workers to be of the same type for simplicity, establishments are heterogenous in terms of their marginal costs of producing one unit of output. In a perfectly competitive labor market in which workers derive utility only from wages, all firms would set the same wage—as they will not be able to attract any worker even if they offered a wage just below the prevailing market wage. Firms thus face an infinitely elastic labor supply curve. In contrast, in a monopsonistic labor market in which workers value nonpecuniary job amenities in addition to wages, firms face an upward-sloping labor supply curve and will be able to hire some workers even if they offer lower wages than their competitors. Nonpecuniary job characteristics thus give firms wage-

[28] To follow the terminology of the theoretical literature, in this section we refer to "firms" instead of "establishments", whereas it is the latter that we observe in our empirical analysis.

setting power in the labor market and allow them to set wages below workers' marginal productivity. We show that in this environment, more-efficient firms will be larger, pay higher wages (to the same worker type) and be more profitable than less-efficient firms (see Lemma 1 in Online Appendix C and Manning 2003).

Now suppose a minimum wage is coming into effect. Consider first less-efficient firms in the market that paid wages below the minimum wage before its introduction. The minimum wage forces these firms to increase their wages to comply with the minimum wage law. The least efficient firms will now no longer be profitable and hence exit the market (see Lemma 2.1). This prediction is consistent with our empirical finding that the minimum wage increases closures of small businesses in districts heavily exposed to it (e.g., panel (b) of Figure VIII).[29] On the other hand, more-efficient firms that paid wages below the minimum wage before its introduction continue to be profitable and will stay in business after the minimum wage comes into effect. These firms pay the minimum wage to their workers, which reduces the gap between the marginal product of labor and wages and increases employment (see Lemma 2.2 and Chapter 12 in Manning 2003).[30] Next, consider even more efficient firms that paid wages above the minimum wage before its introduction. It is ambiguous what happens to the employment choices and wage offers of these firms. On the one hand, some firms have exited the market, which reduces competition in the labor market and ceteris paribus allows surviving firms to pay lower wages and yet attract the same number of workers. On the other hand, some surviving firms raise wages in response to the minimum wage, which ceteris paribus forces more-efficient firms to also increase their wage offers in order to attract the same number of workers (see Lemma 2.3).

[29] Findings from our establishment level analysis in Online Appendix C further corroborate this prediction from the model. While the minimum wage increases the probability that small establishments with no more than four employees exit the market, this is not the case for larger establishments.

[30] This prediction is in line with our findings from the establishment-level analysis that medium-sized firms expand employment in response to the minimum wage (Online Appendix C).

The model is therefore consistent with our findings that the minimum wage did not reduce the employment prospects of low-wage workers; neither did it lower employment in districts heavily exposed to the minimum wage.

In sum, in this monopsonistic model of the labor market, a minimum wage will unambiguously raise wages, whereas the overall employment effects are unclear. A minimum wage will further lead to the reallocation of workers from less-efficient—and hence smaller and lower-paying—to more-efficient firms. According to the model, the least efficient firms close down after the introduction of the minimum wage and workers in these firms are at least partially absorbed by more-efficient firms that raise their wages and expand employment in response to the minimum wage—in line with the empirical evidence that we provide. Yet, the model also highlights that not all minimum wage workers are necessarily better off after the minimum wage policy, as workers who reallocate to a more efficient firm may trade off higher wages with lower utility from nonpecuniary job characteristics.

We explore the possibility that the reallocation of low-wage workers to higher-paying establishments comes at the expense of lower utility from nonpecuniary job characteristics in Table VIII. We focus on commuting time (which we compute as the distance between the centroids of the municipalities of residence and work) as one important nonwage amenity. The difference-in-differences estimates in Table VIII are consistent with a trade-off between wages and commuting time: commuting distance increased by 1.8km (or 10%) for low-wage workers relative to high-wage workers after the introduction of the minimum wage. The increase in commuting time induced by the minimum wage is considerably larger for men than for women, in line with the hypothesis that women have a particularly strong preference to work close to home (e.g., Hanson and Johnston 1985; Caldwell and Danieli 2021).

While these findings suggest that there may be some minimum wage workers who have lost out because of the policy despite earning a higher wage, our model also emphasizes that workers will on average be no worse off after the introduction of the minimum wage, provided that the minimum wage does not lower employment. Overall, our empirical findings (e.g., the

point estimates on employment from the individual or regional approach), therefore, suggest that the minimum wage improved welfare of low-wage workers on average.

In the theoretical model, we have assumed that product markets are perfectly competitive and that firms produce the same homogenous product. We acknowledge that in a set-up where firms produce differentiated products and consumers value variety, as in Melitz (2003), the exit of inefficient firms may leave some consumers worse off despite being able to purchase similar products at a lower price. For example, some consumers may prefer nearby restaurants and shops even if they charge higher prices than restaurants and shops further away, but some of these small businesses close down after the minimum wage is implemented.

6 Conclusion

This paper investigates the labor market responses to Germany's first-time introduction of a nationwide minimum wage. We find that the minimum wage policy pushed up wages without lowering employment. The lack of employment responses, however, masks some important structural shifts in the economy: the minimum wage led to a reallocation of workers from smaller to larger, from lower-paying to higher-paying and from less- to more-productive establishments, and thereby helped to improve the quality of establishments in the economy. These findings suggest that minimum wages increased allocational efficiency of workers.

These findings are hard to reconcile with a perfectly competitive labor market where a minimum wage unambiguously reduces employment, efficiency, and welfare. However, the reallocation of labor toward higher-paying and more-productive establishments, coupled with the absence of disemployment effects, naturally emerges in a monopsonistic model of the labor

market in which firms have some wage-setting power as workers care not only about wages but also about nonpecuniary job amenities such as commuting time.

Even though we did not detect any obviously concerning impacts of the minimum wage, such as reduced employment prospects of low-wage workers, our results do not imply that there are no establishments or workers who lost out as a result of the introduction of the minimum wage. We find that the minimum wage caused some small businesses to exit the market. As Williamson (1968) highlighted, increased exits may lead to increased market concentration and reduced competition among firms in the product market, which can lead to higher prices. We further find that the reallocation of low-wage workers to higher-paying establishments came at the expense of increased commuting time, which might have left some workers worse off despite earning a higher wage. Yet, if viewed through the lens of our model, our empirical findings suggest that low-wage workers' welfare improved on average after the introduction of the minimum wage.

Supplementary Material

An Online Appendix for this article can be found at The Quarterly Journal of Economics online.

Data Availability

Data and code replicating the tables and figures in this article can be found Dustmann et al (2021) in the Harvard Dataverse, https://doi.org/10.7910/DVN/V01YTM.

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Table I: Which Individuals are Heavily Affected by the Minimum Wage?

	Wage bin in 2014		
	$4.5<W_{t-2}\leq 8.5$	$8.5<W_{t-2}\leq 12.50$	$12.50<W_{t-2}\leq 20.50$
East Germany	0.30	0.27	0.17
Non-German citizen	0.14	0.12	0.07
Women	0.66	0.57	0.48
By education			
share low skilled	0.23	0.15	0.08
share medium skilled	0.70	0.79	0.83
share high skilled	0.07	0.07	0.10
By age			
share less than 24	0.17	0.13	0.08
share 24-44	0.44	0.48	0.51
share 45 -59	0.39	0.39	0.42
By employment status			
unemployed in previous year	0.22	0.15	0.06
share full-time	0.31	0.57	0.72
share part-time	0.28	0.27	0.25
share marginally employed	0.42	0.17	0.03
By industry structure			
Agriculture; Mining	0.00	0.00	0.00
Manufacturing; Electricity; Waste Management	0.10	0.15	0.23
Construction; Wholesale and Retail	0.24	0.26	0.29
Transportation; Accomodation and Food Services	0.23	0.14	0.09
Information and Communication; Finance, Insurance; Real Estate	0.04	0.03	0.04
Professional Services; Administrative and Support Services	0.21	0.21	0.11
Public Administration; Education; Human Health	0.11	0.17	0.21
Arts, Entertainment; Other Services	0.08	0.04	0.03
By establishment size			
1-4 Employees	0.22	0.14	0.07
5-19 Employees	0.31	0.28	0.22
20-49 Employees	0.17	0.18	0.18
50+ Employees	0.30	0.40	0.53
Number of observations (Individual analysis, 50% Random sample)	1,107,304	2,170,353	3,791,061

Notes: The table compares individuals located at different parts of the hourly wage distribution in terms of location, education, age, employment status, industry affiliation, and establishment size in June 2014, 6 months prior to the introduction of the hourly minimum wage of 8.50 EUR per hour in January 2015. "Low skilled" refers to individuals without vocational training, "medium skilled" to individuals with vocational training and "high skilled" to individuals with academic education. Marginally employed are individuals who are employed in marginal part-time jobs (so-call Mini- or 450-EUR-Jobs).

Table II: The Effects of the Minimum Wage on Wages and Employment: Individual Approach

Wage bin in *t* - *2*	Changes relative to 2011 vs 2013 [4.5,8.5)	[8.5,12.5)	[12.5,20.5)	Difference-in-differences (1) minus (3)	(2) minus (3)
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Panel (a): Hourly Wages					
2014 vs 2016	0.060	0.021	0.006	0.054	0.015
	(0.0021)	(0.0007)	(0.0004)	(0.0019)	(0.0005)
2012 vs 2014 (Placebo)	0.015	0.008	0.006	0.009	0.002
	(0.0005)	(0.0003)	(0.0002)	(0.0005)	(0.0003)
Baseline Change (2011 vs 2013)	0.150	0.086	0.057		
Panel (b): Daily Wages					
2014 vs 2016	0.099	0.031	0.006	0.093	0.025
	(0.0022)	(0.0008)	(0.0005)	(0.0020)	(0.0007)
2012 vs 2014 (Placebo)	0.016	0.008	0.005	0.011	0.003
	(0.0008)	(0.0004)	(0.0002)	(0.0009)	(0.0005)
Baseline Change (2011 vs 2013)	0.242	0.105	0.053		
Panel (c): Employment (1 if employed)					
2014 vs 2016	0.011	0.005	0.003	0.008	0.002
	(0.0005)	(0.0003)	(0.0002)	(0.0005)	(0.0003)
2012 vs 2014 (Placebo)	0.004	0.001	0.001	0.002	0.000
	(0.0004)	(0.0002)	(0.0001)	(0.0004)	(0.0003)
Baseline Change (2011 vs 2013)	-0.211	-0.135	-0.083		
Panel (d): Employment (full-time equivalents)					
2014 vs 2016	0.025	0.009	0.002	0.023	0.007
	(0.0007)	(0.000)	(0.0003)	(0.0008)	(0.0004)
2012 vs 2014 (Placebo)	0.007	0.002	0.001	0.006	0.002
	(0.0004)	(0.0002)	(0.0002)	(0.0005)	(0.0003)
Baseline Change (2011 vs 2013)	-0.084	-0.093	-0.072		

Notes: In panel (a), we report the excess hourly wage growth in the 2014 vs 2016 postpolicy period and the 2012 vs 2014 "placebo" period relative to the 2011 vs 2013 prepolicy period for three groups of workers: workers who earned less than the minimum wage at baseline ([4.5, 8.5), column (1)), workers who earn more but close to the minimum wage at baseline ([8.5, 12.50), column (2)), and workers who earn more than 12.50 Euro at baseline (column (3)). Estimates refer to coefficients δ_{kt} in equation (2) in the text, where workers are grouped into three bins only. Columns (4) and (5) report difference-in-differences estimates that compare the excess wage growth of workers who earn less or close to the minimum wage at baseline with the excess wage growth of workers who earn more than 12.50 Euro at baseline (i.e., estimates in columns (1) and (2) minus estimates in column (3)). In panel (b), we repeat the analysis, but now use the change in daily wages as the dependent variable. In both panels (a) and (b), the sample is restricted to individuals who are employed both in period t - 2 and t. In panel (c), we report corresponding estimates using employment as the dependent variable. (All workers are employed in t - 2). In panel (d), we instead use the change in full-time equivalents, where we assign values of 1, 0.5, 0.2 and 0 to full-time, part-time, marginally employed, and nonemployed workers, as the dependent variable. All regressions control for individual characteristics at baseline (age, education, sex, nationality full-time status, district fixed effects, industry fixed effects) and standard errors (in parentheses) are clustered at the district level.

Table III: Reallocation to Higher-Paying Establishments: Individual Approach (Difference-in-Differences Estimates)

	Main Effects (2014 vs 2016)		Placebo Effects (2012 vs 2014)	
Wage bin in *t* - *2*	[4.5,8.5)	[8.5,12.5)	[4.5,8.5)	[8.5,12.5)
	(1)	**(2)**	**(3)**	**(4)**
Panel (a): Daily Wages				
Estimated effect	0.093	0.025	0.011	0.003
	(0.0020)	(0.0007)	(0.0009)	(0.0005)
Panel (b): Establishment's Average Daily Wage				
Estimated effect	0.018	0.005	0.003	0.000
	(0.0011)	(0.0004)	(0.0007)	(0.0004)
Daily wage growth due to reallocation (% of total effect)				
Calculated using all switchers	**14.5%**	**13.9%**		
Calculated using upward switchers	**17.2%**	**16.6%**		
Panel (c): Hourly Wages				
Estimated effect	0.054	0.015	0.009	0.002
	(0.0019)	(0.0005)	(0.0005)	(0.0003)
Panel (d): Establishment's Average Wage Premium				
Estimated effect	0.004	0.002	0.001	0.000
	(0.0004)	(0.0003)	(0.0003)	(0.0002)
Hourly wage growth due to reallocation (% of total effect)				
Calculated using all switchers	**4.3%**	**7.1%**		
Calculated using upward switchers	**5.0%**	**8.1%**		
Panel (e): AKM Establishment Effects				
Estimated effect	0.003	0.001	0.000	0.000
	(0.0004)	(0.0002)	(0.0003)	(0.0001)
Hourly wage growth due to reallocation (% of total effect)				
Calculated based on all switchers	**5.1%**	**6.3%**		
Calculated based on switchers	**7.1%**	**8.9%**		

Notes: The table investigates the effect of the minimum wage on the reallocation of low-wage workers to establishments that pay higher wages. Establishment wages are measured before the minimum wage came into effect and only change for workers who switch establishments. In panel (b), we use the change in the establishment's average daily wage as the dependent variable. In panel (d), the dependent variable is the change in the establishment's wage premium, calculated as the residual from an individual daily wage regression that controls for workers' full-time status (full-time, part-time, and marginally employed) in addition to worker age, skill, and nationality, aggregated to the establishment level. In panel (e), the dependent variable is the change in the establishment's fixed effect, obtained from an individual daily wage regression for full-time workers that controls for worker age and worker, establishment and year fixed effects and is estimated over a seven-year period prior to the baseline year. The table reports difference-in-differences estimates for the 2014 vs 2016 postpolicy period (columns (1) and (2)) and the 2012 vs 2014 "placebo" prepolicy period (columns (3) and (4)); see columns (4) and (5) in Table 2. All regressions control for individual characteristics at baseline (age, education, sex, nationality, full-time status, district fixed effects, and industry fixed effects) and standard errors (in parentheses) are clustered at the district level. The table further reports the fraction of the overall improvement in daily or hourly wages (displayed again for convenience in panels (a) and (c)) that can be attributed to the reallocation of workers to higher-paying establishments in bold; see Section 3.3 in the main text for how these are computed.

Table IV: Reallocation to Establishments of Higher Quality: Individual Approach (Difference-in-Differences Estimates)

	Main Effects (2014 vs 2016)		Placebo Effects (2012 vs 2014)	
Wage bin in t - 2	[4.5,8.5)	[8.5,12.5)	[4.5,8.5)	[8.5,12.5)
	(1)	**(2)**	**(3)**	**(4)**
Panel (a): Establishment's High-Skilled Employment Share				
Estimated effect	0.002	0.000	0.001	0.000
	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Panel (b): Establishment's Full-time Employment Share				
Estimated effect	0.007	0.001	0.001	0.000
	(0.0005)	(0.0003)	(0.0003)	(0.0002)
Panel (c): Establishment's Marginal Employment Share				
Estimated effect	-0.006	-0.001	-0.001	0.000
	(0.0004)	(0.0001)	(0.0002)	(0.0001)
Panel (d): Establishment Size				
Estimated effect	0.038	0.011	0.010	0.003
	(0.0039)	(0.0023)	(0.0022)	(0.0015)
Panel (e): Establishment's Churning Rate				
Estimated effect	-0.008	-0.002	0.001	0.002
	(0.0010)	(0.0006)	(0.0007)	(0.0005)
Panel (f): Establishment's Poaching Index				
Estimated effect	0.005	0.003	0.001	0.000
	(0.0004)	(0.0002)	(0.0003)	(0.0002)
Panel (g): Establishment's Revenue per Worker				
Estimated effect	0.013	0.002	0.002	-0.001
	(0.0010)	(0.0005)	(0.0006)	(0.0004)

Notes: The table investigates the effect of the minimum wage on the reallocation of low-wage workers to establishments of higher quality. Establishment quality is measured before the minimum wage came into effect and only changes for workers who switch establishments. In panels (a) to (c), we use changes in the share of high-skilled workers (i.e., workers with a university education), full-time workers, and marginally employed workers as dependent variables. In panel (d), establishment quality is measured as establishment size (i.e., (log) number of employees in full-time equivalents). In panel (e), the dependent variable is the change in establishment's churning rate, measured as the sum of workers who leave and join the establishment, divided by the number of workers at baseline. The dependent variable in panel (f) is the change in the establishment's poaching index, computed as the share of new hires that come from employment rather than unemployment. In panel (g) the dependent variable is the change in the establishment's revenue per worker, where we predict revenue per worker based on an establishment's state, industry, size and the average earnings of full-time workers (see Online Appendix B.4). The table reports difference-in-differences estimates for the 2014 vs 2016 postpolicy period (columns (1) and (2)) and the 2012 vs 2014 "placebo" prepolicy period (columns (3) and (4)), as in columns (4) and (5) in Table 2. All regressions control for individual characteristics at baseline (age, education, sex, nationality, full-time status, district fixed effects, and industry fixed effects) and standard errors (in parentheses) are clustered at the district level.

Table V: Additional Effects of the Minimum Wage: Individual Approach (Difference-in-Differences Estimates)

	Main Effects (2014 vs 2016)		Placebo Effects (2012 vs 2014)	
Wage bin in *t* - *2*	[4.5,8.5)	[8.5,12.5)	[4.5,8.5)	[8.5,12.5)
	(1)	(2)	(3)	(4)
Panel (a): Average Daily Wage in the District				
Estimated effect	-0.0001	0.0000	-0.0001	0.0000
	(0.00008)	(0.00003)	(0.00004)	(0.00003)
Panel (b): Average Daily Wage in the Industry (three-digit)				
Estimated effect	0.0064	-0.0002	0.0009	-0.0014
	(0.00068)	(0.00040)	(0.00041)	(0.00027)
Panel (c): Probability of Switching Establishments				
Estimated effect	0.0004	0.0066	-0.0021	0.0013
	(0.00162)	(0.00111)	(0.00115)	(0.00092)
Panel (d): Probability of Switching to an Establishment Born after (t-2)				
Estimated effect	-0.0011	-0.0012	-0.0009	-0.0008
	(0.00107)	(0.00097)	(0.00088)	(0.00070)
Panel (e): Probability of Switching to an Exempted Industry				
Estimated effect	-0.0001	0.0009	0.0001	0.0005
	(0.00021)	(0.00014)	(0.00020)	(0.00012)
Panel (f): Probability of Having More than One Job				
Estimated effect	0.0051	0.0018	0.0015	0.0003
	(0.00066)	(0.00048)	(0.00051)	(0.00036)

Notes: The table first investigates potential channels through which the minimum wage-induced reallocation of low-wage workers to establishments of higher quality may occur. In panel (a), we investigate whether low-wage workers reallocate to districts that pay higher wages following the introduction of the minimum wage. The dependent variable here is the change in the (log) mean daily wage in the district, measured prior to the introduction of the minimum wage. In panel (b), we use the change in the (log) daily wage in the (three-digit) industry as the dependent variable to examine whether low-wage workers move to higher-paying industries in response to the minimum wage. In panel (c), we investigate whether the minimum wage increased the probability that low-wage workers leave their baseline establishment; the dependent variable here is equal to 1 if the worker is employed in the same establishment in period t as in period t - 2, and 0 otherwise. In panel (d) we investigate whether the probability of moving to a newly founded establishment is affected by the minimum wage. In panel (e) we assess whether the minimum wage increased the probability that a low-wage worker moves to an industry temporarily exempted from the minimum wage. In panel (f), we study the effects of the minimum wage on the probability that low-wage workers hold more than one job. The table reports difference-in-differences estimates for the 2014 vs 2016 postpolicy period (columns (1) and (2)) and the 2012 vs 2014 "placebo" prepolicy period (columns (3) and (4)), as in columns (4) and (5) in Table 2. All regressions control for individual characteristics at baseline (age, education, sex, nationality, full-time status, district fixed effects, and industry fixed effects) and standard errors (in parentheses) are clustered at the district level.

Table VI: Wage, Employment and Reallocation Effects of the Minimum Wage: Robustness Checks (Difference-in-Differences Estimates)

Wage bin in t - 2	[4.5,8.5)	[4.5,8.5)	[4.5,8.5)	[4.5,8.5)	[4.5,8.5)	[4.5,8.5)
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Panel (a): Hourly Wages						
2014 vs 2016	0.051	0.053	0.054	0.052	0.054	0.051
	(0.0020)	(0.0020)	(0.0019)	(0.0020)	(0.0019)	(0.0018)
2012 vs 2014 (Placebo)	0.007	0.008	0.009	0.008	0.009	0.008
	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0006)
Panel (b): Employment (1 if Employed)						
2014 vs 2016	0.004	0.010	0.008	0.011	0.008	0.008
	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0006)
2012 vs 2014 (Placebo)	0.001	0.003	0.002	0.003	0.002	0.002
	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0005)
Panel (c): Establishment's Average Daily Wage						
2014 vs 2016	0.016	0.016	0.018	0.013	0.018	0.017
	(0.0013)	(0.0013)	(0.0011)	(0.0012)	(0.0011)	(0.0012)
2012 vs 2014 (Placebo)	0.002	0.002	0.003	0.001	0.003	0.002
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Panel (d): Establishment Size						
2014 vs 2016	0.050	0.051	0.038	0.048	0.038	0.036
	(0.0045)	(0.0045)	(0.0040)	(0.0044)	(0.0039)	(0.0040)
2012 vs 2014 (Placebo)	0.015	0.016	0.010	0.015	0.010	0.010
	(0.0025)	(0.0025)	(0.0022)	(0.0024)	(0.0022)	(0.0023)
Panel (e): Establishment's Poaching Index						
2014 vs 2016	0.0040	0.0039	0.0047	0.0039	0.0047	0.0047
	(0.00045)	(0.00044)	(0.00043)	(0.00044)	(0.00043)	(0.00044)
2012 vs 2014 (Placebo)	0.0005	0.0005	0.0007	0.0005	0.0007	0.0007
	(0.00037)	(0.00036)	(0.00036)	(0.00036)	(0.00036)	(0.00036)
Panel (f): Establishment's Revenue per Worker						
2014 vs 2016	0.0037	0.0025	0.0125	0.0025	0.0127	0.0116
	(0.00133)	(0.00133)	(0.00103)	(0.00131)	(0.00105)	(0.00107)
2012 vs 2014 (Placebo)	-0.0014	-0.0016	0.0017	-0.0016	0.0018	0.0013
	(0.00070)	(0.00069)	(0.00065)	(0.00069)	(0.00065)	(0.00066)
Demographic Controls and Full-Time Status	no	yes	yes	yes	yes	yes
Industry FEs	no	no	yes	no	yes	yes
District FEs	no	no	no	yes	yes	yes
District UR X wage bin	no	no	no	no	no	yes

Notes: The table shows the robustness of our key results with respect to the inclusion of various control variables. The table reports difference-in-differences estimates (as in column (4) of Table 2). In column (1), we do not include any baseline controls. In column (2), we add demographic controls (education, age, and nationality) and full-time status (full-time, part-time, and marginally employed). In column (3), we control for industry affiliation (at the three-digit level) in addition to demographic and full-time status controls. In column (4), we control for district fixed effects instead of industry affiliation. In column (5), we control for demographic characteristics, full-time status as well as industry and district fixed effects, as in our baseline specification. In column (6), we further add the unemployment rate in the district interacted with wage bins as a control, to account for potential business cycle effects that differentially affect workers at different parts of the wage distribution. Standard errors clustered at the district level are reported in parentheses.

Table VII: Wage, Employment, and Reallocation Effects of the Minimum Wage: Regional Approach

	No controls for differential pre-trends	Controls for differential pre-trends		
	(1)	(2)	(3)	(4)
Wage and Employment Effects				
Panel (a): Hourly Wages				
	0.795	0.685	0.754	0.798
	(0.0540)	(0.0652)	(0.0652)	(0.119)
Panel (b): Employment (Number of Workers)				
	-1.513	0.0176	0.131	0.375
	(0.211)	(0.0811)	(0.114)	(0.269)
Reallocation Effects: Improvement of Establishment Quality in the District				
Panel (c): Number of Establishments				
	-1.458	-0.188	-0.216	-0.243
	(0.180)	(0.0526)	(0.0786)	(0.178)
Panel (d): Number of Small Businesses (1-2 employees)				
	-1.479	-0.271	-0.318	-0.350
	(0.152)	(0.121)	(0.130)	(0.264)
Panel (e): Average Establishment size				
	-0.0428	0.154	0.220	0.307
	(0.101)	(0.0772)	(0.0918)	(0.168)
Panel (f): Average AKM Establishment Fixed Effects				
	0.468	0.087	0.291	0.544
	(0.0698)	(0.0453)	(0.0685)	(0.142)
Panel (g): Average Revenue per Worker				
	0.410	0.314	0.541	1.038
	(0.140)	(0.128)	(0.141)	(0.173)
District fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
District baseline characteristics interacted with linear time trend	no	no	yes	no
District-specific linear time trends	no	yes	no	no
District baseline characteristics interacted with year fixed effects	no	no	no	yes

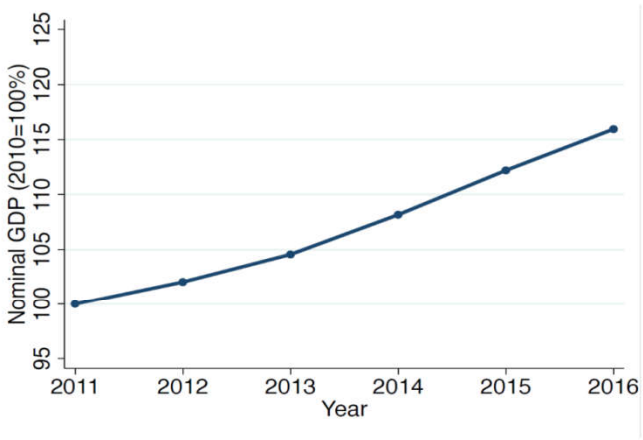
Notes: In column (1) of the table, we report difference-in-differences estimates for the impact of the district's exposure to the minimum wage, measured as the average gap measure for the 2011 to 2014 prepolicy years (equation (3)), on the (log) mean hourly wage (panel (a)); (log) employment (number of workers in full-time equivalents, panel (b)); (log) number of establishments (panel (c)); (log) number of small businesses with 1 or 2 employees (panel (d)); (log) mean establishment size (panel (e)); the average (weighted by establishment size) establishment fixed effect (obtained from an AKM style log wage regression estimated over the prepolicy period, panel (f)); and (log) mean revenues per worker in the district (panel (g)), where we predict revenue per worker based on an establishment's state, industry, size, and the average earning of full-time workers (see Online Appendix B.4). Estimates in column (1) are based on regression equation (5) but do not include district-specific linear time trends and thus do not allow for possibly divergent pretrends in districts heavily and barely affected by the minimum wage. In columns (2) to (4), we account for such differential pretrends by including, as in regression equation (5), a district-specific linear time trend (column (2)); by including baseline district characteristics interacted with a linear time trend (column (3)); or by including baseline district characteristics interacted with fully flexible year fixed effects (column (4)). Regressions are weighted by district employment averaged over the 2011 to 2013 prepolicy period. Standard errors clustered at the district level are in parentheses.

Table VIII: Effect of the Minimum Wage on Commuting Distance
(Difference-in-Differences Estimates)

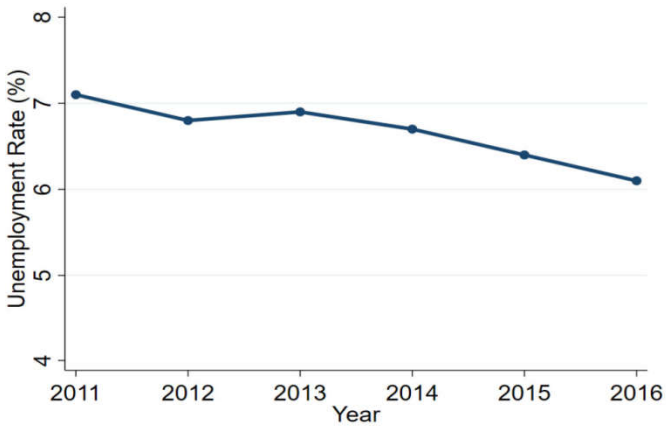
	Main Effects (2014 vs 2016)		Placebo Effects (2012 vs 2014)	
Wage bin in *t* - *2*	[4.5,8.5)	[8.5,12.5)	[4.5,8.5)	[8.5,12.5)
	(1)	(2)	(3)	(4)
Panel (a): Driving Distance				
Estimated Effect	1.774	0.566	0.533	0.013
	(0.2189)	(0.1434)	(0.1181)	(0.0884)
Panel (b): Driving Distance - Men vs Women				
Men	3.328	0.614	1.062	-0.045
	(0.2872)	(0.2309)	(0.1827)	(0.1270)
Women	0.762	0.381	0.130	-0.011
	(0.2127)	(0.1138)	(0.1207)	(0.0832)

Notes: The table investigates whether the reallocation of low-wage workers to better establishments in response to the minimum wage comes at the expense of increased commuting distance. The dependent variable is the change in the driving distance in kilometres between the centre of the municipality of residence and the municipality of work. While we report estimates for men and women combined in panel (a), we examine whether the minimum-wage induced change in commuting distance differs for men or women in panel (b). The table reports difference-in-differences estimates for the 2014 vs 2016 postpolicy period (columns (1) and (2)) and the 2012 vs 2014 "placebo" prepolicy period (columns (3) and (4)), as in columns (4) and (5) in Table 2. All regressions control for individual characteristics at baseline (age, education, sex, nationality, full-time status, location fixed effects, and industry fixed effects) and standard errors (in parentheses) are clustered at the district level.

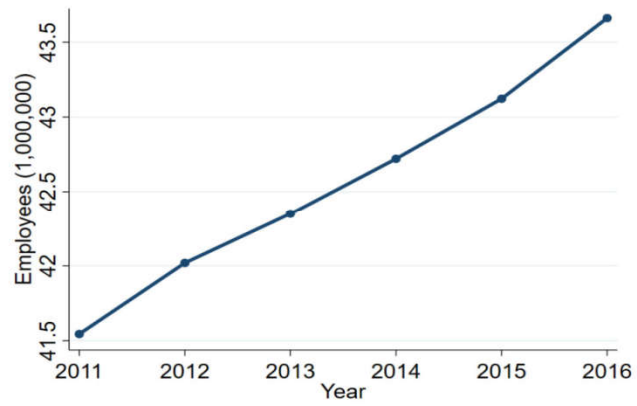
Figure I: Macroeconomic Conditions, 2011 to 2016



Panel (a) Nominal GDP



Panel (b): Unemployment Rate

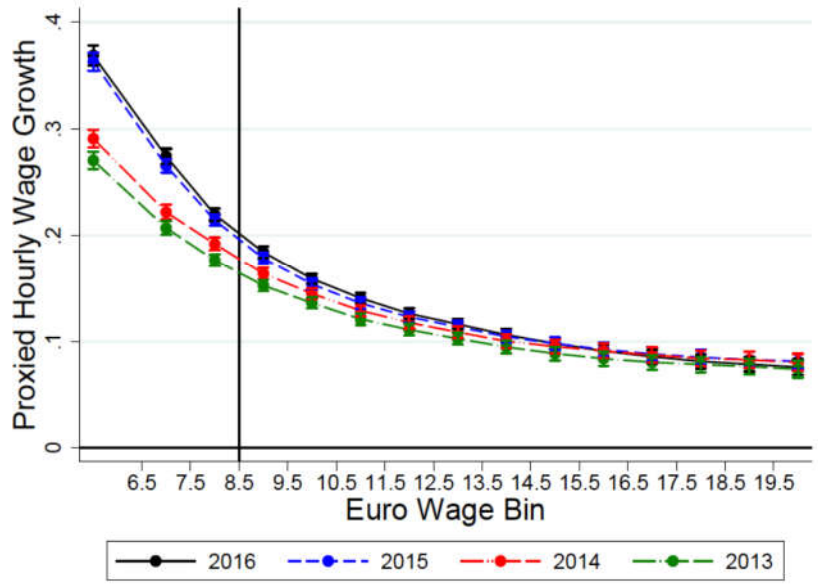


Panel (c): Employment

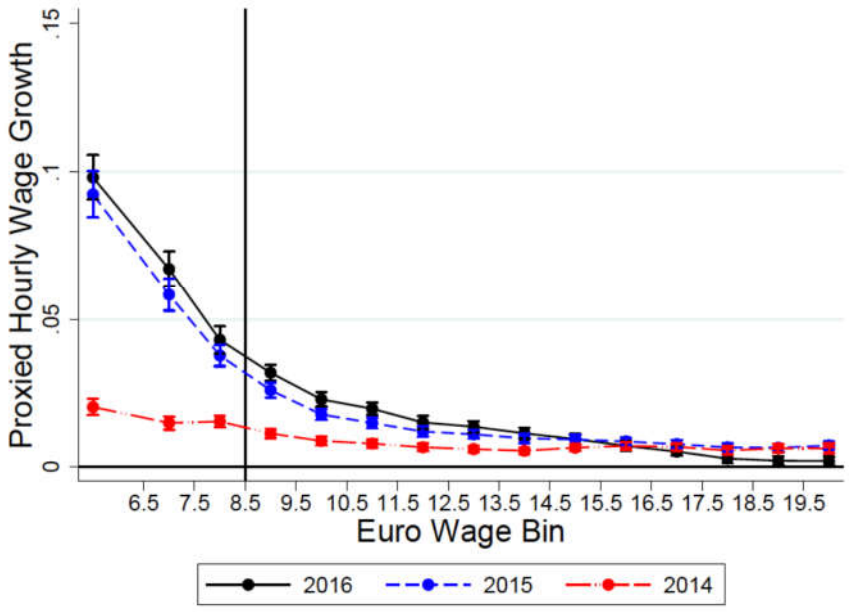
Notes: The figure provides an overview of the macroeconomic conditions at the time of the introduction of the minimum wage in January 2015. Panel (a) shows nominal GDP growth; panel (b) shows the unemployment rate, and panel (c) shows total employment between 2011 and 2016.

Source: : Destatis, 2011-2016.

Figure II: Wage Effects of the Minimum Wage: Individual Approach



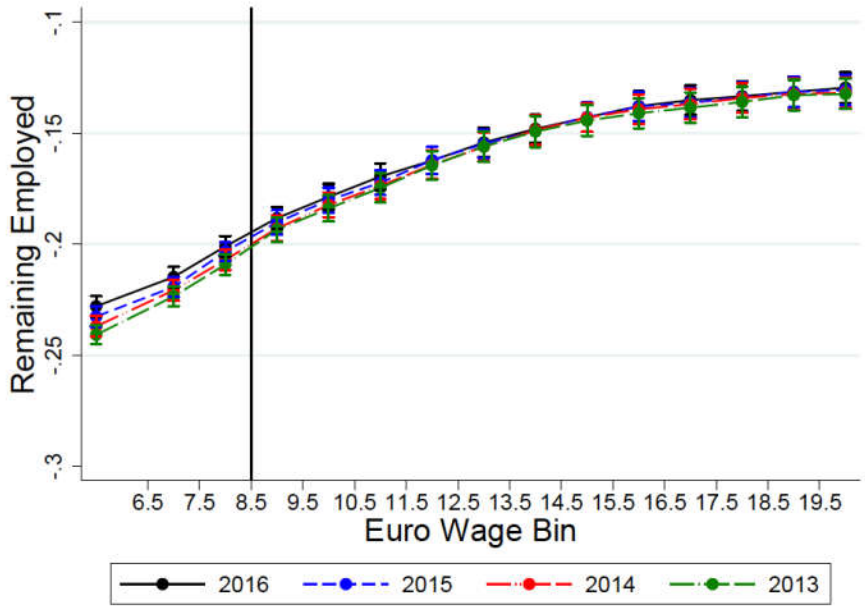
(a) Two-Year Hourly Wage Growth by Initial Wage Bin



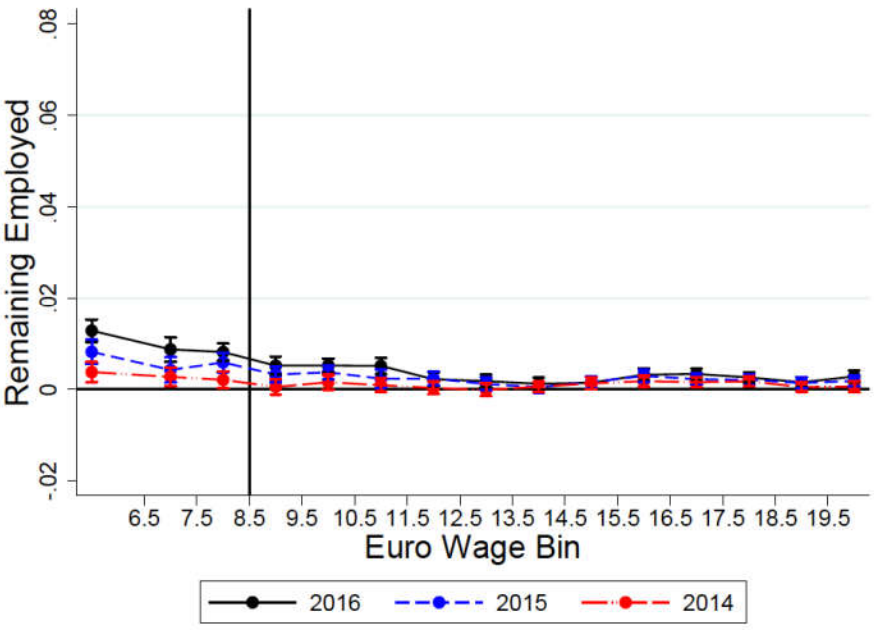
(b) Two-Year Hourly Wage Growth by Initial Wage Bin, relative to 2011 vs 2013

Notes: In panel (a), we plot two-year hourly wage growth of individuals who were employed in t - 2 and t against their initial wage bin, separately for the periods 2011 vs 2013 (green line) to 2014 vs 2016 (black line), while controlling for individual characteristics at baseline (age, education, sex, nationality, full-time status, district fixed effects, and industry fixed effects). Estimates refer to coefficients γwt in regression equation (1) in the text. In panel (b), we plot two-year excess wage growth by initial wage bin in the periods 2012 vs 2014 to 2014 vs 2016 relative to the 2011 vs 2013 prepolicy period, once again controlling for individual characteristics at baseline. Estimates refer to coefficients δwt in regression equation (2), and correspond to the differences between the solid black, dashed blue, and double-dot dashed red lines and the dot dashed green line in panel (a). The black vertical line indicates the minimum wage of 8.50 Euro per hour. We also show the 95% confidence interval based on standard errors that are clustered at the district level.

Figure III: Employment Effects of the Minimum Wage: Individual Approach



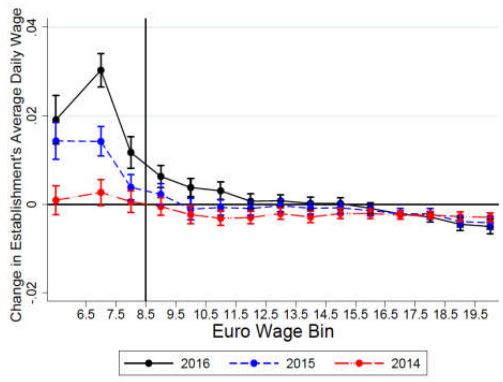
(a) Employment Probablity in Year *t* by Initial Wage Bin



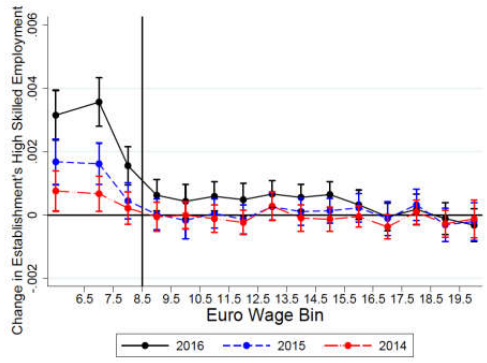
(b) Employment Probablity in Year t by Initial Wage Bin, relative to 2011 vs 2013

Notes: In panel (a), we plot the probability that a worker who was employed in period t - 2 remains employed in period t against her initial wage bin, separately for the periods 2011 vs 2013 (green dot dashed line) to 2014 vs 2016 (solid black line), while controlling for individual characteristics at baseline (age, education, sex, nationality, full-time status, district fixed effects, and industry fixed effects). Estimates refer to coefficients γwt in regression equation (1). In panel (b), we plot the probability that an employed worker is employed two years later against her initial wage bin for the periods 2012 vs 2014 to 2014 vs 2016 relative to the 2011 vs 2013 prepolicy period, once again controlling for individual characteristics at baseline. (Recall that all workers are employed at baseline). Estimates refer to coefficients δwt in regression equation (2), and correspond to the differences between the solid black, dashed blue, and double-dot dashed red lines and the dot dashed green line in panel (a). The black vertical line indicates the minimum wage of 8.50 Euro per hour. We also show the 95% confidence interval based on standard errors that are clustered at the district level.

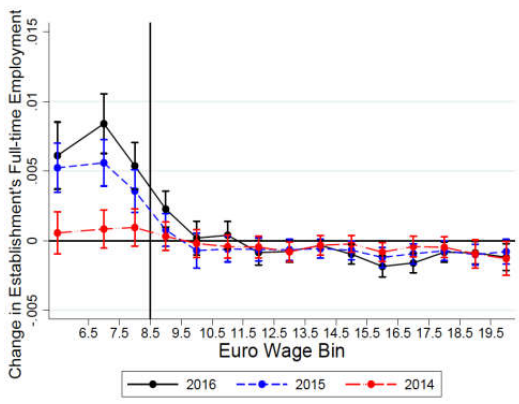
Figure IV: Reallocation Effects of the Minimum Wage I: Individual Approach



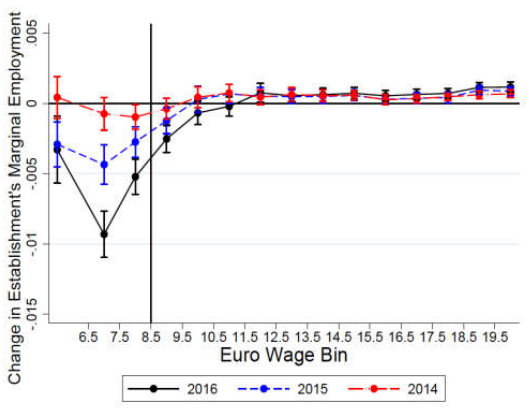
(a) Establishment's Average Daily Wage



(b) Establishment's High-Skilled Employment Share



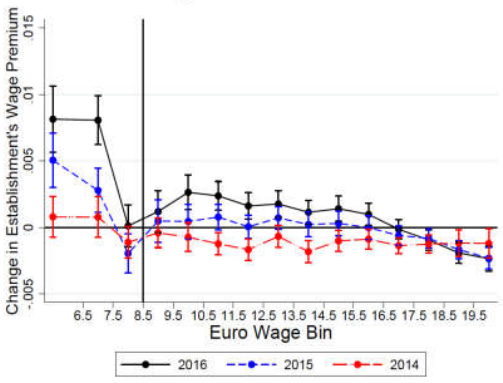
(c) Establishment's Full-Time Employment Share



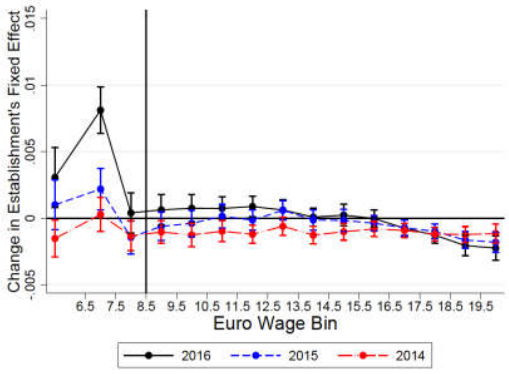
(d) Establishment's Marginal Employment Share

Notes: The figure investigates the effect of the minimum wage on the reallocation of low-wage workers to establishments of higher quality. Establishment quality is measured before the minimum wage came into effect, and only changes for workers who switch establishments. In panel (a), we plot the change in the establishment's (log) average daily wage against the worker's initial wage bin for the periods 2012 vs 2014 to 2014 vs 2016, relative to 2011 vs 2013 prepolicy period, controlling for individual characteristics at baseline (age, education, sex, nationality, full-time status, district fixed effects, and industry fixed effects). In panels (b) to (d), we repeat the analysis, using the change in the establishment's employment share of high-skilled workers (i.e., workers with a university degree; panel (b)) and the change in the establishment's employment share of full-time and marginally employed workers (workers who are employed in marginal part-time jobs; panels (c) and (d)) as dependent variables. Estimates refer to coefficients δwt in regression equation (2). The black vertical line indicates the minimum wage of 8.50 Euro per hour. We also show the 95% confidence interval based on standard errors that are clustered at the district level.

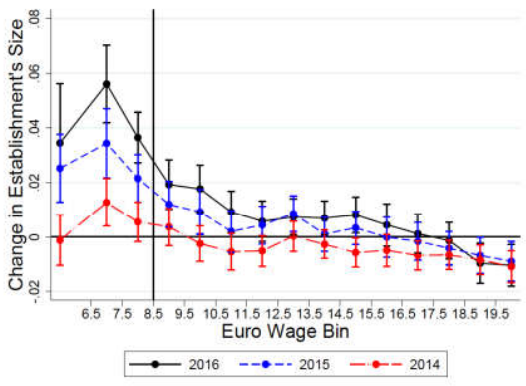
Figure V: Reallocation Effects of the Minimum Wage II: Individual Approach



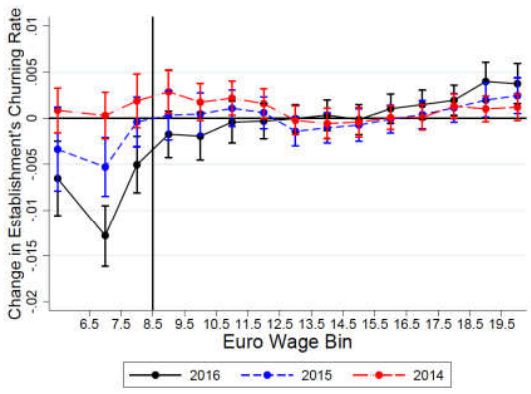
(a) Establishment's Wage Premium



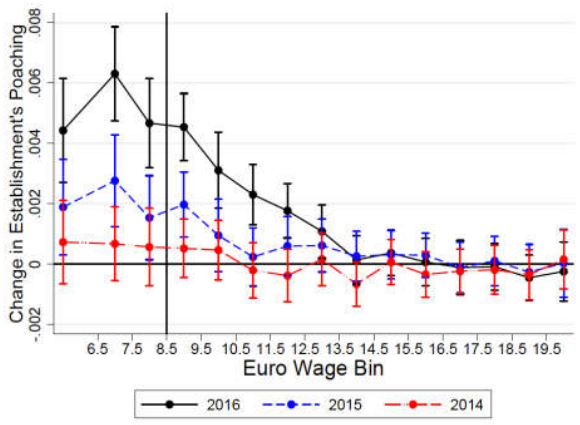
(b) Establishment's AKM Effects



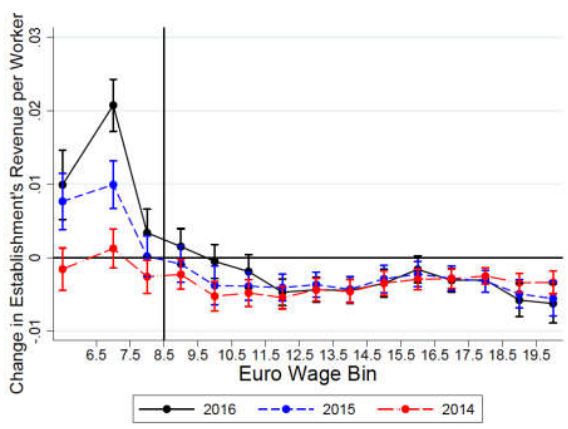
(c) Establishment Size



(d) Establishment's Churning Rate



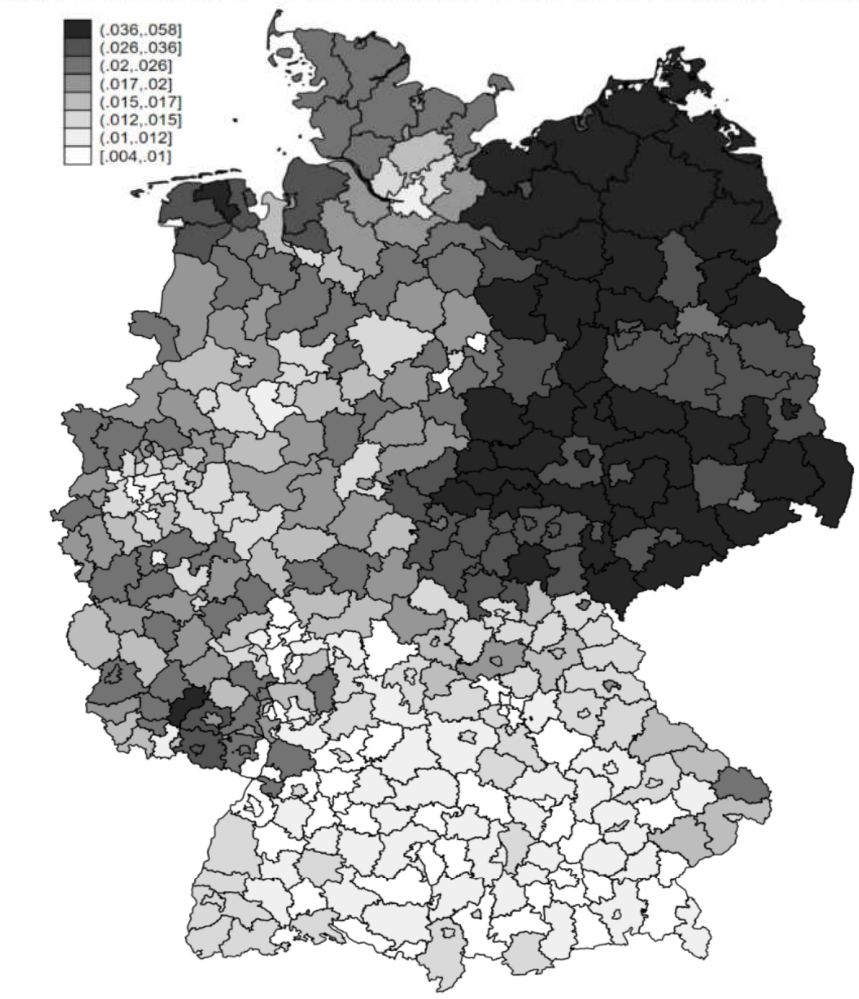
e) Establishment's Poaching Index



f) Establishment's Revenue per Worker

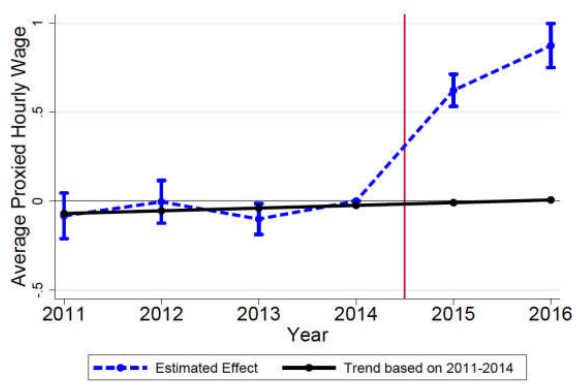
Notes: In the figure, we plot the change in establishment quality between periods t - 2 and t for workers who are employed in both periods against their initial wage bin for the periods 2012 vs 2014 to 2014 vs 2016, relative to the 2011 vs 2013 prepolicy period. Regressions control for individual characteristics at baseline (age, education, sex, nationality, employment status, district fixed effects, and industry fixed effects). Estimates refer to coefficients δwt in regression equation (2). Establishment quality is measured before the minimum wage came into effect, and only changes for workers who switch establishments. In panel (a), establishment quality is measured as the establishment's wage premium, calculated as the average wage residual in the establishment obtained from an individual (log) wage regression that controls for workers' demographic characteristics (age, education, sex, nationality) and full-time status (full-time, part-time, marginally employed). In panel (b), establishment quality is measured as the establishment's fixed effect, estimated in an AKM-style (log) wage regression that controls for worker and establishment fixed effects over a seven-year prebaseline window. In panel (c), we use (log) establishment size as a measure for establishment quality. In panel (d), the dependent variable is the change in the establishment's churning rate, calculated as the sum of workers who leave and join the establishment, divided by the number of employees at baseline. Panel (e) shows the change in the establishment's poaching index, computed as the share of new hires that come from employment rather than unemployment, while in panel (f) we report the change in (log) revenues per worker, where we predict revenue per worker based on establishment's state, industry, size, and the average earning of full-time workers (see Online Appendix B.4). The black vertical line indicates the minimum wage of 8.50 Euro per hour. We also show the 95% confidence interval based on standard errors that are clustered at the district level.

Figure VI: Exposure to the Minimum Wage across German Districts

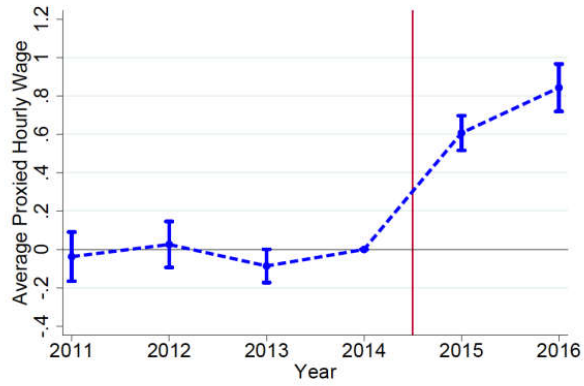


Notes: The figure shows the exposure to the minimum wage across 401 German (Kreise). District-level exposure to the minimum wage is measured using the gap measure, as in equation (3). © GeoBasis-DE / BKG 2017

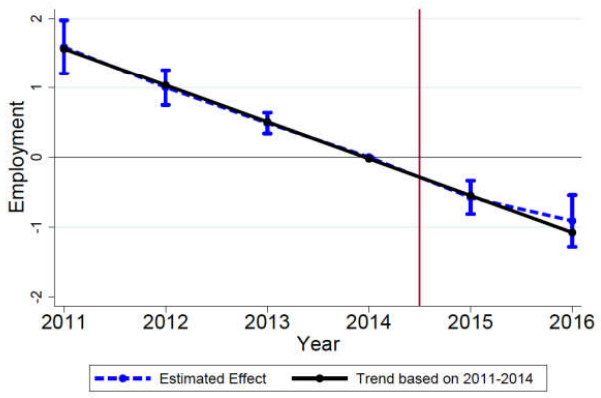
Figure VII: Wage and Employment Effects of the Minimum Wage: Regional Approach



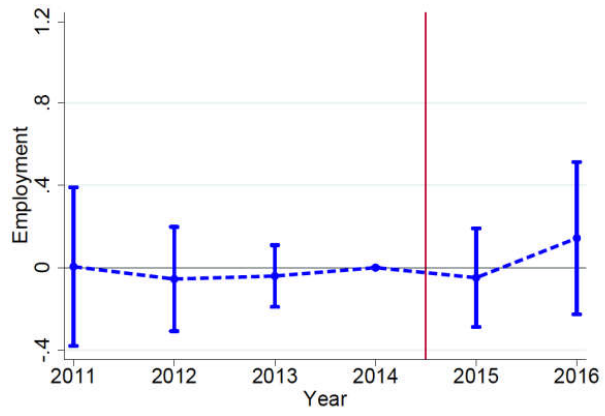
(a) Proxied Hourly Wages



(b) Detrended Proxied Hourly Wages



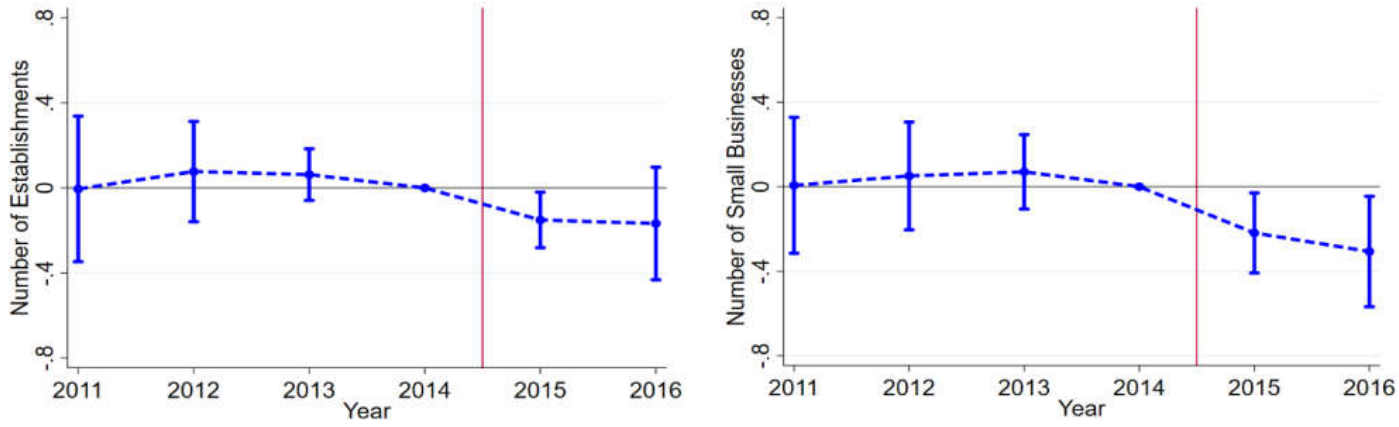
(c) Employment



(d) Detrended Employment

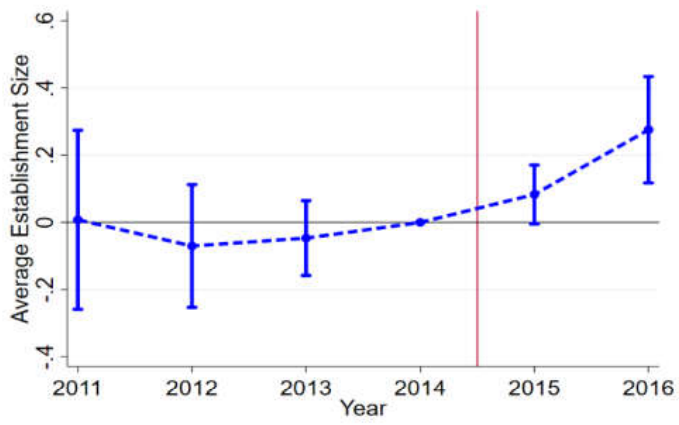
Notes: Panels (a) and (c) trace out how (log) local average hourly wages (average proxied hourly wage in the the district, panel a) and (log) local employment (the number of employed workers in the district, panel c) evolve in regions differentially exposed to the minimum wage, relative to the prepolicy year 2014 (the dashed blue line). Plotted effects refer to coefficients $\gamma\tau$ in regression equation (4). The figures also plot a linear time trend estimated for the 2011-2014 prepolicy years and then updated for later years (the solid black line). Panels (b) and (d) display the deviations between the coefficient estimates and the linear time trend.

Figure VIII: Reallocation Effects of the Minimum Wage: Regional Approach

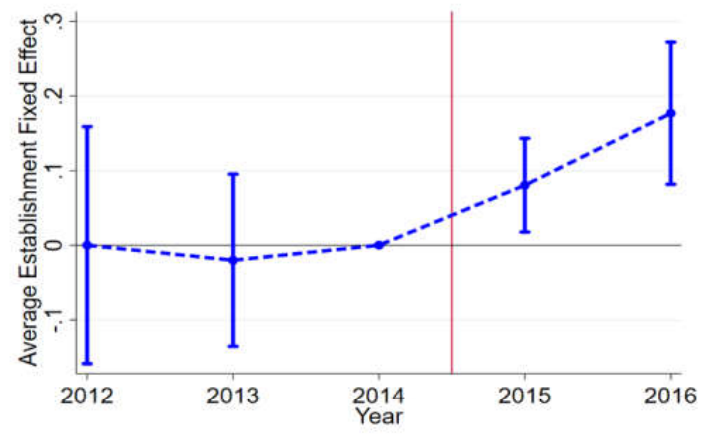


(a) Number of Establishments

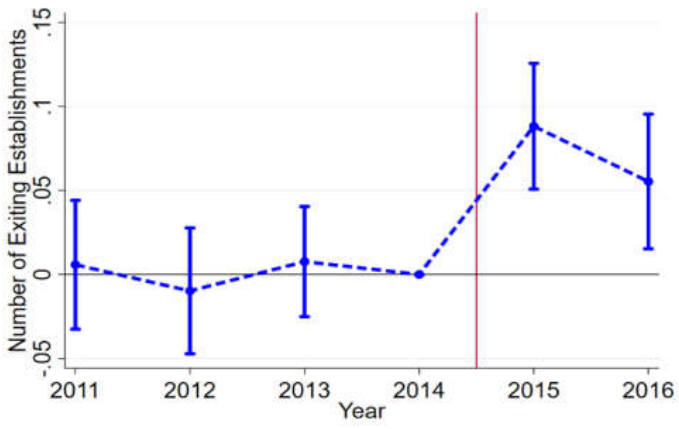
(b) Number of Small Businesses (1-2 Employees)



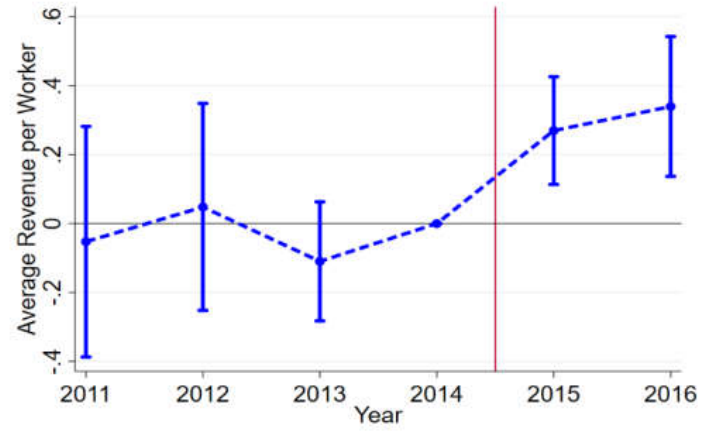
(c) Average Establishment Size



(d) Average AKM Establishment Fixed Effects



(e) Exit of Small Businesses (1-2 Employees)



(f) Revenue per Worker

Notes: This figure depicts the detrended relationship between the district-level exposure to the minimum wage, measured by the gap measure as in equation (3) in the text, and the (log) number of establishments in the district (panel (a)); the (log) number of small businesses with 1 or 2 employees in the district (panel (b)); (log) mean establishment size in the district (panel (c)); the average AKM establishment fixed effect in the district (estimated using AKM style wage regressions that control for worker and establishment effects and are estimated using seven-year prebaseline window, panel (d)); the (log) of the number of small businesses that exited the market (panel (e)); and the (log) mean revenue per worker, where we predict revenue per worker based on the establishment's state, industry, size and the average earning of full-time workers (panel (f)). We plot the deviations between coefficients $\gamma\tau$ in regression equation (4) in the text and the linear time trend estimated for the 2011-2014 prepolicy period and updated for later years (as in panels (b) and (d) of Figure 7).