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Where the minimum wage bites workers. Factor substitutability and innovativeness at the workplace

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Abstract

The introduction of a federal minimum wage in Germany in 2015 created a profound wage shock on the labor market. We exploit the variation of this treatment across regions and different employees to estimate its impact on labor earnings and employment. The main contribution of this paper is to break down the effect heterogeneity for different degrees of labor substitutability. We use administrative data on job content as well as survey information on the workplace to approximate substitutability. Although the federal minimum had a substantial impact on affected wages, a significant impact on employment cannot be identified for the average employee with various identification strategies. Yet, when the treatment is interacted with the substitutability of labor, we find statistically significant negative effects on the probability of remaining employed and a significantly higher unemployment risk for those employees who are more easily replaced by capital as production factor. We find this pattern to be consistent for alternative measures of substitutability as well as alternative specifications of the model. The fact that employers seem to cut primarily replaceable jobs provides valuable insights for targeted policies supporting those employees with the highest labor market risks following the introduction (or increase) of a minimum wage.

Keywords: minimum wage; effect heterogeneity; factor substitution

JEL classification: H22; J38; H55; J20

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1 Introduction

Indeterminate effects or contradictory findings at the employment margin seem to be a recurring subject of controversy in the empirical minimum wage literature (Neumark and Wascher, 2008). At the heart of the classical minimum wage debate from the beginning of the 1990s (Card and Krueger, 1995) as well as the latest wave of minimum wage research (Dube et al., 2010; Neumark et al., 2014) lies the question, whether or not (and for whom) the minimum wage induces negative labor market effects. There are substantial methodological challenges in terms of identification, but also in terms of effect heterogeneity: findings are more coherent for specific groups on the labor market who have a particularly low productivity (younger employees, low-qualified, or marginally employed; see Neumark and Wascher 2008). On the other hand, firms might be able to adjust through different margins, some of which can be measured more easily than others, e.g. working conditions, non-wage pay components or product prices and profits.

Various theoretical arguments (related to employees, firms, markets) are able to reconcile zero (insignificant) average employment effects with underlying labor market dynamics or heterogeneity along several dimensions. There might be monopsonistic competition in certain labor market segments (Manning, 2011). There might be labor market dynamics among employees (Flinn, 2006) or firms hidden behind constant employment and unemployment levels. Depending on the firm structure and the substitutability of labor, there might be other adjustment mechanisms, e.g. entry and exit of firms instead of replacing single employees (Aaronson et al., 2015), adjustment of product prices (Aaronson and French, 2007) or profits (Draca et al., 2013).

In this paper we focus on a particular mechanism at the firm level which might explain why certain firms (do not) react at the labor margin, and (do not) have to adjust at other margins. We look at heterogeneity in employment effects along the dimension of substitutability of the production factor labor. In an empirical exercise employing conventional identification strategies we interact the treatment with substitutability and show that labor market effects are increasing in magnitude and/or statistical significance for those jobs which are easier to substitute. We thus contribute to the empirical minimum wage literature by looking at a rather obvious

dimension of effect heterogeneity which has been neglected so far.

We operationalize substitutability from different angles. First, we use (external) administrative data on the content of different jobs, i.e. what different tasks these jobs imply. On the basis of the information on these tasks, we are able to measure the degree of routinization of different jobs. The underlying assumption is that more routinized tasks are more easily substitutable by capital than others. We then map routinization into (a combination of) branches/sector and occupation variables and impute the degree of substitutability of labor into survey data (which does not contain information on job contents). Second, we use survey information in the SOEP on the innovation at the workplace. The underlying assumption here is that jobs with a large degree of innovativeness are harder to substitute than those with a low degree.

We find significant average wage effects with alternative estimation strategies: the introduction of the minimum wage in Germany has indeed increased wages at the bottom of the distribution. We then show that the same identification approaches fail to produce significant average effects for various labor market transitions between unemployment, regular and marginal employment. However, when the treatment is interacted with the substitutability of labor, we find statistically significant negative effects on the probability of remaining employed and a significantly higher unemployment risk for those employees who are more easily replaced by capital as a production factor. This pattern proves to be consistent for alternative measures of substitutability as well as alternative specifications of the model.

The remainder of the paper is structured as follows. After a brief discussion of related literature (section 2) we provide some background on the underlying theoretical mechanisms we have in mind and on the minimum wage regulations in Germany (section 3). We then describe the methodology (section 4) and the data (section 5). In section 6 we discuss the empirical results. Section 7 concludes.

2 Related literature

The majority of literature on minimum wages stems from the US and the UK. Especially the US faces a long history of minimum wages that vary both by time and by state. In Germany, where statutory minimum wages were introduced only recently, the majority of the existing research is devoted to sector-specific minimum wages or are based on simulation studies. Currently, as data on the post-reform period begin to emerge, studies on both distributional and employment effects on the German minimum wage reform are scarce.

2.1 Distributional effect

Minimum wages initially intend to increase wages at the bottom of the wage distribution. International literature contains plenty of empirical evidence that minimum wages achieve this intended re-distributional effect and, therefore, can be used as an effective policy tool to lower wage inequality.

Dinardo et al. (1996), Lee (1999), Teulings (2003) and Autor et al. (2016) investigate the role of the decreasing real value of minimum wages in the increasing wage inequality in the US in the 1980s. Based on different empirical approaches, all authors come to a conclusion that minimum wages in one of the main drivers of the observed inequality increase.

Neumark et al. (2004) study changes in minimum wages from 1979 to 1997 in the US and find that they have a positive re-distributional effects, especially at the bottom of the wage distribution. At the same time, reductions in working hours and disemployment counter-balance this positive effect for low earners.

Literature for the UK also shows that a decrease in the real value of minimum wages is one of the main contributors to the increasing inequality in 1980s and early 1990s (Machin, 1997; Dolton et al., 2012; Manning, 2013).

In Germany, the simulation studies prior to the introduction of the statutory minimum wage predicted a positive re-distributional effect that would be counter-balanced by taxes and non-labor income sources (Müller, 2009; Müller and Steiner, 2013, 2010). The first descriptive studies for the post-reform period (Amlinger et al., 2016; Mindestlohnkommission, 2016) find over-proportional wage growth at the

lower end of the wage distribution after the introduction of minimum wages. The first causal study by Caliendo et al. (2017b) finds that the minimum wage reform caused additional growth at the low-end of the wage distribution that can be attributed to the reduction in hours worked rather than the growth of monthly incomes. Moreover, in the first post-reform year the authors observe evidence of non-compliance among the eligible that cannot be explained by measurement errors only.

2.2 Employment effect

Following the prediction of the standard neoclassical model, an introduction of binding minimum wage would lead to a displacement of those workers, whose marginal productivity is lower than this minimum wage. In their book, Card and Krueger (1995) discuss the assumptions of this model and present evidence from multiple studies for the US that find that minimum wages does not necessarily lead to more unemployment. Most prominent of the discussed studies are Card (1992) and Card and Krueger (1994) that use a difference-in-differences approach to show that higher minimum wages at the state level do not cause lower employment.

Neumark and Wascher (2008) summarize evidence that, on the contrary, shows that minimum wages are inducing unemployment, especially on the group of low-skilled and young workers. In their more recent paper, Neumark et al. (2014) discuss methodological challenges when estimating disemployment effects and present evidence that employment elasticity among teenagers is about -0.15, which confirms the existence of disemployment effects.

Dube et al. (2010) generalizes the approach of Card and Krueger (1994) and considers all local differences in minimum wage policies. The study shows that neglecting local economic conditions produces spurious negative effects that are unrelated to minimum wage policies. Thus, accounting for these effects leads to the conclusion that minimum wages do not cause negative employment effects.

In the UK, the most influential studies by Machin and Manning (1994) finds no sizable disemployment effect of minimum wages, on average. However, when studying the residential care homes industry that was particularly strongly affected by the reform (Machin et al., 2003), the authors find negative employment effect that they classify not be sizable relative to the magnitude of the wage intervention. Moreover,

in his book Manning (2003a) describes labor market mechanisms that explain why minimum wages on a monopsony should not necessarily lead to disemployment and are absorbed by other channels, such as prices on the product market. Dolton et al. (2015) also claim that local economic conditions and spatial dependence play a decisive role for the estimation of employment effects. Taking account of these characteristics, the authors find that minimum wages introduction and uprating do not lead to adverse employment effects.

The debate in the literature on the existence of disemployment effects due to minimum wages is ongoing. The current state of the debate is that if minimum wages cause disemployment, then only in small magnitude and among the “young and unskilled” (citation). However, meta studies claim that papers estimating negative employment effects have a higher probability to be published (Doucouliagos and Stanley, 2009). When taking this publication bias into account, the summary of the debate would conclude that minimum wages do not cause negative employment effects.

In Germany, the literature on sector-specific minimum wage also did not come to a uniform conclusion about the adverse effects on employment (König and Möller, 2009; Möller, 2012; Frings, 2013; vom Berge et al., 2013). The first descriptive studies for the statutory minimum wage show that after the reform, the ongoing increase in employment did not break up (Mindestlohnkommission, 2016). The first causal studies (Caliendo et al., 2017a) find no disemployment effect in the first post-reform year, but the reform impeded job creation (Bossler and Gerner, 2016).

3 Theoretical and institutional background

3.1 Theoretical mechanisms

This sub-section sketches the theoretical mechanisms we have in mind that potentially drive our findings. The goal for the next version of the paper is to illustrate the underlying causal mechanisms within a small formalized theoretical framework which motivates the subsequent empirical exercise of this paper. In this version we merely present a the general theoretical intuition and the very basic line of argument.

The introduction of the minimum wage leads c.p. to a deterministic increase in an employer's wage costs as long as at least one employee is affected by the minimum wage. In a neoclassical labor market, this leads to unemployment. Allowing for labor market frictions and/or heterogeneity in several dimensions, outcomes from the introduction of a minimum wage differ from the neoclassical textbook model or are at least heterogeneous across different segments of the labor market. Who effectively bears this increase in costs depends on various factors. Behavioral adjustments may thus occur at different margins. The profit margin is directly related to the market structure. This is one of the main strands in the (theoretical) minimum wage literature explaining zero or heterogeneous employment effects (Manning, 2003b,c, 2011). Given that firms have market power, wages are below the competitive equilibrium and firms are able to extract profits. Under those conditions a minimum wage does not reduce employment as long as it is set between the equilibria under monopsony and a competitive labor market. Under those circumstances significant effect on firms' profits should be identifiable (Draca et al., 2013).

Increasing product prices is another channel of adjustment. The increase in wage costs might be (partially) passed on to consumers through higher product prices. To what degree this is possible, depends on the demand elasticity for different products. Employment effects are thus decreasing in the elasticity of demand for goods. There are few papers on this margin, see e.g. Aaronson and French (2007). Whether, where and how large employment effects are, thus depends on these different factors: how is the market structured where firms operate; whether firms are able to shift costs to consumers. The interplay of those different factors (combined with the ubiquitous identification problem) explains the mixed empirical evidence on employment found

in the newer minimum wage literature (Neumark and Wascher, 2008; Dube, 2013).

The mechanism behind a heterogeneous impact of a minimum wage on the labor market we focus on in this paper is related to the production technology of firms. We argue that whether (and by how much) firms will adjust their employment levels, depends on the substitutability of (certain segments) of their labor force by other factors of production. The probability that firms adapt at the employment margin increases with their leverage to substitute labor by capital. Although substitutability might be correlated with productivity, these dimensions are not congruent. Substitutability depends on the production technology, the characteristics of tasks related to a job, e.g. the degree of routinization. Another aspect is the longevity of production techniques and procedures (related to the lifecycle of products), i.e. the tempo of innovations in the production process. We try to approximate both dimensions of substitutability with empirical measures (sub-section 4.3 below).

3.2 Institutions: minimum wages in Germany

Statutory minimum gross wages of €8.50 per hour were introduced in Germany on the 1st of January 2015. The minimum wage intervenes between the 10th and the 14th percentile of the hourly wage distribution (Amlinger et al., 2016; Brenke, 2014; Falck et al., 2013; Kalina and Weinkopf, 2014; Lesch et al., 2014) which is the average intervention depth compared to other OECD countries (OECD, 2015).

The minimum wage in Germany is binding with only several exemptions, such as workers aged under 18 without formal training, trainees and some types of interns, former long-term unemployed¹ in the first 6 months of a new employment. Moreover, the minimum wage is becoming binding with a 2-year delay in those sectors that already have a tariff agreement regulating section-specific minimum wages. Amlinger et al. (2016) documents that most sector-specific minimum wages grew after the introduction of the statutory minimum wages and leaving only few sectors with minimum wages below €8.50 in 2015.

¹vom Berge et al. (2016) shows that the exemption of the former long-term unemployed is hardly used in practice.

4 Methodology

In this section we describe various outcome variables for the different steps of the empirical analysis (sub-section 4.1). We then discuss alternative identification strategies for the causal effect of the minimum wage on wages as well as various labor market transitions (sub-section 4.2). We finally motivate, how we think about capital-labor substitutability (sub-section 4.3).

4.1 Outcome variables

We analyze several outcome variables to cumulate empirical evidence in support of the general argument we want to make in this paper.

(1) (Hourly) wages (labor earnings). We want to analyze the distributional impact the introduction of the minimum wage has on gross labor earnings (and thus labor costs for employers). A significant wage effect is the necessary condition for subsequent effects of the minimum wage on employment. We therefore estimate hourly wage equations with different identification approaches. The dependent variable $\log(w_{i,t,r})$ is the log of the contractual hourly gross wage of individual i at time $t \in (2014, 2015)$ resident in region r .

(2) Labor market transitions: from/into employment and unemployment. We then look at the minimum wage effect on various labor market statuses and the transitions between them. We focus on three relevant labor market statuses: regular employment (RE_t), marginal employment (ME_t), and unemployment (UE_t). With regular employment we mean full-time or part-time employees eligible to the statutory minimum wage. Marginal employment means jobs with monthly payment below €450 (so-called mini-jobs). Unemployment means being officially registered at an unemployment office. We will analyze the overall effect of the minimum wage on labor market transitions and then break down the effect heterogeneity by degree of capital-labor substitutability (sub-section 4.3).

(3) Non-wage job characteristics. As supporting piece of evidence we plan to also show the effect the minimum wage has on various job features beyond the wage

rate, e.g. working conditions, extracurricular earnings components, unpaid working time, i.e. overtime hours (Stewart and Swaffield, 2008). The impact is also broken down by degree of substitutability. We want to show that the effect on non-wage characteristics of the job is higher for a lower degree of capital-labor substitutability.

4.2 Identification strategies

Getting clean identification is the crucial issue in the empirical minimum wage literature. The introduction of a nationwide minimum wage (without major exemptions) almost by definition eliminates natural control groups, i.e. sub-populations for whom the minimum wage does not apply. There is neither regional variation (as in the U.S., e.g. Dube et al., 2010) nor sectoral variation (as was exploited in the evaluation of sectoral minima in Germany, e.g. Möller, 2012) in the level of the minimum wage. We therefore have to resort to alternative identification strategies.

4.2.1 Regional (sectoral) variation in the bite of the minimum wage

This identification approach was developed by Card (1992) and amended for the German context by Caliendo et al. (2017b). Variation in the real treatment intensity is exploited which is generated by differences in regional (alternatively sectoral) wage distributions. For each of 96 German planning regions (‘Raumordnungsregione’) in the pre-reform year 2014, we compute a region-specific wage distribution and the respective share of employees earning less than €8.50 using the SOEP data. This treatment intensity exhibits substantial variation from less than one percent in Donau-Iller to almost 40 percent in Western Pomerania. This treatment measure is robust across data sets and years. Moreover, it exhibits high correlation with alternative measures of treatment intensity, such as Kaitz index (Caliendo et al., 2017a).

Based on this regional variation in the bite of the minimum wage, one can estimate the effect of the minimum wage reform for the different outcome variables. This is essentially a simple a difference in differences (DiD) framework which looks for the effect on the hourly wage distribution as follows:

$$\log(w_{i,t,r}) = \alpha + \beta \times D^{2015} + \gamma \text{Bite}_r^{2013} + \delta (D^{2015} \times \text{Bite}_r^{2013}) + \epsilon_{i,r,t}, \quad t \in (2014, 2015). \quad (1)$$

The dependent variable is the log of the contractual hourly gross wage of individual i at time $t \in (2014, 2015)$ resident in region r . The independent variables are period dummy variable D^{2015} distinguishing the pre- and post-reform year, with $D^{2015} = 1$ if $t = 2015$ and zero else. The associated coefficient β captures the average change in hourly wages between 2014 and 2015. $Bite_r^{2013}$ denotes the treatment intensity as captured by the region-specific fractions of eligible employees with hourly wages below €8.50 and normalized by the average regional bite. Because of the possibility of anticipation effects and in order to avoid endogeneity, we are using the lagged bite for 2013. The associated coefficient γ captures differential changes in wages dependent on the regional treatment intensity. $(D^{2015} \times Bite_r^{2013})$ is the interaction between the period dummy and the treatment intensity. The associated coefficient δ captures the treatment effect of the reform. $\epsilon_{i,r,t}$ is the error term.

Based on specification 1, we estimate a pooled OLS and a fixed-effects regression with a set of socio-demographic characteristics, such as gender, marital status, German citizenship, highest educational level, and presence of children under 16 in the household. As a result, this estimation yields the effect of the minimum wage reform on average wages. However, as the reform is intended to induce growth at the bottom of the wage distribution, we re-estimate the model specified in 1 within quintiles of the wage distribution. Our expectation is that the estimated wage growth in lower quintiles is substantially higher than on average or at the top of the wage distribution.

We use the identical framework to assess the effect of the minimum wage reform on transitions between various labor market statuses. More concretely we estimate changes in probabilities of transitions between labor market statuses induced by the minimum wage. For each of the aforementioned three statuses we estimate the probability to remain in the status or switch to one of the two other statuses. Again, the interaction of the lagged bite of the reform with period dummies as key explanatory variable. To obtain the causal effect of the minimum wage reform on transition probabilities, we estimate a fixed-effects model of the form:

$$\Delta ES_{ES_t, ES_{t-1}} = \alpha + \beta_t D^{2015} + \gamma Bite_r^{2013} + \delta D^{2015} Bite_r^{2013} + \epsilon_{t,i}, \quad t \in \{2014, 2015\}, \quad (2)$$

where $\Delta ES_{ES_t, ES_{t-1}}$ denotes a dummy variable indicating a particular status com-

bination in periods t and $t - 1$, with $ES_t \in \{RE_t, ME_t, UE_t\}$. Hereby, RE_t stands for regular employment, ME_t marginal employment, and UE_t unemployment. This specification 2 is estimated as a linear probability and fixed effects model. the latter helps to control for unobserved time-constant heterogeneity. In order to compare the estimation results to the pre-reform period, we re-estimate the regression equation specified in 2 with all variables lagged by one year.

4.2.2 Affected vs. non-affected employees

In the next version of the paper we will complement the identification based on the regional variation by an alternative identification strategy based on affected an non-affected individuals. We want to show that our result patterns do not rely on one particular identification strategy (all of which will always be flawed to some degree in empirical applications).

- This approach is based on a similar DiD framework as in the last sub-section (now the 1st difference: affected/not affected by minimum wage, again the 2nd difference: before/after introduction of the minimum wage).
- The federal minimum wage in Germany is universal. There are only very few exemptions. We might use that it is non-binding for younger individuals. Yet, we probably will not have enough observations when we use younger employees as control group as legal exemptions from the law do not seem to be actively used by employers. However, we might be able to use sample stratification by eligible/non-eligible sectors.
- A more promising alternative would be to use individuals as control group who earned hourly wages above the level of the minimum wage before it was introduced (König and Möller, 2009). The problem here is that those individuals will also be affected by the minimum wage when the wage distribution shifts, i.e. there are spillover effects to higher quantiles.
- An alternative to standard DiD might be changes-in-changes (Athey and Imbens, 2006).

4.3 Effect heterogeneity

The main point of this paper is to show that the effects on labor market transitions – in particular in and out of (un)employment – are heterogeneous in the firms’ ability to substitute labor by capital. We will thus allow the effects to be heterogeneous, i.e. include interaction terms, in the specifications for the different identification approaches. As indicated above, we expect average employment effects to be zero or insignificant, but to be increasing and statistically significant for a high degree of substitutability.

We do not observe firm characteristics in the SOEP and thus not directly whether given jobs of employees are more or less substitutable by other factors of production. We therefore start from a theoretical notion about the drivers of substitutability. The ‘model’ presumes that the probability for an individual of having his/her job substituted away is a function of certain job characteristics M_t^{job} as well as conditions at the workplace M_t^{WP} :

$$Prob(sub_{ijt}) = f(M_t^{job}, M_t^{WP}) \quad (3)$$

M_t^{job} includes – among other things – the degree of routinization, i.e. $M_t^{job} = \{RTN, nNRC\}$. Likewise M_t^{WP} includes innovativeness at the workplace, $M_t^{WP} = \{nQUALIF, nPROD\}$. The substitution probability is increasing in RTN, nNRC and decreasing (?) in nQUALIF, nPROD:

$$\frac{\partial Prob(sub_{ijt})}{\partial RTN, nNRC} > 0 \quad (4)$$

$$\frac{\partial Prob(sub_{ijt})}{\partial nQUALIF, nPROD} < 0 \quad (5)$$

Based on information of RTN, nNRC and nQUALIF, nPROD we approximate the degree of substitutability. We include different indicators for substitutability into the identification approaches and analyze effect heterogeneity. Introduce one measure for substitutability with capital $SM_i \in \{nQUALIF, nPROD, RTN, nNRC\}$ (as defined in sub-section 5.5 below) in the regression equation 2 at a time yields the following specification:

$$\begin{aligned} \Delta ES_{ES_t, ES_{t-1}} &= \alpha + \beta_t D^{2015} + \gamma Bite_r^{2013} + \delta D^{2015} Bite_r^{2013} \\ &+ \mu SM^{2014} + \theta SM^{2014} D^{2015} Bite_r^{2013} + \epsilon_{t,i}, \quad t \in \{2014, 2015\}, \end{aligned} \quad (6)$$

with $\Delta ES_{ES_t, ES_{t-1}}$ denoting a dummy variable indication a particular status combination in periods t and $t - 1$, with $ES_t \in \{RE_t, ME_t, UE_t\}$. Our parameter of interest is θ , as it captures the effect on the transition probability between labor market statuses for the workers who are highly exposed to labor-capital substitutability.

5 Data

For the empirical analyses, we mainly use the German Socio-Economic Panel (SOEP), a longitudinal panel survey conducted annually since 1984 (Wagner et al., 2007). Unlike administrative data sources, SOEP contains detailed information not only on monthly earnings, but also on hours worked, which allows to calculate hourly wages and to study the reform’s effect both at the extensive and intensive margins. In 2015, SOEP additionally contains a set of questions on innovations at the workplace that allow to infer about the individual substitutability with capital. Last but not least, based on the occupational classification, SOEP allows imputation of occupation-level characteristics from other data sources. For our analyses we use waves 2013-2015 from SOEP v32 (SOEP, 2016).

5.1 Working sample

For our analyses we use only those employees who are eligible to the minimum wage. Therefore, our main working sample (Sample 1) excludes employees from exempted groups as well as respondents with item non-response on relevant variables (such as wages or individual characteristics). For the analysis of transitions between employment and unemployment we employ Sample 2 that extends Sample 1 by the group of unemployed.

We proceed with the restriction of the sample in several steps that are described in table 1. We depart with the total amount of 83,303 completed interviews in SOEP for the survey samples that are available for the years 2013-2015. In the next step, we exclude the following groups:

1. *Non-eligible:* some groups of workers, such as interns, trainees, former long-term unemployed in the first six months of employment and workers aged below 18 are exempted from the reform. Appendix 7 explains the construction of the eligibility status in details. For workers from sectors with existing minimum wage tariffs are allowed to pay below the statutory minimum wage for two years. We use information on the sector of employment to exclude these workers. Discarding the non-eligible leaves us with 36,901 observations for the years 2013-2015.

2. *Wage outliers:* We exclude respondents with hourly wages belonging to the top percentile of the wage distribution in each survey year. Moreover, we exclude respondents with hourly wages below €3.50.
3. *Small regions:* We exclude regions (Raumordnungsregionen) that contain less than 25 observations in at least one of the survey years.
4. *Non-consecutive wage information:* Since the identification of the reform's effect relies on the computation of wage growth, we exclude respondents for which we do not have wage information in two consecutive years.
5. *Missing individual information:* such individual characteristics as gender, highest educational level, presence of children under 16 in the household, marital status and German citizenship are used as controls in regression analysis. Respondents for whom this information is unavailable are excluded.
6. *Missing information on substitutability:* Last but not least, we exclude respondents for whom we cannot construct the substitutability measures due to unavailable information on their occupation. This leaves us with *Sample 1* that we mainly use for the analysis of the re-distributive effect of the reform.
7. *Unemployed:* For the estimation of transition matrices, we extend *Sample 1* by the unemployed.

5.2 Calculation of minimum wages

The SOEP does not include information on gross hourly wages directly. Instead, it contains information on gross monthly earnings and weekly working hours, distinguishing between hours worked according to the contract and hours worked actually. In the following, we compute gross hourly wages by dividing gross monthly earnings by weekly contractual hours multiplied by 4.33. Caliendo et al. (2017b) provide a thorough discussion of robustness of this measure and the sources of measurement errors.

Tab. 1: Observations per year under imposition of sample restrictions

	2013	2014	2015	Total
SOEP v32	30,778	27,237	25,288	83,303
- non-eligible	13,406	12,206	11,289	36,901
- wage outliers	11,139	10,344	9,348	30,831
- small regions	11,062	10,271	9,293	30,626
- non-consecutive biannual wage info	6,056	6,208	6,341	18,605
- missing individual info	5,975	6,109	6,237	18,321
- missing info substitutability (Sample 1)	5,912	6,082	6,216	18,210
+ unemployed (Sample 2)	9,038	10,169	9,001	28,208

Source: SOEP v32, own calculations.

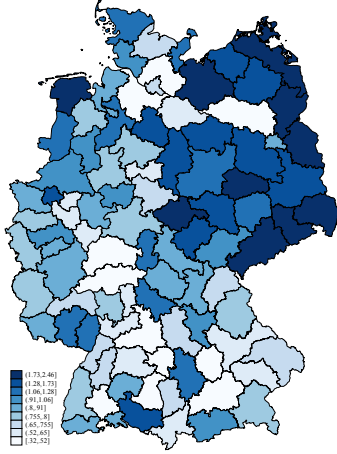
5.3 Regional variation in minimum wages

Although the minimum wage in Germany was introduced at the uniform level of €8.50 per hour, the exposure to the reform was not uniform. In particular, given differences in region-specific prices and wage distributions, the real value of the uniform threshold of €8.50 per hours translates into exposure to the minimum wage reform that differs across German regions. Thus, economically weak regions are more exposed to the minimum wage reform than economically strong regions.

We use the SOEP variable *region of residence* that assigns respondents to 96 administrative planning regions (‘Raumordnungsregionen’, or ROR BBSR, 2016). For each region, we compute the year-specific fraction of eligible employees with gross hourly wages below €8.50 that is used as the measure for treatment intensity in the difference-in-differences analysis. On average, SOEP data have 107 respondents per year in each regions. Regions with less than 25 observations in one of the analyzed years are not used in the analysis.

Figure 1 depicts the variation in treatment exposure in the SOEP data in 2013 that is used in the following difference-in-differences estimation. The measure reveals that eastern and northern parts of Germany are more exposed to the reform than the south and the west.

Fig. 1: Regional intensity of treatment in 2013



Source: SOEP v32 (Sample 1), own calculations.

At the same time, regions exhibit enough variation to be used for causal inference. A detailed discussion on the robustness of the chosen exposure measure relative to alternative measures (such as Kaitz index) and based on other data sources can be found in Caliendo et al. (2017a).

5.4 Labor market statuses

[The exact definition of the different labor market statuses will be added in the next version of the paper.]

5.5 Substitutability by capital

Heterogeneity of labor in respect of its substitutability with capital is the main focus of the analysis. Factor substitutability, especially at the individual level, is hardly observed, though. We are relying on two main sources of information to proxy labor-capital substitutability. First, we employ a block of questions in the SOEP concerning innovations at the workplace and the self-evaluation of the expected effect on respondent's productivity and qualification. Second, we combine SOEP with the German Employment Survey 2012 to infer about job tasks contents. So-called routine tasks exhibit high complementarity with computer capital, whereas non-routine cognitive tasks exhibit low complementarity with computer capital (Autor et al., 2003). We define all four measures employed in our study in such a way that they – by construction – exhibit positive substitutability with capital .

5.5.1 Innovativeness at the workplace

In 2015, all respondents in the SOEP who were employed in 2014 were asked whether they can report introduction of any innovations in technology, equipment, working or production processes that took place prior to the minimum wage reform. All respondents reporting the introduction of any innovations were asked for an evaluation of the influence that these innovations had on their health status, productivity, qualification requirements, work intensity and the risk of unemployment. The possible answers were “decrease”, “stays unchanged” and “increase”. We expect that an increase in individual productivity and an increase in qualification requirements through innovations would take place for workers whose labor input is complementary to the introduced innovations. In particular, we define the following two measures for high complementarity with capital:

- $nQUALIF = 1$ if the introduced innovations had no or adverse effect on qualification requirements or if no innovations took place, $= 0$ otherwise;
- $nPROD = 1$ if the introduced innovations had no or adverse effect on individual productivity or if no innovation took place, $= 0$ otherwise.

5.5.2 Job content and tasks

Job contents are not directly observed in the SOEP. Therefore, we use respondents' current occupation provided in the SOEP to impute information on job tasks from the most recent wave of the German Employment Survey from 2012.² This data set, also known as the Qualification and Career Survey (QCS), is actively used in the task-related literature for Germany, as it contains detailed information on job tasks and allows to define task categories as suggested by Autor et al. (2003). The survey information on job contents can be classified into the three main task groups: routine, non-routine cognitive and non-routine manual (see table 2 for details). The convenience of this classification for the purpose of our approach is that routine tasks are treated as substitutes for computer capital, non-routine cognitive tasks are treated as complements to computer capital, whereas non-routine manual tasks

²The survey is carried out by the Federal Institute for Vocational Education and Training (BiBB) together with the Federal Institute for Occupational Safety and Health (BAuA) doi:10.7803/501.12.1.1.30.

exhibit low substitutability with machines. Consequently, extending the SOEP data with task information enables us to directly incorporate substitutability with computer capital into the research design.

Tab. 2: Classification of job content information from the BiBB/BAuA Employment Survey into task categories

Tasks	Job description
NRC	Human resources management: recruiting, negotiating, prescribe rules, instruct Research and development: researching, analyzing, evaluating, designing, developing Public relations: marketing, publishing, acquisition, presenting, consultation Management and organization: purchasing, sales, coordinating, planning, legal interpretation Education: teaching, training
R	Accounting and controlling: calculating, bookkeeping, archiving, sorting, correction Quality management: measuring, monitoring, quality check Production: producing, packaging, loading, transporting, sending, operate machines
NRM	Maintenance: repairing, renovation, servicing machines Construction: building, installing Hotel and restaurant: serve, accommodating, catering Other services: cleaning, security, care

NRC – non-routine cognitive tasks; R – routine tasks; NRM – non-routine manual tasks.

We construct individual-level task shares (TS_{ij}) following the approach by Antonczyk et al. (2009):

$$TS_{ij} = \frac{\# \text{ of activities in category } j \text{ performed by } i}{\text{total } \# \text{ of activities performed by } i \text{ over all categories}}, \quad (7)$$

where i denotes the individual and j refers to the respective task category - $j \in \{\text{routine, non-routine cognitive, non-routine manual}\}$. By construction, the task measures sum up to 1. The individual-level task shares are then aggregated

at the level of 3-digit ISCO08 occupations and imputed to the SOEP data of 2013, 2014 and 2015.

For the subsequent analysis, we suggest two measures of exposure to high labor-capital substitutability:

- $RTN = 1$ if the respondent's job in 2014 was allocated in the top 30 percentiles of the distribution of routine tasks, $= 0$ otherwise;
- $nNRC = 1$ if the respondent's job in 2014 was allocated in the bottom 30 percentiles of the distribution of non-routine cognitive tasks, $= 0$ otherwise.

We test the robustness of our results to the definition of these measures.

5.5.3 Heterogeneity in substitutability

Table 3 provides descriptive statistics for *Sample 1* by such categories as wage intervals, region of residence, or socio-demographics (Column 1, Share). We break down the average of these characteristics by the four substitutability measures (RTN, nNRC, nQUALIF, nPROD).

Tab. 3: Description of the sample and measures to routinization

	Share	RTN	nNRC	nQUALIF	nPROD
Total		0.31	0.27	0.88	0.90
Hourly wage < €8.50	0.07	0.31	0.47	0.96	0.96
Hourly wage ≥ €8.50 to < €10	0.06	0.39	0.56	0.92	0.88
Hourly wage ≥ €10 to < €12.50	0.12	0.32	0.42	0.94	0.93
Hourly wage ≥ €12.50	0.75	0.30	0.20	0.86	0.89
Women	0.53	0.45	0.34	0.85	0.87
Men	0.47	0.15	0.19	0.90	0.92
Age 18 to 24	0.02	0.30	0.26	0.87	0.81
Age 25 to 60	0.93	0.31	0.26	0.88	0.90
Age over 60	0.07	0.28	0.37	0.90	0.94
West Germany	0.76	0.30	0.26	0.87	0.89
East Germany (incl. Berlin)	0.24	0.32	0.30	0.90	0.91
Full-time employed	0.77	0.34	0.26	0.87	0.89
Part-time employed	0.18	0.14	0.20	0.90	0.92
Marginally employed	0.05	0.19	0.52	0.96	0.96
Primary education	0.22	0.46	0.54	0.89	0.92
Secondary education	0.49	0.30	0.25	0.87	0.88
Tertiary education	0.29	0.18	0.04	0.88	0.90

Source: SOEP v32 (Sample 1), own calculations.

On average, the share of respondents belonging to top 30 percent of routine jobs (*RTN*), whereas the respective share belonging to the lowest 30 percent of non-routine cognitive jobs is 27 percent (*nNRC*). The share of respondents not exposed to innovations that require qualification upgrade is 88 percent (*nQUALIF*) and the share of respondents not exposed to innovations that boost their productivity is 90 percent (*nPROD*).

When we divide *Sample 1* by wage intervals, we observe that the wage interval from €8.50 to €10 exhibits the highest shares of RTN and nNRC, whereas the wage interval below €8.50 exhibits the highest shares of nQUALIF and nPROD. However, also respondents with high wages exhibit high substitutability with capital. Note also, that also in 2012, the middle intervals of the wage distribution exhibits the highest shares of routine tasks, in line with the hypothesis of Autor et al. (2003).

When comparing women and men, we observe that the shares of RTN and nNRC are substantially higher for women than for men. Considering the innovation-related measures nQUALIF and nPROD, this is not the case. Also among the different age groups and across regions of residence, substitutability with capital is distributed fairly evenly. Among full-time employed, we observe the highest exposure to routine tasks and only average share of low non-routine cognitive tasks. Part-time employed have low shares of task-based measures for substitutability with capital. Marginally employed have rather low shares of RTN and rather high shares in nNRC (implying that many marginal workers are employed in non-routine manual jobs). Innovation-related measures are evenly distributed among these groups. Concerning the highest educational levels, substitutability with capital measured by task contents is lower for higher educational levels. Again, innovation-related measures are more evenly substituted across these groups.

On the whole, table 3 reveals that groups that tend to be more exposed to the minimum wage reform (low-wage earners, women, young and old workers, East Germans, marginally employed, or workers with primary education) do not necessarily exhibit higher substitutability with capital as defined by the four suggested measures (RTN, nNRC, nQUALIF, nPROD). Therefore, we conclude that the suggested substitutability measures are a valid source of external variation in workplace characteristics that may affect the probability of job termination and are not directly related to the exposure by the minimum wage reform.

6 Empirical results

The primary goal of a minimum wage reform is to improve wages at the bottom of the wage distribution. In the first step of our analysis we assess the distributional effect of the reform on gross earnings (sub-section 6.1), as a significant wage effect is the necessary condition a potential impact on employment. Second, we provide evidence on the overall employment effect of the minimum wage reform by looking at various transition on the labor market (sub-section 6.2). Third, we take heterogeneity of labor with respect to capital substitutability into account and break down the minimum wage effects according to the degree of substitutability (sub-section 6.3).

6.1 Effect on the hourly wage distribution

We follow the empirical strategy of Caliendo et al. (2017b) that relies on variation in the regional bite of the minimum wage (sub-section 4.2.1). Table 4 presents the δ -coefficients for the estimation of distributional effects on wages. Results are based on OLS and FE for the average wage growth on and separate quintiles. We find statistically significant positive wage effect for the two lowest quintiles in both model specifications. Consistent with prior expectations the largest effect arises in the bottom quintile of the distribution where individual bound by the minimum wage reside.

At the same time a significantly negative wage effect emerges in the third quintile. This may point to some problem in this identification strategy. However, the magnitude of this effect is about one third compared to the positive effect in the bottom quintile.

In order to assess whether the observed pattern of wage growth is attributable to the minimum wage reform, we re-estimate the same specification lagged by one time period. Table 5 presents the corresponding estimation results.

Based on the estimation results, we conclude that exposure to minimum wages was not associated with additional wage growth in the pre-reform year, neither on average nor in quantiles. This results supports the conclusion that estimates presented in table 4 can be interpreted as the causal effect of the minimum wage reform on wages.

Tab. 4: Wage growth 2014-2015

	OLS		FE	
	Coef.	p-value	Coef	p-value
Base	0.010	0.176	0.006	0.220
Base by quintiles:				
Q1	0.076***	0.005	0.072***	0.001
Q2	0.034**	0.017	0.022*	0.055
Q3	-0.027**	0.029	-0.024**	0.030
Q4	-0.003	0.757	-0.003	0.777
Q5	0.007	0.449	0.008	0.340

Source: SOEP v32, own calculations.

Tab. 5: Wage growth 2013-2014

	OLS		FE	
	Coef.	p-value	Coef	p-value
Base	0.009	0.316	-0.006	0.312
Base by quintiles:				
Q1	-0.024	0.366	-0.027	0.384
Q2	0.009	0.506	0.004	0.737
Q3	0.014	0.188	-0.003	0.733
Q4	0.001	0.876	0.002	0.813
Q5	0.001	0.942	-0.011	0.243

Source: SOEP v32, own calculations.

6.2 Labor market transitions

The average effect of the minimum wage reform on labor market transitions is summarized in three tables. Again, we report the estimates for the interaction of the treatment intensity with the dummy for the post-reform year $\hat{\delta}$. Table 6 provides the results for the regressions concerning the transitions from regular employment

in $t - 1$ into a particular status in t for both the reform year $t = 2015$ and the pre-reform year $t = 2014$. For each of the three potential statuses in t , we estimate a separate regression as OLS and FE.

Tab. 6: Transitions from regular employment

		OLS	FE	OLS	FE
		t=2015	t=2015	t=2014	t=2014
RE (t-1) $\rightarrow$ RE (t), $\hat{\delta}$		0.006	-0.002	-0.002	-0.006
p-value		0.357	0.590	0.837	0.165
RE (t-1) $\rightarrow$ ME(t), $\hat{\delta}$		-0.004	-0.002	-0.002	0.001
p-value		0.164	0.027	0.627	0.526
RE (t-1) $\rightarrow$ UE(t), $\hat{\delta}$		-0.002	0.004	0.003	0.005
p-values		0.752	0.253	0.622	0.219
N		15,537	15,537	14,442	14,442

Source: SOEP v32, own calculations.

Concerning the transitions from regular employment (table 6), the results of the linear probability model suggest that the probability of staying in regular occupation did not change due to the minimum wage reform. Also according to the linear probability model, transitions from regular employment to marginal employment and to unemployment did not change. The fixed-effects models confirm these results with one exception: the probability to transit from regular to marginal employment is slightly, yet significantly reduced. In the pre-reform year, all transition probabilities remain unchanged, confirming the absence of pre-reform trends in the labor market structure.

Concerning the transitions from marginal employment (table 7), both the linear probability and the fixed-effects models imply unchanged patterns both in the post- and in the pre-reform year. We get insignificant transitions throughout.

Regarding the transitions from unemployment (table 8), the linear probability model documents lower probability to change to marginal employment in 2015. However, the fixed effect model does not confirm this finding. The fixed effects model shows that in 2015 the probability to be in regular employment dropped by

Tab. 7: Transitions from marginal employment

		OLS	FE	OLS	FE
		t=2015	t=2015	t=2014	t=2014
ME (t-1) $\rightarrow$ RE (t), $\hat{\delta}$		-0.016	0.023	0.031	0.008
p-value		0.844	0.701	0.678	0.912
ME (t-1) $\rightarrow$ ME(t), $\hat{\delta}$		0.028	-0.035	-0.088	0.002
p-value		0.699	0.604	0.232	0.976
ME (t-1) $\rightarrow$ UE(t), $\hat{\delta}$		-0.012	0.011	0.057	-0.010
p-values		0.796	0.715	0.113	0.702
N		972	972	844	844

Source: SOEP v32, own calculations.

4.2 percent (for each 1 additional percentage point of the treatment intensity). At the same time, the probability to stay in unemployment rises by 3 percent for each 1 additional percentage point of the treatment intensity (with the significance level of eleven percent). In the pre-reform year these trend are not observed.

Tab. 8: Transitions from unemployment

		OLS	FE	OLS	FE
		t=2015	t=2015	t=2014	t=2014
UE (t-1) $\rightarrow$ RE (t), $\hat{\delta}$		-0.045	-0.042	-0.042	0.044
p-value		0.128	0.017	0.209	0.107
UE (t-1) $\rightarrow$ ME(t), $\hat{\delta}$		0.035	0.010	0.002	-0.015
p-value		0.008	0.225	0.835	0.009
UE (t-1) $\rightarrow$ UE(t), $\hat{\delta}$		0.011	0.031	0.039	-0.029
p-values		0.746	0.104	0.298	0.304
N		2,332	2,332	1,976	1,976

Source: SOEP v32, own calculations.

We conclude, that the minimum wage reform did not substantial (and significant) average effects on the transition probabilities between labor market statuses. This

finding is in line with other recent studies for Germany identifying average effects (Bossler and Gerner, 2016; Caliendo et al., 2017a).

6.3 Heterogeneity by substitutability with capital

Table 9 contains results from the estimation of the specification (6) where we break down the average treatment effect by labor for capital substitutability (sub-section 4.3) for the transition probabilities from regular employment in $t - 1$ to regular employment in t . We use alternatively all four measures of substitutability (sub-section 5.5) and analyze transitions for the years 2014/2015 and 2013/2014.

We can see that the probability of remaining in regular employment significantly decreases for individuals with a high labor-capital substitutability as the linear probability models for all four different measures of substitutability show. Although there is no average effect on the probability of keeping a regular job, there is a clearly negative impact of the minimum wage on individuals exposed to employment reduction induced by the increase in labor costs. For three of our measures this effect remains constant in the FE where some of the variation is wiped out by the fixed individual effect. It is reassuring that we do not find such a clear pattern for the year 2014 before the minimum wage was introduced.

We find a similarly consistent pattern when we look at the results for the transition from regular employment into unemployment (Table 10): The transition probability is significantly higher for individuals which can more easily being substituted by capital. Again, this pattern remains robust when individual fixed effects are added. We do not get such a consistent pattern for the pre-reform year 2014.

The overall evidence puts to considerable effect heterogeneity of the minimum wage as far as an employee's substitutability by capital is concerned. The minimum wage in Germany seems to have exerted a significantly negative impact on the labor market prospects of employees which are exposed in this dimension.

Tab. 9: Transitions from regular employment to regular employment

RE (t-1) $\rightarrow$ RE (t)	OLS	FE	OLS	FE
	2014 $\rightarrow$ 2015		2013 $\rightarrow$ 2014	
Treatment	0.014	-0.002	-0.012	-0.014
p-value	(0.031)	(0.655)	(0.122)	(0.005)
RTN	0.034	0.000	0.015	0.000
p-value	(0.000)		(0.001)	
RTN $\times$ Treatment	-0.028	0.002	0.016	0.018
p-value	(0.001)	(0.706)	(0.006)	(0.000)
Treatment	0.018	0.003	-0.013	-0.012
p-value	(0.015)	(0.475)	(0.075)	(0.015)
nNRC	0.020	0.000	0.002	0.000
p-value	(0.001)		(0.757)	
nNRC $\times$ Treatment	-0.035	-0.013	0.018	0.012
p-value	(0.001)	(0.009)	(0.001)	(0.000)
Treatment	0.016	0.017	0.001	0.005
p-value	(0.018)	(0.000)	(0.850)	(0.357)
nQUALIF	-0.026	0.000	-0.024	0.000
p-value	(0.000)		(0.000)	
nQUALIF $\times$ Treatment	-0.011	-0.021	-0.003	-0.012
p-value	(0.010)	(0.000)	(0.529)	(0.001)
Treatment	0.015	0.018	0.003	0.005
p-value	(0.046)	(0.000)	(0.654)	(0.258)
nPROD	-0.026	0.000	-0.022	0.000
p-value	(0.000)		(0.000)	
nPROD $\times$ Treatment	-0.009	-0.022	-0.005	-0.013
p-value	(0.027)	(0.000)	(0.326)	(0.000)
	15,537	15,537	14,442	14,442

Source: SOEP v32, own calculations.

Tab. 10: Transitions from regular employment to unemployment

RE (t-1) $\rightarrow$ UE (t)	OLS	FE	OLS	FE
	2014 $\rightarrow$ 2015		2013 $\rightarrow$ 2014	
Treatment	-0.010	0.003	0.014	0.012
p-value	(0.071)	(0.408)	(0.021)	(0.007)
RTN	-0.030	0.000	-0.010	0.000
p-value	(0.000)		(0.004)	
RTN $\times$ Treatment	0.029	0.002	-0.018	-0.017
p-value	(0.000)	(0.695)	(0.000)	(0.000)
Treatment	-0.015	-0.001	0.016	0.011
p-value	(0.009)	(0.809)	(0.015)	(0.014)
nNRC	-0.027	0.000	-0.007	0.000
p-value	(0.000)		(0.082)	
nNRC $\times$ Treatment	0.041	0.014	-0.020	-0.013
p-value	(0.000)	(0.003)	(0.001)	(0.000)
Treatment	-0.015	-0.013	0.002	-0.004
p-value	(0.015)	(0.000)	(0.806)	(0.461)
nQUALIF	0.018	0.000	0.017	0.000
p-value	(0.000)		(0.000)	
nQUALIF $\times$ Treatment	0.014	0.020	0.002	0.010
p-value	(0.001)	(0.000)	(0.726)	(0.008)
Treatment	-0.013	-0.014	0.001	-0.004
p-value	(0.068)	(0.000)	(0.884)	(0.330)
nPROD	0.018	0.000	0.017	0.000
p-value	(0.000)		(0.000)	
nPROD $\times$ Treatment	0.011	0.020	0.003	0.011
p-value	(0.008)	(0.000)	(0.610)	(0.002)
	15,537	15,537	14,442	14,442

Source: SOEP v32, own calculations.

7 Discussion and conclusion

Points for conclusion:

- It cannot be said that there are no losers from the introduction of minimum wages. Those who are replaceable by technology are prone to lose their jobs or have a harder time finding jobs.
- This might be a neglected margin for effect heterogeneity, i.e. people with high exposure to potentially negative effects of the minimum wage (besides younger employees, or other individuals with low productivity)
- The good thing is: we have relatively good proxies to identify those groups of employees.
- Thus, preventive policy measures can target those in jobs with high substitutability with capital, as they have higher probabilities to become unemployed.

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Appendix

Deriving labor market status from SOEP data

We use the rich information from the SOEP questionnaire to classify all individuals in mutually exclusive groups. Such a classification is surely a simplification of the amount of possible labor market statuses observed in actuality, but it is needed to operationalize the affectedness of respondents by the minimum wage reform. The labor market status is defined in several steps, which order is important as it mirrors the assumed dominance of the statuses over each other. As an example, we depart from the non-employment status which definition does not need any information from the survey questionnaire (Step 1). Then, in Step 2 we employ survey information that helps to classify a respondent as a full-time employee, and, if all the imposed conditions are binding, the labor market status is updated from non-employed to full-time employment. Further, in Step 12 we employ the information of currently employed, but with the employment that started less than 6 months ago and was preceded by an unemployment spell of more than 12 months. If this conditions are binding, then the labor market status received an additional update to exempted former long-term unemployed.

Step 1: Non-employment. We depart with declaring all respondent non-employed. Using additional information from the questionnaire, this status is overwritten as follows.

Step 2: Full-time employment with social security. Respondent who fulfill the following conditions: pay social security contributions (plb0022), not self-employed (plb0059, plb0060, plb0061, plb0062), working more than 30 hours per contract (plb0176, if this information unavailable, then use actual hours worked plb0186).

Step 3: Part-time employment with social security. Respondent with social security contributions (plb0022), not self-employed, working 30 hours or less per contract (plb0176, if this information unavailable, then use actual hours worked plb0186), aged 18 and older.

Step 4: Unemployed, not working. Registered unemployed (plb0021) with zero or missing information on wages or hours worked.

Step 5: Unemployed, working. Registered unemployed (plb0021) with either non-zero wages or hours worked.

Step 6: Marginally employed. Marginally employed (plb0187), not registered as unemployed and aged over 18.

Step 7: Employed in sectors with minimum wages under €8.50. Employed with information on sector of employment and in sectors which have a minimum wage regulation and where minimum wages are set below €8.50.

Step 8: Employed in sectors with minimum wages at €8.50 or above. Employed with information on sector of employment and in sectors which have a minimum wage regulation and where minimum wages are set at €8.50 or higher.

Step 9: Self-employed. Respondents reporting being self-employed with or without employees or being supporting family members (plb0059, plb0060, plb0061, plb0062).

Step 10: Civil servants. Respondents employed as civil servants (plb0065) previously unclassified in other categories.

Step 11: Exempted trainees. Respondents in any type of training or internship (plb0063).

Step 12: Exempted former long-term unemployed. Respondents who have started a new employment less than 6 months ago (but starting no earlier than January 1st, 2015) and being in an unemployed status for at least 12 months prior to this employment. Here we use both the month of the interview, as well as information on the timing of the beginning of the last job, and calendar information on previous unemployment.

Labor market categories Mutually exclusive categories that result from the step-wise application of survey information define the labor market statuses of the respondents.

Eligibility Categories “Full-time employment with social security”, “Part-time employment with social security”, “Marginal employment” and “Civil servants” are used in the analysis as eligible to minimum wages.

Deriving wages and working hours from SOEP data

Questionnaire entry: monthly wages

What did you earn from your work last month? *If you received extra income such as vacation pay or back pay, please do not include this. Please do include overtime pay. If you are self-employed: Please estimate your monthly income before and after taxes.*

Please state both:

- gross income, which means income before deduction of taxes and social security
- net income, which means income after deduction of taxes, social security, and unemployment and health insurance.

I earned: [reported number] gross euros,
[reported number] net euros.

Questionnaire entry: working hours

Contractual working hours How many hours per week are stipulated in your contract (excluding overtime)? [reported number] hours per week

Actual working hours And how many hours do you generally work, including any overtime? [reported number] hours per week

Additional figures

Additional tables

Tab. A1: Transitions from regular employment to regular employment

RE (t-1) → RE (t)	OLS 2014 → 2015	FE 2014 → 2015	OLS 2013 → 2014	FE 2013 → 2014
Treatment	0.014	-0.002	-0.012	-0.014
p-value	(0.031)	(0.655)	(0.122)	(0.005)
RTN	0.034	0.000	0.015	0.000
p-value	(0.000)		(0.001)	
RTN × Treatment	-0.028	0.002	0.016	0.018
p-value	(0.001)	(0.706)	(0.006)	(0.000)
Treatment	0.018	0.003	-0.013	-0.012
p-value	(0.015)	(0.475)	(0.075)	(0.015)
nNRC	0.020	0.000	0.002	0.000
p-value	(0.001)		(0.757)	
nNRC × Treatment	-0.035	-0.013	0.018	0.012
p-value	(0.001)	(0.009)	(0.001)	(0.000)
Treatment	0.016	0.017	0.001	0.005
p-value	(0.018)	(0.000)	(0.850)	(0.357)
nQUALIF	-0.026	0.000	-0.024	0.000
p-value	(0.000)		(0.000)	
nQUALIF × Treatment	-0.011	-0.021	-0.003	-0.012
p-value	(0.010)	(0.000)	(0.529)	(0.001)
Treatment	0.015	0.018	0.003	0.005
p-value	(0.046)	(0.000)	(0.654)	(0.258)
nPROD	-0.026	0.000	-0.022	0.000
p-value	(0.000)		(0.000)	
nPROD × Treatment	-0.009	-0.022	-0.005	-0.013
p-value	(0.027)	(0.000)	(0.326)	(0.000)
	15,537	15,537	14,442	14,442

Source: SOEP v32, own calculations.

Tab. A2: Transitions from regular employment to marginal employment

RE (t-1) $\rightarrow$ ME (t)	OLS 2014 $\rightarrow$ 2015	FE 2014 $\rightarrow$ 2015	OLS 2013 $\rightarrow$ 2014	FE 2013 $\rightarrow$ 2014
Treatment	-0.004	-0.001	-0.003	0.001
p-value	(0.237)	(0.177)	(0.499)	(0.487)
RTN	-0.004	0.000	-0.004	0.000
p-value	(0.087)		(0.048)	
RTN $\times$ Treatment	-0.001	-0.003	0.003	-0.001
p-value	(0.601)	(0.000)	(0.383)	(0.676)
Treatment	-0.002	-0.002	-0.003	0.001
p-value	(0.537)	(0.072)	(0.449)	(0.656)
nNRC	0.007	0.000	0.006	0.000
p-value	(0.015)		(0.062)	
nNRC $\times$ Treatment	-0.006	-0.001	0.002	0.001
p-value	(0.023)	(0.199)	(0.515)	(0.588)
Treatment	-0.001	-0.004	-0.003	-0.001
p-value	(0.650)	(0.024)	(0.363)	(0.494)
nQUALIF	0.008	0.000	0.007	0.000
p-value	(0.000)		(0.000)	
nQUALIF $\times$ Treatment	-0.003	0.001	0.002	0.002
p-value	(0.056)	(0.237)	(0.369)	(0.001)
Treatment	-0.002	-0.005	-0.004	-0.001
p-value	(0.442)	(0.000)	(0.231)	(0.534)
nPROD	0.008	0.000	0.005	0.000
p-value	(0.000)		(0.006)	
nPROD $\times$ Treatment	-0.002	0.003	0.003	0.002
p-value	(0.134)	(0.000)	(0.205)	(0.001)
	15,537	15,537	14,442	14,442

Source: SOEP v32, own calculations.

Tab. A3: Transitions from regular employment to unemployment

RE (t-1) $\rightarrow$ UE (t)	OLS 2014 $\rightarrow$ 2015	FE 2014 $\rightarrow$ 2015	OLS 2013 $\rightarrow$ 2014	FE 2013 $\rightarrow$ 2014
Treatment	-0.010	0.003	0.014	0.012
p-value	(0.071)	(0.408)	(0.021)	(0.007)
RTN	-0.030	0.000	-0.010	0.000
p-value	(0.000)		(0.004)	
RTN $\times$ Treatment	0.029	0.002	-0.018	-0.017
p-value	(0.000)	(0.695)	(0.000)	(0.000)
Treatment	-0.015	-0.001	0.016	0.011
p-value	(0.009)	(0.809)	(0.015)	(0.014)
nNRC	-0.027	0.000	-0.007	0.000
p-value	(0.000)		(0.082)	
nNRC $\times$ Treatment	0.041	0.014	-0.020	-0.013
p-value	(0.000)	(0.003)	(0.001)	(0.000)
Treatment	-0.015	-0.013	0.002	-0.004
p-value	(0.015)	(0.000)	(0.806)	(0.461)
nQUALIF	0.018	0.000	0.017	0.000
p-value	(0.000)		(0.000)	
nQUALIF $\times$ Treatment	0.014	0.020	0.002	0.010
p-value	(0.001)	(0.000)	(0.726)	(0.008)
Treatment	-0.013	-0.014	0.001	-0.004
p-value	(0.068)	(0.000)	(0.884)	(0.330)
nPROD	0.018	0.000	0.017	0.000
p-value	(0.000)		(0.000)	
nPROD $\times$ Treatment	0.011	0.020	0.003	0.011
p-value	(0.008)	(0.000)	(0.610)	(0.002)
	15,537	15,537	14,442	14,442

Source: SOEP v32, own calculations.

Tab. A4: Transitions from marginal employment to regular employment

ME (t-1) $\rightarrow$ RE (t)	OLS 2014 $\rightarrow$ 2015	FE 2014 $\rightarrow$ 2015	OLS 2013 $\rightarrow$ 2014	FE 2013 $\rightarrow$ 2014
Treatment	-0.027	-0.021	0.037	0.005
p-value	(0.745)	(0.723)	(0.639)	(0.945)
RTN	0.060	0.000	0.095	0.000
p-value	(0.191)		(0.114)	
RTN $\times$ Treatment	0.021	0.189	-0.047	0.011
p-value	(0.765)	(0.030)	(0.617)	(0.858)
Treatment	-0.049	0.030	0.066	0.062
p-value	(0.570)	(0.643)	(0.429)	(0.409)
nNRC	-0.052	0.000	0.008	0.000
p-value	(0.071)		(0.851)	
nNRC $\times$ Treatment	0.050	-0.009	-0.092	-0.105
p-value	(0.289)	(0.862)	(0.134)	(0.023)
Treatment	-0.417	0.279	-0.065	0.027
p-value	(0.093)	(0.272)	(0.754)	(0.834)
nQUALIF	-0.312	0.000	-0.159	0.000
p-value	(0.025)		(0.266)	
nQUALIF $\times$ Treatment	0.401	-0.258	0.097	-0.019
p-value	(0.092)	(0.298)	(0.624)	(0.880)
Treatment	-0.428	-0.096	-0.014	0.142
p-value	(0.003)	(0.295)	(0.930)	(0.358)
nPROD	-0.250	0.000	-0.089	0.000
p-value	(0.025)		(0.370)	
nPROD $\times$ Treatment	0.420	0.120	0.049	-0.136
p-value	(0.002)	(0.095)	(0.743)	(0.371)
	972	972	844	844

Source: SOEP v32, own calculations.

Tab. A5: Transitions from marginal employment to marginal employment

ME (t-1) → ME (t)	OLS 2014 → 2015	FE 2014 → 2015	OLS 2013 → 2014	FE 2013 → 2014
Treatment	0.043	0.003	-0.071	-0.001
p-value	(0.549)	(0.967)	(0.340)	(0.992)
RTN	-0.022	0.000	-0.067	0.000
p-value	(0.628)		(0.276)	
RTN × Treatment	-0.047	-0.161	0.039	0.011
p-value	(0.502)	(0.066)	(0.661)	(0.857)
Treatment	0.096	-0.050	-0.110	-0.070
p-value	(0.216)	(0.492)	(0.152)	(0.382)
nNRC	0.091	0.000	0.001	0.000
p-value	(0.010)		(0.982)	
nNRC × Treatment	-0.115	0.028	0.109	0.140
p-value	(0.035)	(0.615)	(0.113)	(0.004)
Treatment	0.469	-0.270	0.102	0.002
p-value	(0.052)	(0.290)	(0.611)	(0.988)
nQUALIF	0.322	0.000	0.205	0.000
p-value	(0.014)		(0.148)	
nQUALIF × Treatment	-0.442	0.237	-0.192	0.000
p-value	(0.059)	(0.339)	(0.311)	(0.999)
Treatment	0.408	0.106	-0.001	-0.110
p-value	(0.002)	(0.266)	(0.995)	(0.482)
nPROD	0.179	0.000	0.076	0.000
p-value	(0.093)		(0.467)	
nPROD × Treatment	-0.389	-0.141	-0.090	0.114
p-value	(0.003)	(0.048)	(0.538)	(0.454)
	972	972	844	844

Source: SOEP v32, own calculations.

Tab. A6: Transitions from marginal employment to unemployment

ME (t-1) $\rightarrow$ UE (t)	OLS 2014 $\rightarrow$ 2015	FE 2014 $\rightarrow$ 2015	OLS 2013 $\rightarrow$ 2014	FE 2013 $\rightarrow$ 2014
Treatment	-0.016	0.018	0.034	-0.004
p-value	(0.722)	(0.592)	(0.264)	(0.878)
RTN	-0.038	0.000	-0.028	0.000
p-value	(0.046)		(0.127)	
RTN $\times$ Treatment	0.026	-0.027	0.008	-0.022
p-value	(0.273)	(0.059)	(0.827)	(0.068)
Treatment	-0.047	0.020	0.044	0.008
p-value	(0.239)	(0.584)	(0.212)	(0.769)
nNRC	-0.039	0.000	-0.009	0.000
p-value	(0.057)		(0.699)	
nNRC $\times$ Treatment	0.065	-0.019	-0.017	-0.036
p-value	(0.015)	(0.373)	(0.632)	(0.055)
Treatment	-0.052	-0.009	-0.037	-0.029
p-value	(0.557)	(0.750)	(0.621)	(0.572)
nQUALIF	-0.010	0.000	-0.046	0.000
p-value	(0.877)		(0.536)	
nQUALIF $\times$ Treatment	0.040	0.021	0.095	0.019
p-value	(0.583)	(0.056)	(0.228)	(0.566)
Treatment	0.019	-0.010	0.015	-0.032
p-value	(0.649)	(0.746)	(0.746)	(0.235)
nPROD	0.071	0.000	0.012	0.000
p-value	(0.001)		(0.772)	
nPROD $\times$ Treatment	-0.031	0.021	0.041	0.023
p-value	(0.228)	(0.049)	(0.379)	(0.084)
	972	972	844	844

Source: SOEP v32, own calculations.

Tab. A7: Transitions from unemployment to regular employment

UE (t-1) $\rightarrow$ RE (t)	OLS 2014 $\rightarrow$ 2015	FE 2014 $\rightarrow$ 2015	OLS 2013 $\rightarrow$ 2014	FE 2013 $\rightarrow$ 2014
Treatment	-0.082	-0.177	-0.080	0.042
p-value	(0.221)	(0.010)	(0.222)	(0.501)
RTN	0.284	0.000	0.051	0.000
p-value	(0.000)		(0.330)	
RTN $\times$ Treatment	-0.377	-0.118	0.173	0.152
p-value	(0.000)	(0.146)	(0.001)	(0.009)
Treatment	-0.079	-0.162	-0.081	0.072
p-value	(0.254)	(0.018)	(0.236)	(0.269)
nNRC	0.083	0.000	-0.060	0.000
p-value	(0.057)		(0.211)	
nNRC $\times$ Treatment	-0.188	-0.071	0.107	0.061
p-value	(0.001)	(0.253)	(0.056)	(0.222)
Treatment	0.174	0.766	0.040	0.224
p-value	(0.214)	(0.036)	(0.806)	(0.186)
nQUALIF	-0.490	0.000	-0.236	0.000
p-value	(0.000)		(0.040)	
nQUALIF $\times$ Treatment	-0.220	-0.803	-0.077	-0.179
p-value	(0.113)	(0.028)	(0.636)	(0.278)
Treatment	-0.097	0.239	0.191	0.377
p-value	(0.421)	(0.294)	(0.006)	(0.000)
nPROD	-0.584	0.000	-0.248	0.000
p-value	(0.000)		(0.004)	
nPROD $\times$ Treatment	0.053	-0.284	-0.235	-0.349
p-value	(0.654)	(0.210)	(0.000)	(0.000)
	2,332	2,332	1,976	1,976

Source: SOEP v32, own calculations.

Tab. A8: Transitions from unemployment to marginal employment

UE (t-1) $\rightarrow$ ME (t)	OLS 2014 $\rightarrow$ 2015	FE 2014 $\rightarrow$ 2015	OLS 2013 $\rightarrow$ 2014	FE 2013 $\rightarrow$ 2014
Treatment	0.068	0.043	0.008	-0.049
p-value	(0.025)	(0.247)	(0.761)	(0.009)
RTN	0.004	0.000	0.015	0.000
p-value	(0.891)		(0.361)	
RTN $\times$ Treatment	0.037	0.058	0.000	0.010
p-value	(0.359)	(0.370)	(0.984)	(0.614)
Treatment	0.076	0.047	-0.003	-0.053
p-value	(0.021)	(0.262)	(0.883)	(0.011)
nNRC	0.055	0.000	0.019	0.000
p-value	(0.027)		(0.210)	
nNRC $\times$ Treatment	-0.024	0.005	0.025	0.017
p-value	(0.425)	(0.884)	(0.195)	(0.348)
Treatment	0.007	0.001	-0.005	0.106
p-value	(0.876)	(0.928)	(0.945)	(0.426)
nQUALIF	-0.004	0.000	-0.035	0.000
p-value	(0.915)		(0.436)	
nQUALIF $\times$ Treatment	0.028	0.009	0.008	-0.121
p-value	(0.521)	(0.106)	(0.915)	(0.364)
Treatment	0.020	0.001	0.018	0.019
p-value	(0.410)	(0.916)	(0.381)	(0.628)
nPROD	-0.007	0.000	0.003	0.000
p-value	(0.815)		(0.801)	
nPROD $\times$ Treatment	0.015	0.010	-0.017	-0.036
p-value	(0.505)	(0.010)	(0.443)	(0.386)
	2,332	2,332	1,976	1,976

Source: SOEP v32, own calculations.

Tab. A9: Transitions from unemployment to unemployment

UE (t-1) $\rightarrow$ UE (t)	OLS 2014 $\rightarrow$ 2015	FE 2014 $\rightarrow$ 2015	OLS 2013 $\rightarrow$ 2014	FE 2013 $\rightarrow$ 2014
Treatment	0.015	0.134	0.072	0.007
p-value	(0.835)	(0.070)	(0.317)	(0.913)
RTN	-0.288	0.000	-0.066	0.000
p-value	(0.000)		(0.218)	
RTN $\times$ Treatment	0.340	0.060	-0.172	-0.162
p-value	(0.001)	(0.531)	(0.001)	(0.006)
Treatment	0.003	0.115	0.084	-0.019
p-value	(0.966)	(0.128)	(0.240)	(0.777)
nNRC	-0.139	0.000	0.041	0.000
p-value	(0.006)		(0.414)	
nNRC $\times$ Treatment	0.211	0.066	-0.133	-0.079
p-value	(0.001)	(0.314)	(0.034)	(0.131)
Treatment	-0.181	-0.767	-0.035	-0.330
p-value	(0.183)	(0.036)	(0.837)	(0.050)
nQUALIF	0.494	0.000	0.271	0.000
p-value	(0.000)		(0.019)	
nQUALIF $\times$ Treatment	0.193	0.794	0.070	0.300
p-value	(0.150)	(0.030)	(0.682)	(0.070)
Treatment	0.077	-0.239	-0.209	-0.396
p-value	(0.525)	(0.293)	(0.004)	(0.000)
nPROD	0.591	0.000	0.245	0.000
p-value	(0.000)		(0.003)	
nPROD $\times$ Treatment	-0.069	0.274	0.252	0.385
p-value	(0.558)	(0.226)	(0.000)	(0.000)
	2,332	2,332	1,976	1,976

Source: SOEP v32, own calculations.