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// MAXIMILIAN J. BLÖMER, NICOLE GUERTZGEN, LAURA POHLAN, HOLGER STICHNOTH, AND GERARD J. VAN DEN BERG

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Unemployment Effects of the German Minimum Wage in an Equilibrium Job Search Model

Maximilian J. Blömer[1], Nicole Guertzgen*[2], Laura Pohlan[3], Holger Stichnoth[4], and Gerard J. van den Berg[5]

[1] *ifo Institute, HU Berlin*
[2] *University of Regensburg, IAB Nuremberg, ZEW Mannheim*
[3] *ZEW Mannheim, IAB Nuremberg*
[4] *ZEW Mannheim*
[5] *University of Groningen, IFAU, IZA, CEPR, ZEW Mannheim, CESifo*

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We structurally estimate an equilibrium search model using German administrative data and use the model for counterfactual analyses of a uniform minimum wage. The model with worker and firm heterogeneity does not restrict the sign of employment effects a priori; it allows for different job offer arrival rates for the employed and the unemployed and lets firms optimally choose their recruiting intensity. We find that unemployment is a non-monotonic function of the minimum wage level. Effects differ strongly by labour market segment. The differences are mostly driven by firm productivity levels, but differences in search frictions matter as well.

Keywords: monopsony, wages, employment, productivity, structural estimation
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*Corresponding author: Nicole Guertzgen, IAB, Regensburger Strasse 104, D-90478 Nuremberg. nicole.guertzgen@iab.de. We are grateful to Richard Blundell, Philipp Dörrenberg, Bernd Fitzenberger, Clemens Fuest, Mario Meier, Fabien Postel-Vinay, Jean-Marc Robin, Sebastian Siegloch, Jan Tilly, Carsten Trenkler as well as participants of a ZEW Workshop on Labour Market Policy Evaluations, the ZEW Summer Workshop on Structural Models for Policy Evaluation, the ESPE, EEA, SaM, VfS, and EALE conferences, a Workshop of the German Minimum Wage Commission and various seminars for helpful comments. We thank Andrew Shephard for kindly having shared programming routines with us. Financial support by the State of Baden-Württemberg and access to administrative data provided by the IAB are also gratefully acknowledged. Paul König, Julius Koll and Pierre Poulon provided excellent research assistance.

1. Introduction

A large number of empirical studies have examined the labour market effects of minimum wages (see Dube, 2019 and Neumark, 2019 for recent surveys). Most of these studies have found only small negative effects on employment. The absence of negative employment effects is often used as an argument by proponents of minimum wage increases. However, the ex-post studies of the effects of actually observed minimum wage levels provide only limited guidance about the potential effects of minimum wage increases if these effects are characterised by non-linearities (Christl et al., 2018; Neumark, 2019).

In this paper, we structurally estimate an equilibrium job search model that takes such non-linearities into account. Because of search frictions, employers have market power that allows them to set wages below the marginal productivity of labour. The effects of firms' market power on wages have received increasing attention in the literature, accompanied by a resurgence of interest in monopsony models (see the survey by Manning, 2020). Azar et al. (2019) explicitly focus on how the employment effects of a minimum wage depend on the degree of firms' monopsony power. While Azar et al. measure monopsony power using regional variation in the concentration of online job postings, our study derives monopsony power from structurally estimated parameters.

Our model is based on the wage-posting model by Bontemps et al. (1999). The model accounts for heterogeneity in both firms' productivity and unemployed workers' reservation wages. It does not restrict the sign of unemployment effects of minimum wages a priori and allows for non-linearities in the effects. Following Shephard (2017), we extend the model to allow for different job offer arrival rates for the employed and the unemployed and let firms optimally choose their recruiting intensity.[1]

We study the employment effects of a minimum wage in the context of Germany, which introduced a statutory minimum wage in 2015. Prior to this, minimum wages had existed only at the sectoral level in a small number of industries. The minimum wage introduced in 2015 was set at a uniform level of 8.50 euros.[2] Estimating our model for a country in which a minimum wage was only recently introduced has an important advantage. The shapes of the heterogeneity distributions are important determinants of the magnitude of minimum wage effects. However, data from a market with a minimum wage are not informative on the shapes of the left-hand tails of these distributions, as the minimum wage effectively left-truncates wage outcomes (see e.g. Bontemps et al., 1999). To study counterfactual minimum wage effects, it is useful to have data from periods without minimum wages, as the

[1] Engbom and Moser (2018) use a similar wage-posting model, extended for heterogeneity in workers' ability, to study the role of the minimum wage in the decline of earnings inequality in Brazil. A closely related literature assumes wage bargaining instead of wage posting; Flinn (2006) provides an application of these models to analyse minimum wage effects; see also Breda et al. (2019).

[2] While a number of transitional measures respected existing collective agreements and those signed in the meanwhile, the uniform minimum wage applied to all industries by 2017 at the latest. A further transitory exemption was given to those industries where industry-specific minimum wages had already been introduced prior to 2015 via the Posting of Workers Act (*Arbeitnehmerentsendegesetz*). The bargaining parties in an industry subject to this legislation may request that the Federal Ministry of Labour declares its (minimum wage) agreement to be generally binding for the entire industry.

latter data enable identification of the heterogeneity distributions across agents on larger parts of their support. In particular, in the German context, data from before 2015 allow for identification of the effects of minimum wages below the minimum wage that was imposed in 2015. In the paper, we return to the policy change in 2015 at various instances.

Our empirical analysis relies on a large administrative data set, the IAB Sample of Integrated Employment Biographies (SIAB). The SIAB is a two per cent random sample of individuals subject to social security contributions during the time period 1975 to 2014. We focus on data from the period 2010–2013 and leave out 2014 because of potential anticipation effects. The SIAB data provide an ideal basis for estimating a structural equilibrium search model for several reasons. First and most importantly, the data allow us to precisely measure the duration of different labour market states and transitions between them, notably job-to-job as well as employment-to-unemployment transitions. These transitions are crucial to the identification of the model's central parameters, such as job arrival and destruction rates. Second, as the data are based on employers' notifications to the social security authorities, they are less prone to measurement error than comparable information from survey data. Additional advantages over survey data include the larger sample size and absence of panel attrition. We focus on low- and medium-skilled individuals because for these groups the assumption of a wage posting model is more convincing than for high-skilled individuals. The SIAB data do not include information on hours worked. We therefore focus on full-time employment spells and disregard individuals who are employed part-time during the time period under consideration.

Based on our structural model, we find that the introduction of the minimum wage of 8.50 euros in 2015 had a small positive effect on the employment of this group. According to our simulations, the unemployment rate falls from 9.2% (in the baseline level without a minimum wage) to 8.5%, a decrease of 0.7 percentage points. The positive effect is driven by West Germany, where unemployment falls by 0.9 percentage points (9% of the benchmark level). For East Germany, the introduction of the minimum wage leads to an increase in the unemployment rate of 1.2 percentage points, or 12% of the benchmark level.

Our finding of positive or at most small negative unemployment effects of the minimum wage contrasts with earlier predictions of strong job losses that were based on models with perfect competition (Ragnitz and Thum, 2008; Bauer et al., 2009; Knabe and Schöb, 2009; Braun et al., 2020). In such a framework, the effects of a minimum wage can by construction only be zero (if the minimum wage is not binding) or negative. Braun et al. (2020) also find strong negative employment effects in models with monopsony power, which vary greatly with the parameter values used in the calibration.

The studies that have evaluated the introduction of the minimum wage in 2015 using quasi-experimental variation have found no or at most a small negative effect on employment (see the surveys by Bruttel, 2019 and Caliendo et al., 2019 and Section 7.4 below). While these ex-post studies focus on the short-run consequences, our approach looks at long-run effects by contrasting the steady-state equilibria before and after the introduction of the minimum wage. Moreover, our structural approach is informative about the underlying transmission mechanisms and allows us to assess the effect of counterfactual policies. We find that, in the German context of 2010–2013, unemployment is a non-monotonic function of the minimum wage level. For a relatively wide range of minimum wage levels, the unemployment rate is slightly lower than its benchmark level because a higher share of the unemployed receive acceptable wage offers. This positive effect tapers out at a minimum wage level of about 12.50 euros because there is little mass left in the reservation wage density beyond this point. Thereafter, unemployment is almost exclusively frictional. At a minimum wage of 14 euros, the unemployment rate reaches its baseline level again from below. The search frictions and hence the unemployment rate then continue to grow as firms respond to higher minimum wages by lowering their recruiting intensity.

Our estimates suggest that different segments of the German labour market differ in the distribution of reservation wages, firm productivity, search frictions, and the ensuing degree of employers' market power. These differences mean that, while the general mechanisms of the minimum wage effects on unemployment are the same throughout, they operate with different strength and set in at different levels of the minimum wage. In addition to the differences between East and West Germany already noted, we document differences by job classifications. We find that for sales jobs and especially office jobs and white-collar jobs, even relatively high minimum-wage levels do not increase the unemployment rate compared with its benchmark level, while negative effects set in much earlier for service jobs and production and craft jobs.

Finally, we run simulations with counterfactual parameter combinations to find out to what extent the differences in the unemployment effects of the minimum wage across labour market segments are driven by differences in the distribution of reservation wages and search frictions as opposed to productivity differences. We find that the lower productivity in East Germany explains most of the negative unemployment effects there. For job classifications, productivity differences again play a major role, but – in line with the recent study by Azar et al. (2019) – differences in monopsony power resulting from search frictions are also important.

The remainder of the paper is structured as follows: Section 2 gives a brief overview of the model. Section 3 provides a description of the data set and the construction of our main variables of interest, and Section 4 presents descriptive statistics. Section 5 outlines the estimation procedure. Section 6 contains the estimation results and graphical representations of the key steady-state relationships. Section 7 shows simulation results for the counterfactual introduction of different minimum wage levels and compares our findings with the existing reduced-form evidence. Section 8 concludes.

2. Theoretical Model

In this section, we provide a brief description of the model. The framework is based on the model by Bontemps et al. (1999), which is extended by allowing the job offer arrival rate to differ across employed and unemployed individuals and by letting firms optimally choose their recruiting intensity and thus the job offer arrival rates, as in Shephard (2017) and Engbom and Moser (2018). We start by describing firms' and individuals' strategies. Individuals maximise their expected steady-state discounted future income and are characterised by heterogeneous opportunity costs of employment denoted by b, which may include search costs and unemployment benefits. The distribution of b is denoted by H, assumed to be continuous over its support $[\underline{b}, \overline{b}]$. Job offers arrive at constant rate $\lambda_0 > 0$ ($\lambda_1 > 0$) for the unemployed (employed) and are characterised by a draw from a wage offer distribution F with support $[\underline{w}, \overline{w}]$. Layoffs arrive at constant rate δ. Unemployed individuals searching for a job face an optimal stopping problem, the solution to which consists in accepting any wage offer w such that $w > \phi$. Employed individuals, in contrast, accept any wage offers strictly greater than their present wage contract. As in Mortensen and Neumann (1988) and Bontemps et al. (2000), the reservation wage is implicitly defined as

$$\phi = b + (\kappa_0 - \kappa_1) \int_{\phi}^{\overline{w}} \frac{\overline{F}(x)}{1 + \frac{\rho}{\delta} + \kappa_1 \overline{F}(x)} dx, \tag{1}$$

where ρ denotes individuals' discount rate, $\overline{F}(x) = 1 - F(x)$, and $\kappa_i = \frac{\lambda_i}{\delta}$, $i = 0, 1$. The distribution of reservation wages, A, is then given by

$$A(\phi) = H\left(\phi - (\kappa_0 - \kappa_1) \int_{\phi}^{\overline{w}} \frac{\overline{F}(x)}{1 + \frac{\rho}{\delta} + \kappa_1 \overline{F}(x)} dx\right). \tag{2}$$

Equating equilibrium flows into and out of unemployment[3], the fraction of unemployed with a reservation wage no larger than ϕ for $\phi \leq \underline{w}$ is represented by

$$uA_u(\phi) = \frac{1}{1 + \kappa_0} A(\underline{w}). \tag{3}$$

For $\phi > \underline{w}$, the fraction is given by

$$uA_u(\phi) = \frac{1}{1 + \kappa_0} A(\underline{w}) + \int_{\underline{w}}^{\phi} \frac{dA(x)}{(1 + \kappa_0 \overline{F}(x))}. \tag{4}$$

From this, one can derive the steady-state equilibrium unemployment rate as

$$u = \underbrace{\frac{1}{1 + \kappa_0} A(\underline{w})}_{\substack{\text{(1) unemployed} \\ \text{who accept any job offer}}} + \underbrace{\int_{\underline{w}}^{\overline{w}} \frac{dA(b)}{(1 + \kappa_0 \overline{F}(b))}}_{\substack{\text{(2) unemployed} \\ \text{who accept/reject offers}}} + \underbrace{(1 - A(\overline{w}))}_{\substack{\text{(3) unemployed} \\ \text{who accept no offer}}} \tag{5}$$

Moreover, similar to Bontemps et al. (1999) one can show that in steady-state there exists a unique relationship between the unobserved offer and the observed earnings distribution

[3] For details see Bontemps et al. (1999, equations (2)–(5)).

functions. Equating the flow of layoffs and upgraded wages of those with a wage lower than or equal to w and the flow of unemployed individuals accepting w, the distribution of earnings $G(w)$ is derived as

$$G(w) = \frac{A(w) - \left[1+\kappa_0 \overline{F}(w)\right]\left[\frac{1}{1+\kappa_0}A(\underline{w}) + \int\limits_{\underline{w}}^{w} \frac{1}{1+\kappa_0\overline{F}(x)} dA(x)\right]}{\left[1+\kappa_1\overline{F}(w)\right](1-u)}. \tag{6}$$

Each firm offers only one wage and incurs a flow p of marginal revenue per worker. Firms are heterogeneous in their productivity p. The distribution of p across active firms is denoted by $\Gamma(p)$ and is assumed to be continuous over its support $[\underline{p}, \overline{p}]$. Following Shephard (2017), firms choose their optimal level of recruiting intensity ν, which allows them to alter the rate at which they encounter potential employees independent of the offered wage rate. The cost of recruiting effort, c, is a function of ν and p, such that $c(\nu, p)$ may differ across firms. The recruiting cost function takes the form $c(\nu, p) = c(p) \cdot \nu^{\eta}/\eta$, with $c(p) > 0$ and $c(0, p) = 0$ for all p. To ensure convexity of this function, η needs to be greater than one. Shephard (2017) sets η equal to two. We set η equal to 1.75, which is closer to estimates based on German data.[4]

The number of workers that a firm attracts at wage w and recruiting intensity ν is denoted by $l = l(w, \nu)$. In what follows, the conditional firm size will be defined as $l(w, \nu) = \overline{l}(w, \nu) \cdot \nu/V$, with V representing the aggregate recruiting intensity:

$$V = \int\limits_{\underline{p}}^{\overline{p}} \nu(p) d\Gamma(p),$$

where $\nu(p)$ denotes the recruiting intensity of a firm with productivity p. The number of workers, $\overline{l}$, per unit intensity attracted by a firm that offers wage w solves

$$\overline{l}(w) = \frac{d(1-u)G(w)}{dF(w)},$$

and therefore

$$\overline{l}(w) = \frac{\kappa_1 A(w)}{\left(1+\kappa_1\overline{F}(w)\right)^2} + \frac{\kappa_0 - \kappa_1}{\left(1+\kappa_1\overline{F}(w)\right)^2}\left[\frac{1}{1+\kappa_0}A(\underline{w}) + \int\limits_{\underline{w}}^{w} \frac{1}{1+\kappa_0\overline{F}(x)} dA(x)\right]. \tag{7}$$

It can be shown that $\overline{l}(w)$ is a non-decreasing function of the offered wage. Note that the last term distinguishes $\overline{l}(w)$ from the original model by Bontemps et al. (1999), where $\lambda_0 = \lambda_1$. The term reflects that if $\lambda_0 \neq \lambda_1$, the number of employed and unemployed individuals that are attracted by the firm at a wage w may differ from each other.

[4] Using a stylized labour demand model, Muehlemann and Pfeifer (2016) estimate an elasticity of recruiting costs with respect to the number of hires of 1.3 to 1.4. In an earlier discussion paper version, the authors also provide estimates of the elasticity of job posting costs with respect to the number of hires, which amounts to about 1.7 to 1.8 (Muehlemann and Pfeifer, 2013).

Each firm seeks to maximise its steady-state profit flow, by choosing its optimal wage $w(p)$ and recruiting intensity $\nu(p)$. The latter are determined by

$$(w(p),\nu(p)) = \underset{w(p),\nu(p)}{\operatorname{argmax}}\left[\overline{\pi}(w,p)\cdot\frac{\nu}{V} - c(\nu,p)\right].$$

$\overline{\pi}(p,w) = (p-w)\cdot\bar{l}(w,\nu)$ represents the expected profit flow per unit intensity, with $\bar{l}(w,\nu)$ denoting the size of a firm's labour force per unit intensity, such that $l(w,\nu) = \bar{l}(w,\nu)\cdot\nu/V$. The first-order condition defining the optimal recruiting intensity, ν, is given by

$$\frac{\partial c(\nu,p)}{\partial\nu} = \frac{\overline{\pi}(w(p),p)}{V} - c(p)\cdot\nu(p) = 0.$$

Following Shephard (2017), we set $\nu(p) = 1$ in the benchmark, such that $c(p) = \overline{\pi}(w(p),p)$ in the pre-reform setting.[5] With $w = K(p)$ denoting the function that maps the support of the productivity distribution Γ into the support of the wage offer distribution F, we have $F(K(p)) = \int_{\underline{p}}^{p}\nu(y)/V d\Gamma(y)$. With $\nu(p) = 1$ in the benchmark, $F(K(p)) = \Gamma(p) = \Gamma(K^{-1}(w))$. The solution to the optimal wage setting problem of a p-type firm is represented by

$$K(p) = p - \left\{\frac{\kappa_0(\underline{p}-\underline{w})}{(1+\kappa_0)(1+\kappa_1)}A(\underline{w}) + \int_{\underline{p}}^{p}\bar{l}(K(x))dx\right\}\frac{1}{\bar{l}(K(p))}. \tag{8}$$

To complete the model, the total flow of matches is given by $M(V,S)$, with V denoting the aggregate recruiting intensity as defined above. S is the number of employed and unemployed individuals weighted by their search effort, i.e. $S = s_0\cdot u + s_1\cdot(1-u)$, with s_0 and s_1 being the search effort of unemployed and employed individuals, respectively. M is assumed to increase in both, V and S, and to be concave and linearly homogeneous. The model is closed by specifying unemployed and employed individuals' job offer arrival rates, λ_j, with $j = 0,1$, as the search effort weighted meeting rates, such that $\lambda_j = s_j\cdot M(V,S)/S$. The matching function is parametrised as Cobb-Douglas, i.e. $M(S,V) = V^{\theta}\cdot S^{(1-\theta)}$. As in Shephard (2017), we set θ equal to 0.5.

3. Data

Our empirical analysis uses German register data, the IAB Sample of Integrated Employment Biographies (SIAB). This administrative data set, which is described in more detail by Ganzer et al. (2017), is a two per cent random sample of all individuals who have at least one entry in their social security records between 1975 and 2014 in West Germany and between 1991 and 2014 in East Germany, respectively. The SIAB data cover approximately 80 per cent of the German workforce, providing longitudinal information on the employment biographies of 1,707,228 individuals. Self-employed workers, civil servants, and individuals doing military service are not included in the SIAB.

[5] As shown by Shephard (2017, Appendix F.1), the worker equilibrium does not depend on the assumptions concerning the recruiting cost function.

The data provide an ideal basis for estimating a structural equilibrium search model for several reasons. First and most importantly, the data contain daily information on employment records subject to social security contributions, unemployment records of benefit recipients as well as of registered job seekers. This permits us to precisely measure the duration of different labour market states and the transitions between them, notably job-to-job transitions as well as transitions between employment and unemployment (while receiving or not receiving benefits). Second, due to their administrative nature the data are less prone to measurement error than comparable information from survey data. Additional advantages over survey data include the larger sample size and a much more limited degree of panel attrition.

Sample selection proceeds in several steps. Before restricting the sample to a specific time span and population, we fill in missing values using all the information available in the full dataset (see Appendix A.1). We construct a stock sample by keeping only those employment and unemployment spells[6] including the set date 1 January 2010 and restrict the sample to the period 2010 to 2013. We omit 2014 so that our estimates are not affected by the potential anticipation of the minimum wage. This leads to a sample of 684,538 individuals.

From this sample we select only individuals who are part of the workforce. The data do not make it possible to distinguish between involuntarily unemployed individuals not receiving benefits and individuals who voluntarily left the labour force or who became self-employed or civil servants. To distinguish more precisely between voluntary and involuntary unemployment, we follow the assumptions proposed by Lee and Wilke (2009) (see Appendix A.2).

To focus on individuals in the workforce, we restrict the sample to individuals who are at least 20 years old and younger than 63 years. The sample is further restricted to low- and medium-skilled individuals.[7] We exclude highly skilled individuals because this group is less likely to be in a labour market that is characterised by a wage-posting mechanism. We then drop individuals who still have missing values in the relevant observables, such as daily wages, the educational and occupational status as well as the region (East or West Germany). Furthermore, we exclude agricultural professions because their employment durations are often characterised by seasonality. This leads to a new sample size of 360,535 individuals.

The SIAB data do not include information on hours worked. We therefore focus on full-time employment spells and disregard individuals who are employed part-time during the time period under consideration.

To calculate hourly wages for full-time employment spells, we impute the number of hours worked based on information from the German Microcensus. The imputation is done separately by region, sex, sector, job classification, and educational degree.[8]

In the model, each job is characterised by a single, time-invariant wage. For individuals who were employed on 1 January 2010, we compute this wage as the weighted average of the wages earned over the past year in the same job, where the weights are given by

[6] Details on the definition of the different labour market states are given in Appendix A.2.
[7] Details on the definition of the different skill groups are given in Appendix A.1.
[8] For details, see Appendix A.3.

the length of time over which a particular wage was received. Likewise, the wage after an unemployment-to-employment spell is based on the weighted average over the first year after the transition.[9] To reduce the influence of outliers, we discount observations with implausibly low hourly wages (wages below 3 euros or below the existing sectoral minimum wages). The resulting final sample contains information on 219,448 individuals.

The wage information in the IAB data is censored since there is an upper contribution limit in the social security system. We do not include observations with censored wages.[10]

The model assumes that worker productivity is homogeneous. Following Bontemps et al. (1999), we therefore estimate the model separately for different labour market segments. In this way, we treat each segment as a separate labour market characterised by its own structural parameters and its own distributions of reservation wages and firms' productivities. The underlying assumption of this approach is that there is no mobility between segments and no competition among firms across different segments. As individuals of different gender or age are likely to compete within one segment, we define the segments based on five job classifications (occupation types, see Appendix A.6) or two regions (East Germany and West Germany including Berlin). These two dimensions allow us to define fairly well (though not perfectly) segmented labour markets. As Tables 2 and 4 show, 95.9% of employment-to-employment transitions remain in the same region, and 79.2% remain in the same job classification. As for unemployment-to-employment transitions, 94.8% occur within the same region, 74.6% within the same job classification (see Tables 3 and 5).

4. Descriptives

4.1. Transitions

Tables 6 and 7 in Appendix A.7 report the type, number, and share of transitions for our stock sample of individuals who were either unemployed (8.8%) or employed (91.2%) on 1 January 2010. Of the 200,147 individuals who were employed on this date, 69% stayed in their job for the next four years while 20% moved to another job and 11% became unemployed. Transitions in the other direction are much more frequent in relative terms: 45% of the 19,301 unemployment spells ended with a transition into regular employment during the four-year period after 1 January 2010. At the same time, 55% of individuals who were unemployed on this date remained without a job over the entire period.[11]

The table also breaks down these statistics by region and job classification. About 84% of the individuals in the sample worked or searched for a job in West Germany (including Berlin), the remaining 16% in East Germany. On 1 January 2010, the unemployment rate was higher in East Germany (11%) than in West Germany (8%). However, the fraction

[9] For details, see Appendix A.4.

[10] For details, see Appendix A.5. In a robustness check, we address this issue by replacing censored observations with imputed wages, following Gartner (2005).

[11] Left-censoring can occur for the unemployment spells (1%) because in some of the data sources for unemployment benefit histories, recording starts at a fixed date which does not necessarily coincide with the beginning of the unemployment spell (see Appendix A.2).

of unemployed individuals finding a new job over the four-year observation window was almost identical in East and West Germany (about 44%). Looking at transitions of employed individuals, we find that most individuals stayed at their current employer, while around 20% of the employed individuals in West Germany and 19% in East Germany changed their employer within the four years. The relative frequency of transitions into unemployment was higher in East Germany (13%) than in West Germany (10%).

As for the five job classifications, note the large number of observations for "production, craft" occupations which are still fairly important in Germany and especially in our sample of low- and medium-skilled individuals. The unemployment rate on 1 January 2010 varied between 4% in white-collar jobs and 11% in production. The share of unemployment-to-employment transitions was highest in production, craft occupations (52%). At the other end of the spectrum, only 30% of the unemployed individuals in sales found work within the next four years.

4.2. Durations

Figure 7 in Appendix A.7 shows non-parametric Kaplan-Meier estimates of the survival function for remaining in the initial state (employment or unemployment) for the whole sample. The survival functions are also shown for the different sub-samples defined by region (Figures 8) and job classification (Figure 9). In our data, the maximum duration of an unemployment spell is nine years.[12] Employment spells can in principle last over the whole observation period: 39 years in West Germany (1975–2013) and 22 years in East Germany (1992–2013).[13]

Transitions out of Unemployment The chance of transitioning into employment is particularly high within the first year – about 60% of the unemployed were still without a job after twelve months (cf. panel (a) in Figure 7). By the third year, about 50% of the unemployed had not found employment, and after the third year the survival function flattens out. As can be seen in panel (a) of Figure 8, the pattern is similar for East and West Germany, but there is substantial variation across job classifications (Figure 9). In while-collar jobs around 55% of the unemployment spells were shorter than two years. In production and craft jobs, the largest group, around 40% of the unemployment spells last

[12] "Unemployment benefit I" (ALG I), a non means-tested transfer which is part of the unemployment insurance system, is typically paid for only one year (two years for older workers). Once ALG I runs out, the unemployed are entitled to the much lower and means-tested "unemployment benefit II" (ALG II), which was introduced on 1 January 2005. Before 2005, ALG I was followed by "Arbeitslosenhilfe" instead of ALG II. This means that individuals receiving "Arbeitslosenhilfe" before 2005 were entitled to ALG II afterwards. However, spells of receiving ALG II are only recorded in the data from 1 January 2007 onwards. This makes 1 January 2005 the earliest starting point for unemployment spells in our data. These spells refer to those individuals who received ALG I benefits during 2005 and 2006 and who were entitled to ALG II afterwards (starting from 2007). As our sample covers the period 2010–2013, the maximum duration of an unemployment spell is nine years.

[13] 1.26% of the employment spells are left-censored which means employment without interruption at the same firm since 1 January 1975 in West Germany or since 1992 in East Germany. We disregard employment spells recorded in 1991 in East Germany.

two years or less. At the other end of the spectrum, unemployed individuals who formerly had sales and service jobs tend to have long unemployment durations.

Transitions out of Employment For individuals who were initially employed, transitions can be either into another job (panel (b) in Figures 7 to 9) or into unemployment (panel (c)). The durations of employment spells that end because of unemployment are in general longer than employment spells that end in a job-to-job transition. With regard to employment-to-employment transitions, the probability of still being employed at the current employer is typically around 75% after fifteen years. The durations of employment spells do not differ significantly between East and West Germany.

Regarding job classifications, sales jobs stand out both for transitions into other jobs and for transitions into unemployment; at each point in time, the share of the employed who have left their initial job for one of these destinations is particularly high. Employees in production and craft tend to have the longest employment durations, with a large fraction of employment spells being right-censored.

4.3. Wage Distributions

Figure 10 in Appendix A.7 shows the distribution of wages before and after a labour market transition for the whole sample. As part of the descriptives, we include all three types of transitions (e $\rightarrow$ e, e $\rightarrow$ u, u $\rightarrow$ e) and also document the wage distributions for right- and left-censored spells. In the estimation, only the wages in the initial employment spell or after a transition from unemployment to employment will be used.

As expected, wages of individuals who change their job tend to be higher than wages before a transition into unemployment. Comparing wages before and after a job-to-job transition, we find that wages earned in the new job are on average slightly higher than the wages earned in the old position. Also in line with expectations, wages after an unemployment-to-employment transition tend to be relatively low. A sizeable fraction of the unemployed move to jobs paying less than 8.50 euros an hour, the statutory minimum wage introduced in 2015, i.e. after our sampling period 2010–2013. This also holds within the different labour market segments defined by region (Figure 11) and job classification (Figure 12 in Appendix A.7).

These figures confirm the well-known fact that wages tend to be lower in East Germany and also document variation in hourly wages across job classifications. We find that on average wages are higher for production and craft employees as well as for office workers while wages are lower among service workers, and for individuals working in sales.

5. Estimation

We begin this section by deriving the likelihood contributions of unemployed and employed workers, taking into account stock sampling as well as left- and right-censoring. We then outline the estimation procedure, which combines the likelihood function with a non-parametric estimate of the wage distribution.

Likelihood – Unemployed Workers As seen in Equation (5), the steady-state unemployment rate has three components. For individuals with low enough opportunity costs of employment, unemployment is purely frictional. In a second group, unemployment is driven by both search frictions and the opportunity cost of employment; these individuals will accept some job offers, but reject others. Finally, there is a third group for whom unemployment is permanent given the wage offer distribution F, as any wage offer is below their reservation wage. As a result, the likelihood contribution of an individual who is initially unemployed is a mixture distribution:

$$\lambda_0^{2-d_b-d_f} \cdot e^{-\lambda_0\left(t_{0b}+t_{0f}\right)} \cdot \frac{A(\underline{w})}{1+\kappa_0} \cdot f(w_0)^{1-d_f} + \int_{\underline{w}}^{d_f\overline{w}+(1-d_f)w_0} \left(\lambda_0\overline{F}(x)\right)^{2-d_b-d_f} \cdot e^{-\lambda_0\cdot\overline{F}(x)\cdot\left(t_{0b}+t_{0f}\right)} \cdot \frac{f(w_0)}{\overline{F}(x)}^{1-d_f} \cdot \frac{dA(x)}{1+\kappa_0\overline{F}(x)} + \left[1-A(\overline{w})\right]^{d_b\cdot d_f}. \quad (9)$$

The first term of the sum corresponds to purely frictional unemployment. As job offers arrive with Poisson rate λ_0, unemployment durations are exponentially distributed. In a flow sample, where the elapsed ("backward") duration t_{0b} is zero by definition, the density of the residual ("forward") duration t_{0f} is given as $h(t_{0f}) = \lambda_0 \exp(-\lambda_0 t_{0f})$. In a stock sample, we need to consider the total duration $t_{0b}+t_{0f}$, conditional on the elapsed duration t_{0b}. The latter has the density $h(t_{0b}) = \lambda_0 \exp(-\lambda_0 t_{0b})$. It can be shown (e.g., Lancaster, 1990) that the conditional density $h(t_{0f}|t_{0b})$ is given as $\lambda_0 \exp(-\lambda_0 t_{0f})$. For the joint density we then obtain $h(t_{0b}, t_{0f}) = h(t_{0f}|t_{0b})h(t_{0b}) = \lambda_0^2 \exp\left(-\lambda_0(t_{0b}+t_{0f})\right)$, which is the term that figures in the likelihood expression above. The term in front of the exponential function is adjusted if either the elapsed or the residual duration is censored ($d_b = 1$ or $d_f = 1$). $f(w_0)$ is the density function of wage offers evaluated at the offer that we observe as the initially unobserved person transits into employment. If the unemployment duration is right-censored ($d_{0f} = 1$), this term drops out of the likelihood function.

The second term of the sum has the same basic structure, but with some adjustments for the fact that individuals in this group are sometimes faced with wage offers that are below their reservation wage. The unemployment spell hazard rate is therefore given not by λ_0, but by the product $\lambda_0\overline{F}(b)$. The second adjustment concerns the wage offer density, which is now truncated at b, so we have $f(w_0)/\overline{F}(b)$.[14]

Finally, the third term applied to individuals who, given F, are permanently unemployed. This implies that the observed unemployment spell must be both left- and right-censored, hence the $d_b \cdot d_f$ in the exponent.

[14] Note that as $\overline{F}(b) = 1$ for $b < \underline{w}$, the first term of the sum could be integrated into the second term. We choose to present them separately here to better reflect the conceptual difference between the three components behind the unemployment rate.

Likelihood – Employed Workers For individuals who are initially employed, the likelihood contribution is

$$(1-u)\cdot g(w_1)\cdot\left[\delta+\lambda_1\overline{F}(w_1)\right]^{1-d_{1b}}\cdot e^{-\left[\delta+\lambda_1\overline{F}(w_1)\right](t_{1b}+t_{1f})}\left[\delta^v\left(\lambda_1\overline{F}(w_1)\right)^{1-v}\right]^{1-d_{1f}}. \quad (10)$$

In steady state, a fraction $(1-u)$ of all individuals is employed. g is the density of wages in the initial job. Unlike for the unemployed, the reservation wage of a worker is observed and equals his or her current wage, so there is no mixing distribution for the durations. However, there are now two competing reasons for why a spell may end: layoff (at rate δ) or a better job offer (at rate $\lambda_1\overline{F}(w)$). The indicator v equals 1 in the first case and 0 in the second. t_{1b} denotes the elapsed duration, and t_{1f} the residual duration of the current job. d_{1b} equals 1 if the elapsed duration is left-censored, while $d_{1f}=1$ means that the residual duration is right-censored, i.e. the individual does not change his or her job during the observation period.

Estimation Procedure Maximum likelihood estimation of the model requires functional form assumptions for H and Γ. The estimation is numerically cumbersome as f, g, and $\overline{F}$ are highly non-linear functions of Γ. In particular, optimisation involves the numerical computation of the inverse K^{-1}, further complicated by the fact that K contains an integral that has to be evaluated numerically as well. Beyond these numerical concerns, there is the issue that most distributions for Γ imply wage distributions that do not fit the data well.

As an alternative, Bontemps et al. (2000) therefore propose a three-step procedure in which the wage distribution is estimated non-parametrically:

1. In a first step, we estimate G and g (the cdf and pdf of the wage distribution) using a kernel density estimator, and estimate $\underline{w}$ and $\overline{w}$ as the sample minimum and maximum of the wages of workers who are employed on 1 January 2010. Based on these non-parametric estimates and a parametric assumption for the opportunity cost distribution, namely $H\sim\mathcal{N}(\mu_b,\,\sigma_b^2)$, and setting $\nu(p)=1$ in the benchmark, we obtain consistent estimates for $\overline{F}$ and f (conditional on $\mu_b,\sigma_b,\lambda_0,\lambda_1,\delta$ and the assumption that $\rho=0.02$) by numerically solving the following expressions (recall that u is a function of $\overline{F}$):

$$\widehat{\overline{F}}(w)=\frac{A(w)-uA_u(w)-(1-u)\widehat{G}(w)}{\kappa_1\cdot\widehat{G}(w)\cdot(1-u)+\kappa_0\cdot u\cdot A_u(w)} \quad (11)$$

and

$$\widehat{f}(w)=\frac{(1-u)\cdot\widehat{g}(w)\cdot(1+\kappa_1\hat{\overline{F}}(w))}{\kappa_0\cdot u\cdot A_u(w)+\kappa_1\cdot(1-u)\cdot\widehat{G}(w)}. \quad (12)$$

2. The estimates from Step 1 are plugged into the likelihood function, which is then maximised with respect to μ_b, σ_b, λ_0, λ_1, and δ.

3. Once these parameters are known, the productivity of a firm can be inferred from the

wage that it offers:

$$p = K^{-1}(w)$$
$$= w + \left(\frac{\kappa_0 \cdot A'(w) \cdot (1 + \kappa_1 \cdot \widehat{\overline{F}}(w))}{(1 + \kappa_0 \cdot \widehat{\overline{F}}(w)) \cdot (\kappa_1 A(w) + (\kappa_0 - \kappa_1)) \cdot u \cdot A_u(w)} + \frac{2 \cdot \kappa_1 \cdot \widehat{f}(w)}{1 + \kappa_1 \cdot \widehat{\overline{F}}(w))} \right)^{-1} \tag{13}$$

Standard errors are obtained by bootstrapping the three-step procedure.

6. Estimation Results

6.1. Parameter Estimates

Table 1 reports the estimated parameters and the associated bootstrap standard errors.[15] For the whole sample, we estimate a monthly job destruction rate δ of 0.0063. The rate is about 20% higher in East Germany than in the West (0.0072 vs. 0.0061). Sales jobs have the highest job destruction rate (0.0081), white-collar jobs the lowest (0.0051). These orders of magnitude are similar to existing studies. For France in the 1990s, Bontemps et al. (1999) find a δ between 0.0032 and 0.0069, depending on the sector. Using SIAB data for an earlier period (1995–2000), Nanos and Schluter (2014) estimate the monthly layoff rate to be between 0.0032 and 0.0243 in Germany. Holzner and Launov (2010), who use data from the German Socio-Economic Panel 1984–2001, estimate a δ of 0.0047.

The estimated κ, i.e., the ratio of the job arrival over the job destruction rate, is greater for the unemployed than for the employed. We find κ_0 to be 18.31 and κ_1 to be 6.95. Holzner and Launov find a κ_1 of 2.2, while their three values of κ for the unemployed (they assume that individuals search on skill-specific labour markets) range between 5.6 and 17.1. In their study for France, Bontemps et al. (2000) also estimate a much higher job arrival rate for the unemployed than for the employed. In all cases, this reflects that continental European labour markets are characterised by relatively little job-to-job mobility compared with the United States.

The differences between regions and job classifications are potentially relevant for the design of the new statutory minimum wage in Germany. After a transition period, the minimum wage became uniform for all workers by 2017 at the latest. Our results suggest that the uniform rate applies to labour market segments that differ in the extent of search frictions and thus in firms' monopsony power on the labour market.[16]

[15] While multiple equilibria cannot be ruled out (see van den Berg, 2003), we have not found evidence of this for any of our estimated or simulated equilibria.

[16] Bachmann and Frings (2017) adopt a different approach to quantify labour market frictions in Germany and estimate labour supply elasticities specific to the individual firm. Using linked employer-employee data from the IAB (LIAB), the authors document great differences in employers' market power across industries. Their findings indicate that retailing, hotels and restaurants and agriculture feature a larger degree of monopsonistic power than other services and manufacturing of food products. Note that even though their estimates are based on different sub-samples and time periods, they are well in line with our results, pointing to larger frictions in sales and service jobs than in production and white-collar jobs.

Table 1: Estimation results

	N	δ	κ_1	κ_0	μ_ϕ	μ_b	σ_b	u
Whole sample	219448	0.0063	6.95	18.31	6.11	0.00	3.58	0.0920
		(0.0000)	(0.10)	(0.33)	(0.04)	(0.00)	(0.05)	(0.0005)
Region								
West	185154	0.0061	7.32	18.66	6.28	0.00	3.91	0.0884
		(0.0000)	(0.10)	(0.28)	(0.03)	(0.00)	(0.06)	(0.0005)
East	34294	0.0072	5.05	17.27	5.71	0.00	3.82	0.0989
		(0.0001)	(0.14)	(0.58)	(0.06)	(0.00)	(0.09)	(0.0009)
Job classification								
Production, Craft	81748	0.0063	8.11	25.70	7.28	0.00	5.06	0.0845
		(0.0000)	(0.37)	(1.37)	(0.05)	(0.01)	(0.07)	(0.0005)
White-collar	23843	0.0051	10.82	30.02	7.64	0.00	4.66	0.0778
		(0.0000)	(0.92)	(2.73)	(0.09)	(0.00)	(0.11)	(0.0010)
Sales	12343	0.0081	4.08	11.03	5.10	0.00	2.15	0.1312
		(0.0001)	(0.15)	(0.52)	(0.08)	(0.00)	(0.10)	(0.0017)
Office	46698	0.0060	7.29	17.16	6.04	0.00	3.35	0.0948
		(0.0000)	(0.18)	(0.50)	(0.07)	(0.00)	(0.06)	(0.0008)
Service	54816	0.0070	5.60	14.79	5.25	0.00	3.74	0.0960
		(0.0000)	(0.16)	(0.52)	(0.07)	(0.00)	(0.12)	(0.0012)

Note: Calibrated parameters: $\rho = 0.02$. Bootstrapped standard errors in parentheses (50 runs).

According to our estimates, the distribution of the opportunity costs of employment has a mean μ_b close to 0 euros per hour, both in the whole sample and for the different sub-samples. The standard deviation σ_b is estimated to be 3.58 for the whole sample. However, unlike in the model of Bontemps et al. (1999), the reservation wages are not identical to the opportunity costs of employment. This is because job offer arrival rates are higher when unemployed, so it is optimal for the unemployed to reject certain wage offers in the hope of getting a higher offer in the future (cf. Equation (1)). Based on the estimated parameters, we find that the distribution of reservation wages is centred around a value of about 6.11 euros per hour. The reservation wage is higher and slightly more dispersed in the West. Among job classifications, sales jobs stand out for having both the smallest mean (5.10 euros) and by far the smallest standard deviation of the reservation wage. White-collar workers and workers in production and craft have the highest reservation wages.

The differences in the reservation wages between the sub-samples are almost exclusively driven not by inherent differences in opportunity costs (recall that μ_b is close to zero everywhere), but by differences in the frictional parameters. For instance, the difference between κ_0 and κ_1 is particularly large for production and craft jobs and white-collar jobs and particularly small for sales jobs, which is reflected in a much higher μ_ϕ in the first two cases. Note that differences in κ_0 and κ_1 also reflect differences in layoff rates. The higher the layoff rate, the smaller the expression $\beta \equiv \rho/\delta$ in Equation (1), and thus the smaller the incentive for the unemployed to be picky when accepting a wage offer – after all, accepting a job already means giving up a higher job arrival rate. If the job has a higher probability of ending, the costs of accepting it in terms of foregone employment opportunities become smaller.

Finally, based on Equation (5) we can compute the steady-state unemployment rate u implied by our estimates. For the entire sample, we find a predicted rate of 9.2%, which is close to the rate of 8.8% observed in our stock sample. The variation in the predicted rate across regions and job classifications is broadly consistent with the patterns observed in the sample, i.e. steady-state unemployment is higher in the East than in the West and higher in sales jobs than in, say, white-collar jobs (cf. Table 7). The model tends to overpredict unemployment in white-collar, office, and sales jobs somewhat, while it underpredicts the rate in East Germany and production and craft jobs a little. For West Germany and for service jobs (as well as for the sample as a whole), the fit is nearly perfect.

6.2. Distribution of Wages, Opportunity Costs, Markups, Productivity

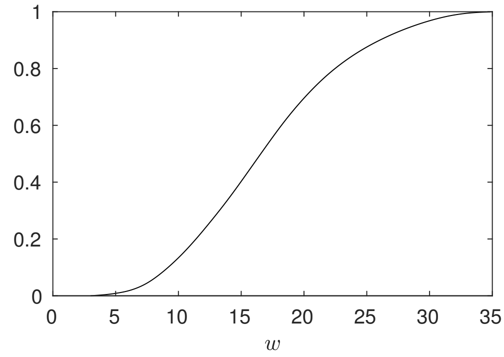
Figure 1 shows key plots for the whole sample summarising the steady-state equilibrium. Panel (a) depicts our non-parametric estimate for G, the cdf of the wage distribution. The pdf g, which is not shown here, is similarly estimated using a kernel density estimator.

To find the wage offer distribution F (panel (b)), the estimate for G is combined with the maximum likelihood estimates for the frictional parameters and the opportunity cost distribution, as outlined in Section 5 above. Note that the location and the shape of the wage offer distributions differ from the wage distribution. For instance, more than 70% of the wage offers but only about 10% of observed wages are below 10 euros.

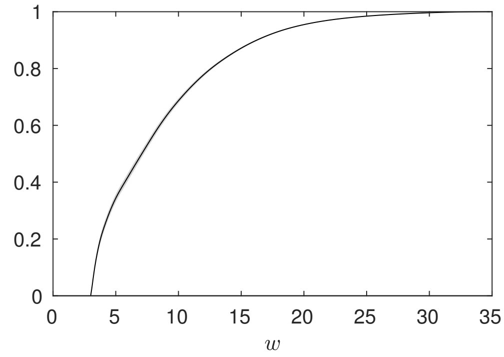
Panel (c) shows the estimated distribution of reservation wages. This is a normal distribution centred around $\mu_\phi = 6.11$ euros and truncated at 3 euros, the lowest admissible hourly wage. Note that there is hardly any mass left beyond 12.50 euros.[17] This means that the positive effect of higher minimum wages operating through a lower rate of job offer rejections will be mostly limited to minimum wage levels below this amount.

Panel (d) presents the optimal wage offer as a function of firm productivity p. For example, a firm with a value product of 20 euros per hour will optimally set a wage of about 15 euros per hour. The absolute markup, which is shown in a log-log-scale in panel (e), grows monotonically and at a fairly constant rate with a firm's productivity. Expressed as a percentage of productivity (panel (f)), the relationship is no longer (log-)linear: there is a relatively slow increase first, a plateau at productivity levels around 12-15 euros, and a strong increase thereafter. While the lowest-productivity firm has a markup of about 15%, the markup is over 90% for the firms with the highest productivity. Put differently, workers obtain less than 10% of the value product in these high-productivity firms. However, as the estimate of the productivity distribution Γ in panel (g) makes clear, such cases are fairly rare. Most firms have a value product of less than 20 euros per hour, and there is hardly any mass left beyond 40 euros per hour. Finally, panel (h) shows that our three-stage estimate of firm productivity results in a (non-parametric) distribution that is not too dissimilar from

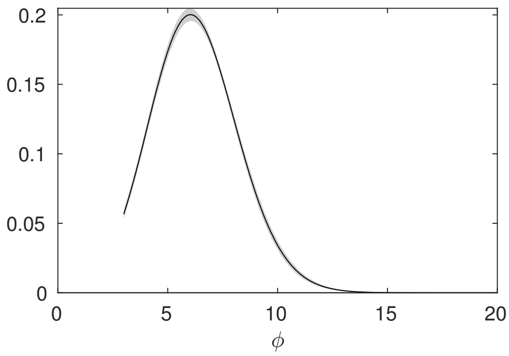
[17] The distribution of reservation wages is very close to the one estimated by Fedorets et al. (2018) based on a survey question from the Socio-Economic Panel.



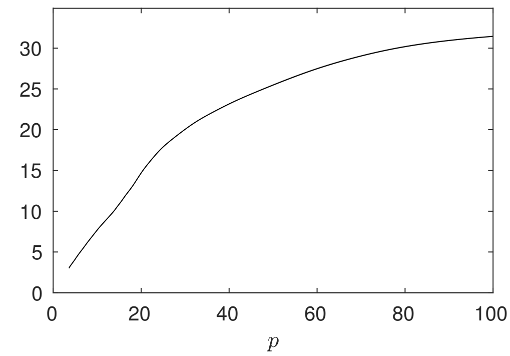
(a) Wage distribution $G(w)$



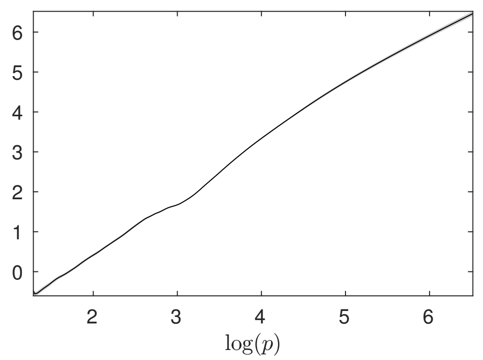
(b) Wage offer distribution $F(w)$



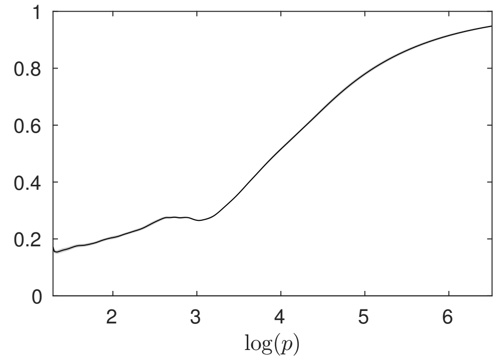
(c) Reservation wage density $A(w)$



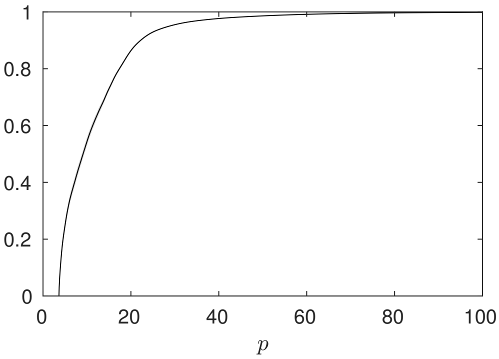
(d) Wage function $K(p)$



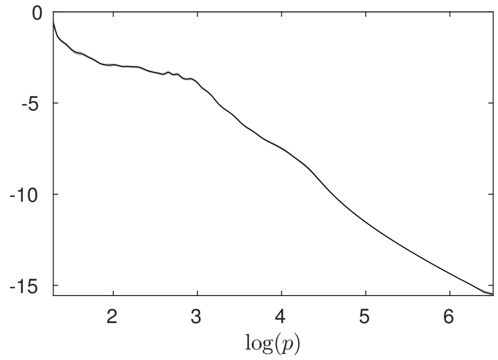
(e) Log absolute markup



(f) Monopsony power $[p - K(p)]/p$



(g) Productivity distribution $\Gamma(p)$



(h) Productivity log density $\log(\gamma(p))$

Key: Grey area indicates 95% confidence bands based on 50 bootstrap runs.

Figure 1: Main Equilibrium Functions – Whole sample

a Pareto distribution in that the density γ is a straight line in log-log-coordinates over a wide range of p.

The main equilibrium functions for the different labour markets defined by region and job classification can be found in Appendix A.8. Both the wage distribution and the wage offer distribution in West Germany lie to the right of the curves for East Germany. Firms in West Germany tend to be more productive, and they also offer higher wages for any given productivity level above 15-20 euros per hour. Below this range, the wage offer functions are almost identical in the East and in the West. This difference in wage setting is mirrored in the distribution of markups, which are higher in East Germany for productivity levels of about 15 euros and more. The relative markup in East Germany grows monotonically with productivity, while in West Germany there is a decline over a short range; these different shapes explain the plateau that is observed for the sample as a whole.

Across job classifications, the productivity distribution and also the wage offer distributions are fairly close together, but there are clear differences in reservation wages, wage-setting policies, and the wage distribution. Sales jobs in particular stand out for low reservation wages, low wage offers for a given firm productivity, and low observed wages. White-collar jobs are at the other end of the spectrum.

6.3. Robustness Checks

Table 8 in Appendix A.8 reports results from a number of robustness checks for the whole sample. First, instead of disregarding individuals with wages right-censored at the upper limit for social security contributions (SSC), we use a Tobit regression to impute wages above this limit. Second, we replace the imputation of working hours with the assumption that all full-time employees work 40 hours per week. Third, we experimented with different ways of assigning a single wage to employment spells that last over several years, during which time individuals typically experience wage increases. In the theoretical model, this cannot happen as each job is characterised by a single, time-invariant wage. In our main specification, we use the average wage in the same job over the past year. In a robustness check, we use the last observed wage only. The two measures differ to the extent that individuals experience wage changes within the last year. Fourth, we truncated the wage distribution at a different level. In our main specification, wages below 3.00 euros per hour are discarded. As a robustness check, we changed this threshold to 4.00 euros. Moreover, when replacing the right-censoring at the upper limit for SSC with an imputation procedure, we tried two variants in which we truncated the imputed wages at the 95th or 99th percentile. Finally, we set ρ, which is assumed to be 0.02 in our main specification, to alternative values (0.01 or 0.04). We also combined the robustness checks along the different dimensions. While the first three dimensions have a negligible impact on the parameter estimates, the assumptions regarding the truncation level and the discount rate ρ matter slightly more. However, the impact is limited to the estimates of the job offer arrival rates, while the other parameters remain almost unchanged. The following comparative statics results remain qualitatively very similar in all these specifications.

7. Unemployment Effects of Different Minimum Wage Levels

7.1. Pathways

Decomposition of the Unemployment Rate The unemployed fall into three different groups, as shown by the decomposition in Equation (5). Group (1) consists of individuals whose reservation wage is below $\underline{w}$, i.e., who will accept any job offer. This purely frictional unemployment decreases in κ_0, the ratio of the job arrival rate of the unemployed over the job destruction rate. For Group (2), unemployment is partly frictional (through κ_0) and partly driven by the interplay between the reservation wage and the wage offer distribution. Unemployed individuals in this group accept some job offers but reject others, depending on the wage offer. Finally, individuals in Group (3) are permanently unemployed because their reservation wage is higher than the highest wage offer $\overline{w}$.

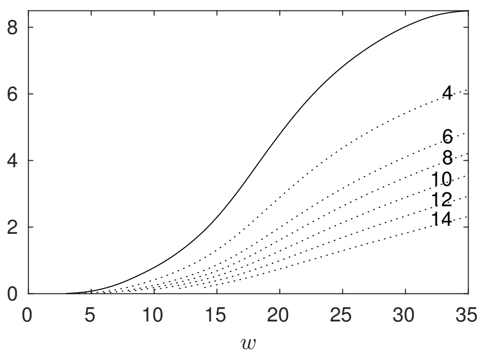
Effects through the Wage Offer Distribution For minimum wage levels below the lowest productivity level $\underline{p}$, the model predicts that a minimum wage *reduces* unemployment, as long as the minimum wage shifts up firms' optimal wage offers. The reason is that in this case unemployed individuals are now more likely to receive acceptable wage offers. With $\underline{w} = 3.00$ euros and our estimate for the wage offer function, this cutoff level is $\hat{\underline{p}} = \hat{K}^{-1}(3.00) = 3.62$ euros for the whole sample. The introduction of a minimum wage of, say, 3.10 euros limits firms' power to set wages below productivity. The lowest wage is now 3.10 euros instead of 3.00 euros and, via Equation (8), this increase has repercussions throughout the wage offer distribution.[18] This is illustrated in Panel (a) of Figure 2 for the whole sample: the higher the minimum wage level, the smaller the workforce l that a firm attracts for a given wage offer w. Moreover, the relationship between l and w becomes less steep for higher minimum wages.

As a result of these interactions operating through $l(w)$, different minimum wage levels lead to different optimal wage offer functions $\hat{K}^{MW}$, and therefore to different wage offer distributions $\hat{F}^{MW}$. Increasing the minimum wage generally shifts $\hat{K}^{MW}$ upwards and $\hat{F}^{MW}$ to the right (cf. panels (b) and (c)). While the biggest changes occur for low wages and productivities, even high-productivity firms adjust their wage offer slightly in response to an increase in the minimum wage.

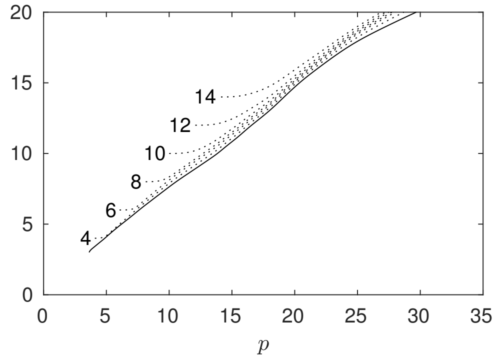
These changes in the wage offer distribution affect the steady-state unemployment rate. A minimum wage below $\underline{p}$ leads to an increase in $\underline{w}$, which in turn means that some individuals shift from Group (2) to Group (1) in Equation (5). As $1 + \kappa_0 > 1 + \kappa_0 \overline{F}(b)$ for all $b \in]\underline{w}, \overline{w}]$, this leads to a reduction in the unemployment rate. For individuals staying in Group (2), unemployment goes down as $\overline{F}(w)$ decreases for all w. Moreover, the highest wage offer $\overline{w}$ increases, which reduces the number of individuals who reject all job offers (Group 3).

Effects through the Job Offer Arrival Rates For minimum wage levels above the lowest productivity level $\underline{p}$, the minimum wage affects the job offer arrival rates, which

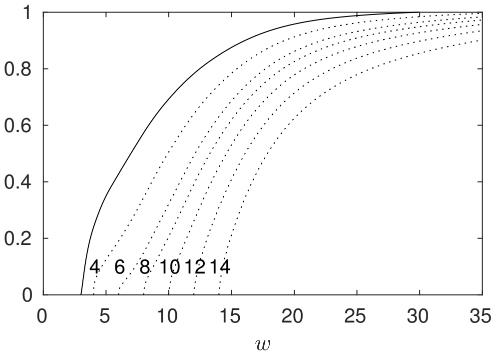
[18] Several empirical studies document spillover effects of minimum wages on wages in the upper part of the wage distribution (e.g., Autor et al., 2016 or, in the context of Germany, Gregory and Zierahn, 2020).



(a) Labour force size $l(w)$



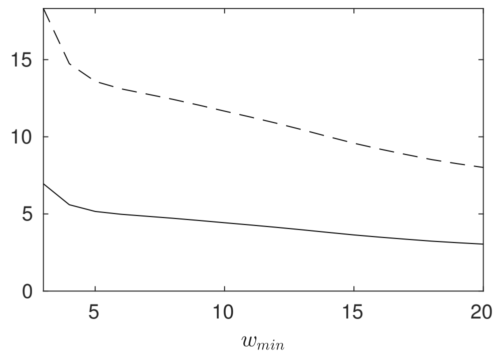
(b) Wage function $K(p)$



(c) Wage offer distribution $F(w)$

Key: No minimum wage (——); different minimum wage levels are 4, 6, 8, 10, and 12 euro (⋯⋯).

Figure 2: Equilibrium Functions for Different Minimum Wage Levels (Whole sample)

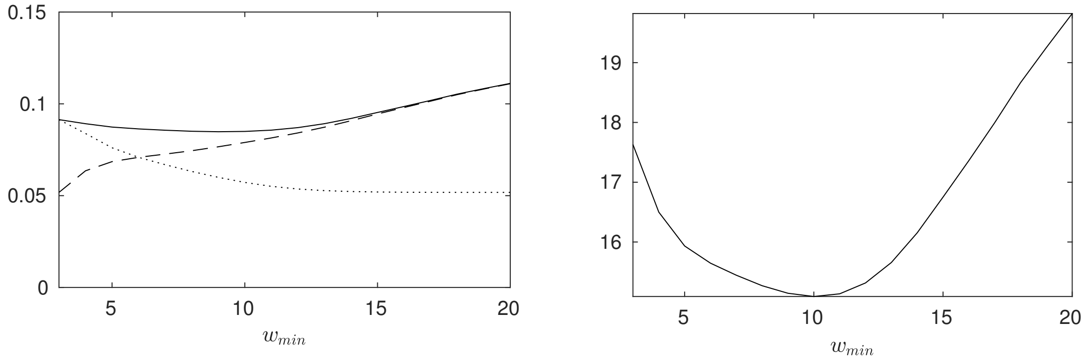


Key: κ_1 (——); κ_0 (– – –);

Figure 3: Change in Minimum Wage: Frictional parameters (Whole sample)

means that the sign of the minimum wage effect on unemployment becomes ambiguous a priori. In the model by Bontemps et al. (1999, 2000), this mechanism arises because the minimum wage raises the lowest feasible wage offer $\underline{w}^{MW}$ and the productivity level $\underline{p}^{MW}$ that is associated with it. Firms with a productivity below this level leave the market, and Bontemps et al. (1999, 2000) assume that κ_0 and κ_1 are proportional to the fraction $\overline{\Gamma}(\underline{p}^{MW})$ of firms that remain in operation. Because the proportionality assumption is somewhat arbitrary, the present paper models firms' vacancy posting directly. As outlined in Section 2, firms choose the job offer arrival rates such that the return from marginally increasing the rates is just offset by the cost of doing so. An increase in the minimum wage leaves the cost unchanged but reduces the return, which leads to a reduction in the optimal job offer arrival rates. The reduction is particularly pronounced for job offers that are made to the unemployed (cf. Figure 3). Our simulations predict that a minimum wage of 8.50 euros would bring down the ratio of the job offer arrival rate to the unemployed over the job destruction rate, which is 18.31 in the actual environment without a minimum wage, by almost a third. As a consequence, the unemployment effect of a minimum wage is now the result of two countervailing forces: the reduction in unemployment as higher wage offers lead to less frequent rejections of job offers, and the negative effect arising from the fact that job offers now arrive at a slower rate. Formally, the second effect reduces the denominators in Equation (5), thereby increasing the frictional component of unemployment in Groups 1 and 2.

Effects through Reservation Wages So far, we have discussed the channels operating through the wage offer distribution and the job offer arrival rates. Both channels are already present in the Bontemps et al. (1999) model with homogeneous λ. In the model with $\lambda_0 \neq \lambda_1$, there is an additional channel operating through A, the distribution of reservation wages ϕ. This channel is present regardless of whether the minimum wage is below or above $\underline{p}$. As shown in Equation (1), the reservation wage ϕ depends on κ_0, κ_1, F and $\overline{w}$, all of which are functions of the minimum wage. While an increase in $\overline{w}$ raises the reservation wage, a proportional reduction in κ_0 and κ_1 lowers it. F has a double effect on ϕ, operating both



(a) Unemployment rate u (b) Mean unemployment duration

Key: Preferred model (——); frictional component of u (– – –); model without change in job offer arrival rates (⋯⋯).

Figure 4: Change in Minimum Wage: Unemployment (Whole sample)

through the numerator and the denominator of the second term in Equation (1). Empirically, the resulting net influence on A turns out to be relatively small in our application. In fact, the different density plots of A are identical to the status-quo plot for the range of minimum wage levels considered here, and are therefore not shown. As a result, the minimum wage effects in the richer model with $\lambda_0 \neq \lambda_1$ prove to be very close to the ones in the model with homogeneous λ.

7.2. Whole Sample

Figure 4 shows the effect of different minimum wage levels on the unemployment rate and the average unemployment duration, based on the estimation results for the whole sample. The solid line is the effect that is actually predicted by the model. In the German context, the introduction of a statutory minimum wage leads to a reduction of the unemployment rate for low levels of the minimum wage. Unemployment is lowest for a minimum wage between 8 and 10 euros. The minimum wage of 8.50 euros that was introduced on January 1st, 2015 leads to an unemployment rate of 8.5% in the model, down 0.7 percentage points from the baseline level (with no minimum wage) of 9.2%. At a minimum wage of 14 euros, the unemployment rate reaches this baseline level again.

The small effect of the minimum wage on the unemployment rate results from two countervailing forces that happen to almost exactly offset each other over a wide range of minimum wage values. The positive effect (in the sense of reducing unemployment) arises because a higher minimum wage means that unemployed individuals are now more likely to receive acceptable wage offers. This effect is illustrated by a simulation (see the dotted line in Figure 4) in which we allow for heterogeneity in the opportunity cost of employment b, but switch off the channel operating through the reduction in job offer arrival rates; these are held constant at their estimated status-quo levels. The positive effect tapers out beyond a minimum wage level of about 12.50 euros because, as seen in Figure 1, there is little mass left in the reservation wage density beyond this level. Since the opportunity cost distribution

H is unbounded, purely frictional unemployment (corresponding to a situation in which all unemployed individuals are in Group (1)) is reached only asymptotically. As w_{min} approaches infinity, the dotted line converges to an unemployment level of $100 \times \frac{1}{1+\widehat{\kappa_0}} = 5.2\%$.

This value is the starting point for the dashed line that shows the ratio $1/(1+\widehat{\kappa_0})$. In this case, the positive effect working through the wage offer distribution is switched off, all unemployment is purely frictional from the start, and higher minimum wages have an unambiguously negative effect on unemployment. Such a scenario would lead to a very different conclusion about how the introduction of a minimum wage of 8.50 euros in 2015 affected the unemployment rate. If all unemployment were always frictional, the rate would have gone up to 7.5%, a sizeable increase from the frictional unemployment rate of 5.2% that we find for the benchmark case without a minimum wage. The fact, however, that this benchmark rate of frictional unemployment is much lower than the actual unemployment rate of 9.2% shows that, according to the analysis here, a substantial part of unemployment in the benchmark is not frictional but the result of wage offers that fall below the reservation wages of the unemployed. For higher values of the minimum wage, by contrast, the reduction in job offer arrival rates becomes the almost exclusive driver behind the increase in the unemployment rate. In Figure 4, this is reflected by the asymptotic convergence of the solid line and the dashed line.

The mean unemployment duration (panel (b) of Figure 4) is given by[19]

$$\frac{A_u(\underline{w})}{\lambda_0 A(\overline{w})} + \int_{\underline{w}}^{\overline{w}} \frac{A_u(b)}{\lambda_0 \overline{F}(b)} \cdot \frac{1}{A(\overline{w})}\, \mathrm{d}b. \tag{14}$$

The effects mentioned above in the context of the unemployment rate are again at play here. In fact, each item in the expression depends on the minimum wage level. The effect on the numerator A_u is ambiguous a priori and, given that A changes little, probably fairly small. The main change is likely to take place in the denominator, where λ_0 decreases in the minimum wage while $\overline{F}$ increases, again giving an ambiguous effect. The influence of the change in the integral limits $\underline{w}$ and $\overline{w}$ is also an empirical question. Our simulations show that with the introduction of a minimum wage, the mean unemployment duration first decreases from its steady-state level of 17.5 weeks. The minimum of about 15 weeks is reached at a minimum wage level of around 10 euros. For higher levels of the minimum wage, the average unemployment duration increases again.

7.3. Heterogeneity between Labour Markets

The simulation results discussed so far have been based on the estimation for the whole sample (first row of Table 1). Figures 5 and 6 show the effects when the simulations are based on a separate estimation for each labour market defined by region or job classification (remaining rows of Table 1). The figures show the change of the unemployment rate compared

[19] Note that the expected value needs to be derived based on the right truncated distribution of reservation wages, as individuals with reservation wages greater than $\overline{w}$ are characterised by infinite unemployment durations. In our application, $A(\overline{w})$ is equal to one. As a result, the mean unemployment durations based on the truncated and untruncated distribution of reservation wages do not differ from each other.

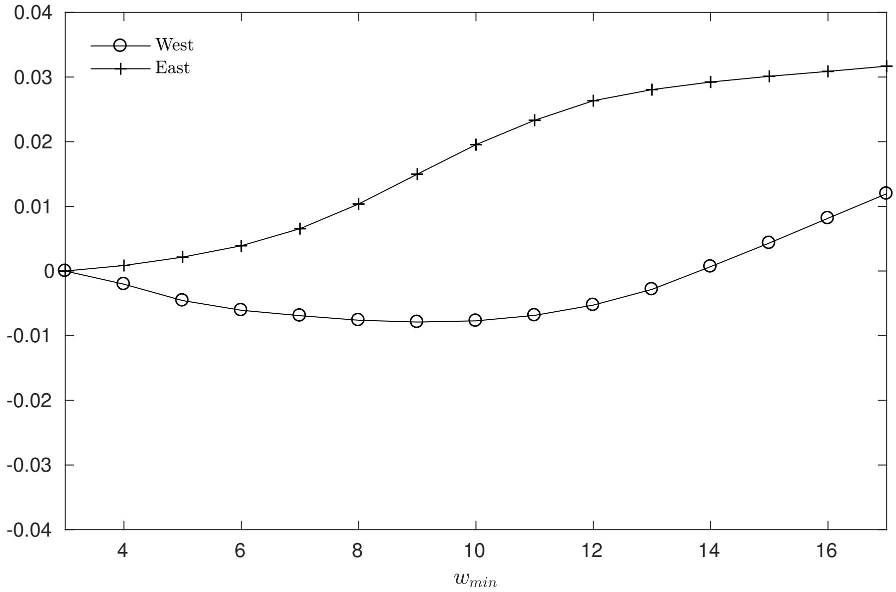


Figure 5: Change in Unemployment Rate by Region

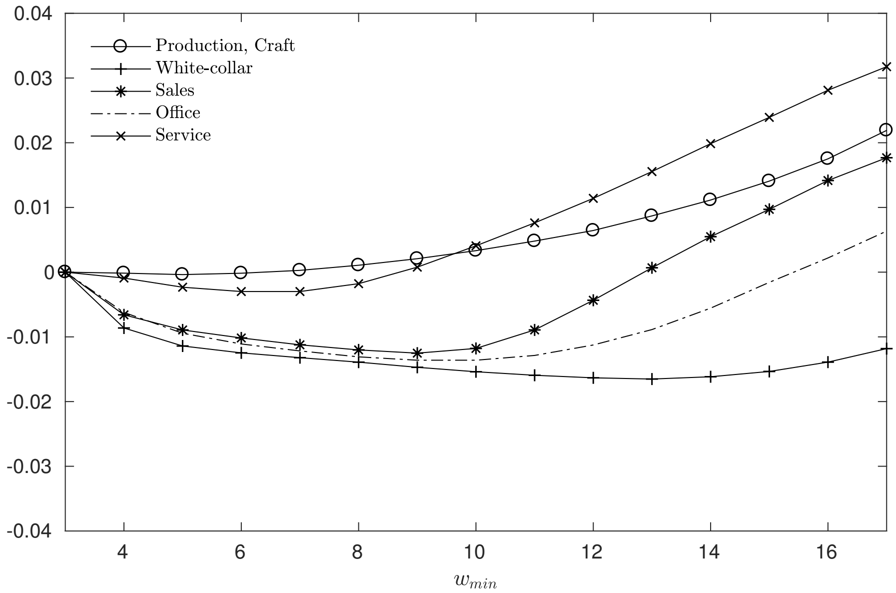


Figure 6: Change in Unemployment Rate by Job Class

with its status-quo level in each labour market, as a function of the minimum wage level.[20] We find that the same minimum wage level can have different effects on unemployment depending on the labour market segment.

By Region East and West Germany differ not only in the level of unemployment (9.9% in the East, 8.8% in the West), but also in how the unemployment rate reacts to the introduction of a minimum wage. According to our simulations, the introduction of any minimum wage – even at low levels – would increase the unemployment rate in East Germany. For the actually implemented level of 8.50 euros, the model predicts an increase of 1.2 percentage points, i.e. 12% of the status-quo level. In West Germany, by contrast, a minimum wage of 8.50 euros reduces unemployment by 0.9 percentage points, or 9% of the rate observed before the introduction. Only for minimum wage levels of more than 14 euros do we see an increase in unemployment in the West compared with the benchmark case without a minimum wage. These remain fairly moderate over the range of values considered here, while in East Germany a minimum wage of 14 euros or higher would bring up the unemployment rate by about 30% compared with its pre-introduction level.

The effect of the minimum wage on unemployment again results from the different pathways described above. The positive effect – other things equal, unemployed individuals are less likely to reject wage offers after the introduction of a minimum wage – is stronger in the East at lower minimum wage levels because the unemployed have lower reservation wages there. At the same time, the productivity of firms is lower and the decline in the job offer arrival rate is more pronounced there. In the East, this second effect dominates throughout, while in West Germany it leads to a negative net effect on unemployment only for relatively high minimum wage levels.

By Job Classification When labour markets are defined via job classifications, the reaction of the unemployment to the introduction of a minimum wage falls into two main groups. In the production and craft sector and the service sector, the unemployment rate stays constant or slightly decreases at first and becomes higher than in the status quo for minimum wage levels of 9 euros and more.

The other three sectors (white-collar, sales, and office) first see a reduction in the unemployment rate of roughly similar magnitude. Beyond a minimum wage level of about 10 euros, the three curves diverge. The sales sector is characterised by low reservation wages and the positive effects of the minimum wage on unemployment are almost entirely exhausted at this point. The negative effect that operates through a reduction in the job offer arrival rate takes over more or less exclusively from then, and the unemployment rate reaches its status-quo level at a minimum wage of about 13 euros. For office jobs, the frictional component takes over less completely, and for the high-productivity white-collar jobs the effect through the

[20] Selected numerical values for these changes are reported in Table 9 in the Appendix. The simulations for the different labour markets can be aggregated in order to derive the overall unemployment rate as a function of the minimum wage level (Table 9 and Figure 15 in the Appendix). The aggregated rate is very similar to the rate that results when the estimation and simulation are directly carried out for the sample as a whole (Table 1 and Figure 4 in the Appendix).

job offer rate sets in so slowly that unemployment is lower than in the status quo even for a minimum wage of 16 euros.

Simulations with Counterfactual Parameter Combinations To explore to what extent the different unemployment effects across labour market segments are driven by differences in the productivity distributions and by differences in the parameters characterising search frictions and the opportunity costs of employment, we ran two simulations with counterfactual parameter combinations. In the first simulation, we combined the productivity distribution estimated for each labour market segment with the parameters estimated for the sample as a whole.[21] In the second one, we combined the productivity distribution of the whole sample with the parameters that we estimated for the different segments.

The bulk of the East-West differences can clearly be explained by the different productivity distributions in the two parts of the country. While assuming identical parameters for both regions goes some way in reducing the gap in the effect of the minimum wage on unemployment (Figure 16 in the Appendix), assuming identical productivity distributions almost completely closes the gap and even leads to a partial reversal: at higher minimum wage levels, the unemployment rate now increases less slowly in the East (Figure 17 in the Appendix).

The variation in the unemployment effects across job classifications is also mainly driven by differences in the firm productivity distribution, rather than by differences in search frictions or the opportunity cost of employment (cf. Figures 18 and 19 in the Appendix). The latter also play a role, however, especially for the sales sector which has high search frictions that create a large gap between wages and productivity (cf. panel (f) of Figure 14 in the Appendix).[22] As a result, the relationship between the minimum wage and the unemployment rate is characterised by a pronounced U-shape in the sales sector, i.e. by a noticeable decrease in unemployment for minimum wages of 14 euros or less (Figure 6). This decrease all but disappears when simulating the effects based on the search frictions that are estimated across all job classifications.

7.4. Comparison to Existing Reduced-form Studies

Our analysis constitutes the first assessment of the new German minimum wage based on a structural model allowing for search frictions. Previous ex-ante studies relied on the assumption of perfect competition (Ragnitz and Thum, 2008; Bauer et al., 2009; Knabe and Schöb, 2009), i.e. on a model that by construction does not allow for positive employment effects of a minimum wage. These studies predicted large negative employment effects of up to one million jobs. Braun et al. (2020) calibrate stylised macro models (both for perfect

[21] The productivity distribution of each labour market segment is implied by the non-parametric estimation of the wage distribution in combination with the estimated model parameters (cf. Equation 13) for each segment. In the counterfactual combinations, we combine these segment-specific productivity distributions with the parameters that we estimated for the whole sample. In other words, while productivity is allowed to differ, search frictions and the opportunity cost of employment are constrained to be the same in each labour market segment.

[22] This sector contains the "general merchandise store sector" studied by Azar et al. (2019).

competition and monopsony) and predict a strong increase in unemployment in their baseline specifications.

There are also a number of ex-post studies on the actual introduction of the minimum wage in 2015 using quasi-experimental variation (see the surveys by Bruttel, 2019 and Caliendo et al., 2019).[23] In line with our own simulations, these studies tend to find that the minimum wage had no or at most a small negative effect on employment.[24] Using the IAB Establishment Panel, Bossler and Gerner (2019) compare establishments with employees affected by the minimum wage with a control group of establishments that are not directly affected. They find that employment remained roughly constant in the treatment group and grew in the control group. As a result, 45,000 to 68,000 jobs were lost (or rather, not created) because of the introduction of the minimum wage. This corresponds to 1.7% of the employment in the affected establishments. In line with our simulations, Bossler and Gerner find that this employment effect is mainly driven by establishments in East Germany. However, the employment effect is longer statistically significant once the intensity of the treatment is taken into account. Using a similar difference-in-differences strategy at the establishment level, Bonin et al. (2018) find a small negative effect of about the same magnitude. The negative effect is exclusively driven by a reduction in marginal employment (below 450 euros per month), while regular employment increased after the introduction of the minimum wage.

Several reduced form studies rely on variation in the regional bite of the minimum wage. Bonin et al. (2020) find a negative effect on total employment of between 0.5% and 0.8%, depending on the specification. Based on the Structure of Earnings Survey, Caliendo et al. (2018) find that overall employment went down by 0.4%, which translates into 140,000 jobs. Using data from the Federal Employment Agency, Schmitz (2019) estimates a slightly larger reduction of up to 260,000 jobs. By contrast, with the same data but a different specification that also exploits variation across gender and age, Garloff (2019) finds some evidence of a positive effect on employment, but the effect is dependent on the specification and in any case very small (11,000 jobs). Adopting a similar approach, Stechert (2018) confirms these results. Based on individual-level data aggregated at the county level and taking commuting flows into account, Ahlfeldt et al. (2018) estimate a small positive effect of the minimum wage on employment (+0.06%). They also find that a one-percentage point increase in the regional bite decreased the unemployment rate by 0.05 percentage points. Holtemöller and Pohle (2020) use variation at the state-industry level. They find a small reduction in overall

[23] There is also a literature that evaluates the pre-2015 industry-specific minimum wages, typically using difference-in-differences designs with industries without minimum wage as control groups. In what is probably the first quasi-experimental study for Germany, König and Möller (2009) analyse the introduction of a minimum wage in the construction industry. The authors find no significant employment effects in West Germany and small negative effects in the East. In 2011, the German Federal Ministry of Labour commissioned an evaluation of minimum wages in several industries. In general, these studies also tend to find limited employment effects (e.g. Boockmann et al., 2013; Frings, 2013), with the exception of the roofing industry (Aretz et al., 2013).

[24] The small employment effects are in line with firms' expectations and plans as reported in survey data in the months before the minimum wage took effect (Bossler, 2017; Link, 2019). In a more recent survey experiment by Bossler et al. (2019), by contrast, firms do report that they would reduce employment if the minimum wage were to be increased above its current level.

employment of, depending on their measure of the regional bite, between 20,000 and 50,000 jobs. Dustmann et al. (2020) do not find a significant negative employment effect in their regional analysis.

Friedrich (2020) exploits the variation in the bite of the minimum wage across occupations. He finds a small positive effect on regular employment when the minimum wage was introduced in 2015, but the effect becomes insignificant in 2016 and 2017. The effect on marginal employment is slightly negative, but statistically insignificant in all three years. Restricting the analysis to West Germany produces the same pattern, while in East Germany the employment effects are more negative, in line with the predictions of our model.

Finally, using individual-level data, Dustmann et al. (2020) find that the introduction of the minimum wage boosted the wages of low-wage workers, but did not reduce their probability of remaining employed. Umkehrer and vom Berge (2020) study the effect of a minimum-wage exemption for the long-term unemployed and find no effect on transitions out of unemployment at the threshold.

Importantly, even in those studies that do find a negative overall employment effect, the decrease is almost exclusively driven by a reduction in marginal employment. Because we restrict our sample to full-time workers and thereby exclude marginal employment, the results are not directly comparable. The effect on regular employment in the reduced-form studies is at most slightly negative (Caliendo et al., 2018; Schmitz, 2019), while Bonin et al. (2020) find no significant effect and Garloff (2019), Holtemöller and Pohle (2020), and Friedrich (2020) estimate a small positive effect.

Regular employment in most of these studies also includes (non-marginal) part-time work, while our own simulation is carried out for full-time workers only. In addition, we exclude high-skilled individuals, i.e. the group of individuals who are least likely to be affected by the minimum wage. Notice also that our results refer to equilibrium changes whereas the existing reduced-form studies capture short-term adjustments.

Finally, our model assumes that prices and the productivity of firms are unaffected by the minimum wage, and we do not consider non-compliance. Based on the extent to which firms can react to the minimum wage along these margins, the unemployment effects of the minimum wage will be dampened.[25]

While keeping in mind these caveats, we conclude that our simulation results for the introduction of the minimum wage are not in contradiction with the existing evidence, which increases our confidence that the counterfactual simulations are reasonably informative about what might happen to unemployment at other minimum wage levels.

[25]Using data from the IAB Establishment Panel, Bossler et al. (2020) fail to detect any effects of the minimum wage on establishment-level productivity. For lack of price data at the micro level, there have been no quasi-experimental studies so far on whether prices were adjusted in response to the minimum wage. Using planned price changes as reported in several business surveys before and after the introduction of the minimum wage, Link (2019) shows that more firms planned to react via the price than via the employment channel.

8. Conclusion

Based on an equilibrium job search model, this paper argues that the statutory uniform minimum wage of 8.50 euros that was introduced in Germany in 2015 had a small positive effect on the employment of full-time workers with low and medium qualifications. The positive effect is driven by West Germany, while in East Germany we do find a small increase in unemployment resulting from the introduction of the minimum wage. These findings from our structural estimation are consistent with the results from studies using quasi-experimental variation, most of which have found no or at most small negative effects on unemployment.

We use the model for a series of counterfactual policy experiments and find that unemployment is a non-monotonic function of the minimum wage level. As a result, simple extrapolations of effects found for actually observed minimum wage levels might be misleading. Our model suggests that there would have been considerable scope for increasing the minimum wage beyond the level of 8.50 euros. We document substantial heterogeneity not only in the productivity distribution, but also in search frictions and in reservation wages across labour markets differentiated by region or type of occupation. To the extent that the minimum wage is motivated by a desire to offset firms' monopsony power, this suggests that a uniform minimum wage is perhaps too blunt a tool. While in the production and craft sector and the service sector minimum wages of more than 9 euros would have raised unemployment, in the sales sector the benchmark level of unemployment is reached again at 13 euros. For office jobs and white-collar jobs, there would have been scope for unemployment-neutral minimum wages of up 16 euros or more.

These numbers do not necessarily translate into today's situation, however, because the various changes that have occurred since then (the continuation of the labour market boom, the major inflow of unskilled migrants in 2015–2016, and the Covid-19 pandemic in 2020) might affect the external validity of the results. We should also note that while the model allows us to assess the scope for unemployment-neutral minimum wage increases, we do not carry out an explicit welfare analysis and therefore refrain from drawing explicit policy conclusions.

In future research, it will be interesting to study correlates of regional and sectoral differences in search frictions and hence firms' market power. For instance, they may be related to differences in workers' characteristics across labour market segments, to firm characteristics, market structure and union coverage.

Disclosure statement

Conflict of Interest: The authors declare that they have no conflict of interest.

References

Ahlfeldt, G. M., D. Roth, and T. Seidel (2018). The Regional Effects of Germany's National Minimum Wage. *Economics Letters 172*, 127–130.

Aretz, B., B. Arntz, H. Bonin, S. Butschek, A. Dörr, B. Fitzenberger, T. Gregory, N. Guertzgen, H. Stichnoth, and T. Walter (2013). Vorbereitende Forschung für die zweite Evaluationsrunde Mindestlöhne: Verbesserung und Erweiterung der Evaluationsmethoden. Report for the German Federal Ministry of Labour, Mannheim.

Autor, D. H., A. Manning, and C. L. Smith (2016). The Contribution of the Minimum Wage to US Wage Inequality over Three Decades: A Reassessment. *American Economic Journal: Applied Economics 8*(1), 58–99.

Azar, J., E. Huet-Vaughn, I. Marinescu, B. Taska, and T. von Wachter (2019). Minimum Wage Employment Effects and Labor Market Concentration. NBER Working Paper 26101.

Bachmann, R. and H. Frings (2017). Monopsonistic Competition, Low-Wage Labour Markets, and Minimum Wages – An Empirical Analysis. *Applied Economics 49*(51), 5268–5286.

Bauer, T. K., J. Kluve, S. Schaffner, and C. M. Schmidt (2009). Fiscal Effects of Minimum Wages: An Analysis for Germany. *German Economic Review 10*(2), 224–242.

Bonin, H., I. Isphording, A. Krause, A. Lichter, N. Pestel, U. Rinne, M. Caliendo, C. Obst, M. Preuss, C. Schröder, and M. Grabka (2018). Auswirkungen des gesetzlichen Mindestlohns auf Beschäftigung, Arbeitszeit und Arbeitslosigkeit. Studie im Auftrag der Mindestlohnkommission. IZA Research Report 83.

Bonin, H., I. E. Isphording, A. Krause-Pilatus, A. Lichter, N. Pestel, and U. Rinne (2020). The German Statutory Minimum Wage and its Effects on Regional Employment and Unemployment. *Jahrbücher für Nationalökonomie und Statistik 240*(2-3), 295–319.

Bontemps, C., J.-M. Robin, and G. J. Van den Berg (1999). An Empirical Equilibrium Job Search Model With Search on the Job and Heterogeneous Workers and Firms. *International Economic Review 40*(4), 1039–1074.

Bontemps, C., J.-M. Robin, and G. J. van den Berg (2000). Equilibrium Search with Continuous Productivity Dispersion: Theory and Nonparametric Estimation. *International Economic Review 41*(2), 305–358.

Boockmann, B., R. Krumm, M. Neumann, and P. Rattenhuber (2013). Turning the Switch: An Evaluation of the Minimum Wage in the German Electrical Trade Using Repeated Natural Experiments. *German Economic Review 14*(3), 316–348.

Bossler, M. (2017). Employment Expectations and Uncertainties Ahead of the New German Minimum Wage. *Scottish Journal of Political Economy 64*(4), 327–348.

Bossler, M. and H.-D. Gerner (2019). Employment Effects of the New German Minimum Wage: Evidence from Establishment-Level Microdata. *ILR Review*, forthcoming.

Bossler, M., N. Gürtzgen, B. Lochner, U. Betzl, and L. Feist (2020). The German Minimum Wage: Effects on Productivity, Profitability, and Investments. *Jahrbücher für Nationalökonomie und Statistik 240*(2/3), 321–350.

Bossler, M., M. Oberfichtner, and C. Schnabel (2019). Employment Adjustments Following Rises and Reductions in Minimum Wages: New Insights From a Survey Experiment. *Labour*, forthcoming.

Braun, H., R. Döhrn, M. Krause, M. Micheli, and T. Schmidt (2020). Macroeconomic Long-Run Effects of the German Minimum Wage when Labor Markets are Frictional. *Jahrbücher für Nationalökonomie und Statistik 240*(2-3), 351–386.

Breda, T., L. Haywood, and H. Wang (2019). Labor Market Responses to Payroll Tax Reductions. Unpublished work, DIW Berlin, Paris School of Economics, and University of Konstanz.

Bruttel, O. (2019). The Effects of the New Statutory Minimum Wage in Germany: A First Assessment of the Evidence. *Journal for Labour Market Research 53*(10), 1–13.

Caliendo, M., A. Fedorets, M. Preuss, C. Schröder, and L. Wittbrodt (2018). The Short-Run Employment Effects of the German Minimum Wage Reform. *Labour Economics 53*, 46–62.

Caliendo, M., C. Schröder, and L. Wittbrodt (2019). The Causal Effects of the Minimum Wage Introduction in Germany – An Overview. *German Economic Review 20*(3), 257–292.

Christl, M., M. Köppl-Turyna, and D. Kucsera (2018). Revisiting the Employment Effects of Minimum Wages in Europe. *German Economic Review 19*(4), 426–465.

Dube, A. (2019). Impacts of Minimum Wages: Review of the International Evidence. Report for the UK Low Pay Commission.

Dustmann, C., A. Lindner, U. Schönberg, M. Umkehrer, and P. vom Berge (2020). Reallocation Effects of the Minimum Wage. CReAM Discussion Paper 07/20.

Engbom, N. and C. Moser (2018). Earnings Inequality and the Minimum Wage: Evidence from Brazil. Columbia Business School Research Paper 18-50.

Fedorets, A., A. Filatov, and C. Shupe (2018). Great Expectations: Reservation Wages and the Minimum Wage Reform. Technical Report 968-2018.

Fitzenberger, B., A. Osikominu, and R. Völter (2006). Imputation Rules to Improve the Education Variable in the IAB Employment Subsample. *Schmollers Jahrbuch 126*(3), 405–436.

Flinn, C. J. (2006). Minimum Wage Effects on Labor Market Outcomes under Search, Matching, and Endogenous Contact Rates. *Econometrica 74*(4), 1013–1062.

Friedrich, M. (2020). Using Occupations to Evaluate the Employment Effects of the German Minimum Wage. *Jahrbücher für Nationalökonomie und Statistik 240*(2-3), 269–294.

Frings, H. (2013). The Employment Effect of Industry-Specific, Collectively Bargained Minimum Wages. *German Economic Review 14*(3), 258–281.

Ganzer, A., A. Schmucker, P. vom Berge, and A. Wurdack (2017). Stichprobe der Integrierten Arbeitsmarktbiografien Regionalfile 1975–2014 (SIAB-R 7514). FDZ Datenreport 01/2017, Bundesagentur für Arbeit.

Garloff, A. (2019). Did the German Minimum Wage Reform Influence (Un)employment Growth in 2015? Evidence from Regional Data. *German Economic Review 20*(3), 356–381.

Gartner, H. (2005). The Imputation of Wages above the Contribution Limit with the German IAB Employment Sample. FDZ Methodenreport 2/2005, Bundesagentur für Arbeit.

Gregory, T. and U. Zierahn (2020). When the Minimum Wage Really Bites Hard: Impact on Top Earners and Skill Supply. CESifo Working Paper 8540.

Holtemöller, O. and F. Pohle (2020). Employment Effects of Introducing a Minimum Wage: The Case of Germany. *Economic Modelling 89*, 108–121.

Holzner, C. and A. Launov (2010). Search Equilibrium and Social and Private Returns to Education. *European Economic Review 54*(1), 39–59.

Knabe, A. and R. Schöb (2009). Minimum Wage Incidence: The Case for Germany. *FinanzArchiv: Public Finance Analysis 65*(4), 403–441.

König, M. and J. Möller (2009). Impacts of Minimum Wages: A Microdata Analysis for the German Construction Sector. *International Journal of Manpower 30*(7), 716–741.

Lancaster, T. (1990). *The Econometric Analysis of Transition Data*. Cambridge; New York: Cambridge University Press.

Lee, S. and R. A. Wilke (2009). Reform of Unemployment Compensation in Germany: A Nonparametric Bounds Analysis Using Register Data. *Journal of Business & Economic Statistics 27*(2), 193–205.

Link, S. (2019). The Price and Employment Response of Firms to the Introduction of Minimum Wages. CESifo Working Paper 7575.

Manning, A. (2020). Monopsony in Labor Markets: A Review. *ILR Review*, forthcoming.

Mortensen, D. T. and G. R. Neumann (1988). Estimating Structural Models of Unemployment and Job Duration. In W. A. Barnett, E. R. Berndt, and H. White (Eds.), *Dynamic Econometric Modeling*, pp. 335–356. Cambridge University Press.

Muehlemann, S. and H. Pfeifer (2013). The Structure of Hiring Costs in Germany: Evidence from Firm-Level Data. IZA Discussion Paper 7656.

Muehlemann, S. and H. Pfeifer (2016). The Structure of Hiring Costs in Germany: Evidence from Firm-Level Data. *Industrial Relations: A Journal of Economy and Society 55*(2), 193–218.

Nanos, P. and C. Schluter (2014). The Composition of Wage Differentials between Migrants and Natives. *European Economic Review 65*, 23–44.

Neumark, D. (2019). The Econometrics and Economics of the Employment Effects of Minimum Wages: Getting from Known Unknowns to Known Knowns. *German Economic Review 20*(3), 293–329.

Ragnitz, J. and M. Thum (2008). Beschäftigungswirkungen von Mindestlöhnen – eine Erläuterung zu den Berechnungen des ifo Instituts. *Ifo Schnelldienst 61*(01), 16–20.

Schmitz, S. (2019). The Effects of Germany's Statutory Minimum Wage on Employment and Welfare Dependency. *German Economic Review 20*(3), 330–355.

Shephard, A. (2017). Equilibrium Search and Tax Credit Reform. *International Economic Review 58*(4), 1047–1088.

Stechert, M. (2018). Eine kritische Analyse ausgewählter Effekte unter der Einführung des gesetzlichen Mindestlohns in Deutschland. *WISTA - Wirtschaft und Statistik 3*, 40–53.

Umkehrer, M. and P. vom Berge (2020). Evaluating the Minimum-Wage Exemption of the Long-Term Unemployed in Germany. *ILR Review*, forthcoming.

van den Berg, G. J. (2003). Multiple Equilibria and Minimum Wages in Labor Markets with Informational Frictions and Heterogeneous Production Technologies. *International Economic Review 44*(4), 1337–1357.

A. Appendix

A.1. Data Preparation – Data Cleaning and Imputation

Imputation of Missing Information To maximise the available information, we fill in missing values using the full dataset, i.e. prior to imposing our sample selection criteria. When imputing missing information for the variable nationality, we first use information from parallel spells for the same individual, then information from previous spells and, if there are still missing values, with information from later spells. Similarly manner, we fill in missing information on region, sector, job title, position and employment status with information of previous and following spells but only if individuals stay at the same workplace.

Educational Status Missing and inconsistent data on education are corrected according to the imputation procedure IP1 described in Fitzenberger et al. (2006). This procedure relies, roughly speaking, on the assumption that individuals cannot lose their educational degrees. Information on educational status will be aggregated in three values:

- Low-skilled: High school diploma or no qualifications.
- Medium-skilled: Completed vocational training.
- High-skilled: Technical college degree or university degree.

The final sample used in the analysis consists only of low- and medium-skilled individuals.

A.2. Definition of Labour Market States

Employment Employment spells include continuous periods of employment (allowing gaps of up to four weeks) subject to social security contributions and (after 1998) marginal employment. For parallel spells of employment and unemployment (e.g. for those individuals who in addition to their earnings receive supplementary benefits), we treat employment as the dominant labour market state. We disregard employment spells where individuals receive Hartz IV benefits while working (*Aufstocker*), because for this group the wage alone is not a useful metric for work incentives. Furthermore, we disregard individuals in apprenticeships and interns. It is possible that individuals have multiple employment spells at the same time. In this case, only the predominant employment spell is kept. The predominant spell is determined as follows: full-time spells outrank part-time spells. When choosing between two full-time or two part-time spells, the spell with the longest duration is kept. To break any remaining ties, the spell with the highest wage wins.

Unemployment Unemployment spells include periods of registered job searching as well as periods of receiving benefits. Prior to 2005, the latter include benefits such as unemployment insurance and means-tested unemployment assistance benefits. Those (employable) individuals who were not entitled to unemployment insurance or assistance benefits could claim means-tested social assistance benefits. However, prior to 2005, spells of receiving social assistance can only be observed in the data if the job seekers' history records social assistance recipients as searching for a job. After 2004, means-tested unemployment and social assistance benefits were merged into one unified benefit, known as 'unemployment benefit II' (ALG II). Unemployment spells during which individuals receive ALG II are recorded in the data from 2007 onwards. For the period 2010–2013 that is used, the data provides a consistent definition of unemployment.

Distinction between Un- and Non-Employment Extending the procedure proposed by Lee and Wilke (2009), involuntary unemployment is defined as comprising all continuous periods of registered job searching and/or receipt of benefits. Gaps between such unemployment periods or gaps between receiving benefits or job searching and a new employment spell may not exceed four weeks, otherwise these periods are considered as non-employment spells (involving voluntary unemployment or leaving the social security labour force). Similarly, gaps between periods of employment and receiving benefits or job searching are treated as involuntary unemployment as long as the gap does not exceed six weeks, otherwise the gap is treated as non-employment.

A.3. Data Preparation – Weekly Hours of Work

While we observe whether an individual works full-time or part-time (defined as working less than 30 hours per week), the data lack explicit information on the number of hours worked. We only look at full-time employees and assign hours of work in the following way:

Main Specification: Imputation We complement the administrative data using the German Microcensus. To calculate hourly wages for full-time employment spells, we impute hours of work based on information from the German Microcensus. The imputation is done separately by region, sex, sector, job classification, and educational degree.

Alternative Specification: 40 Hours for Everyone In a variant, we assume 40 hours of work per week for all individuals in full-time employment.

A.4. Data preparation – Assignment of Wages

In our data, continuous employment spells may consist of a sequence of different spells with time-varying information of daily wages. To address this issue, we adopt two different variants to assign wages to one continuous employment spell. We also assign part- and full-time status consistent with these rules.

Main Specification: Average over one year We assign the duration-weighted average wage confined to the last observed year for employment spell before and without a transition. For subsequent employment spells, the wage information used is an average daily wage in the first year after the transition. An individual is considered mainly full-time employed, if the weighted average duration of full-time spells over one year exceeds 50%.

Alternative Specification: Last and first observations For employment spells before a transition and employment spells without a transition, the last observed wage is assigned. For subsequent employment spells, the first observed wage is assigned. The last part-/full-time status is assigned to the previous employment spell, whereas the first part-/full-time status is assigned to any subsequent employment spell.

A.5. Data Preparation – SSC threshold

Gross daily wages are right-censored at the upper limit for social security contributions.

Main Specification: Exclusion of Censored Observations We do not include observations with censored wages.

Alternative specification: Imputation To analyse this problem, we construct cells based on gender, year, region (East and West Germany), and educational degree. For each cell, a Tobit regression is estimated with log daily wages as the dependent variable and age, age squared, nationality, experience, experience squared, tenure in the current employment, tenure in the current employment squared, two skill dummies, occupational, sectoral as well as regional (Federal State) dummies and dummies for part-time and full-time employment as explanatory variables. As described in Gartner (2005), right-censored observations are replaced by wages randomly drawn from a truncated normal distribution whose moments are constructed by the predicted values from the Tobit regressions and whose (lower) truncation point is given by the contribution limit to the social security system. After this imputation procedure, nominal wages are deflated by the Consumer Price Index of the Federal Statistical Office Germany, normalised to 1 in 2015.

A.6. Definition of Sub-Samples

Region

- East Germany: Former GDR, excluding Berlin
- West Germany, including Berlin

The labour market region of an employed individual is given by the location of the workplace. For the unemployed, we use the region where an individual searches for a job. Where this information is missing, we assign the region of the previous workplace.

Job Classifications

- Production, Craft (*Produktions-/Facharbeiter, Handwerker*)
- White-collar (*Höhere Angestellte*)
- Sales (*Vertriebs-/Verkaufstätigkeiten*)
- Office (*Bürotätigkeiten*)
- Service (*Dienstleister*)

Table 2: Employment-to-Employment Transitions across Region, Percent

	After transition	
Before transition	West	East
West	97.7	2.3
East	14.7	85.3

Note: Of a total of 40,097 employment-to-employment transitions, 95.9% remain in the same region.

Table 3: Unemployment-to-Employment Transitions across Region, Percent

	After transition	
Before transition	West	East
West	96.6	3.4
East	12.0	88.0

Note: Of a total of 8,607 unemployment-to-employment transitions, 94.8% remain in the same region.

Table 4: Employment-to-Employment Transitions across Job Classification, Percent

	After transition				
Before transition	Prod.	White-c.	Sale	Office	Service
Prod.	82.1	5.8	1.4	2.6	8.2
White-c.	8.9	68.3	2.4	12.9	7.5
Sale	5.8	6.1	68.4	14.5	5.2
Office	2.7	7.7	4.3	81.2	4.1
Service	9.2	4.2	1.4	4.6	80.5

Note: Of a total of 40,097 employment-to-employment transitions, 79.2% remain in the same job classification.

Table 5: Unemployment-to-Employment Transitions across Job Classification, Percent

	After transition				
Before transition	Prod.	White-c.	Sale	Office	Service
Prod.	84.3	1.8	1.3	2.4	10.2
White-c.	20.8	42.1	3.0	20.2	13.9
Sale	17.1	4.6	42.9	18.6	16.8
Office	9.9	6.1	4.9	68.2	11.0
Service	21.5	3.7	2.2	5.8	66.9

Note: Of a total of 8,607 unemployment-to-employment transitions, 74.5% remain in the same job classification.

A.7. Descriptives

Table 6: Number of Observations

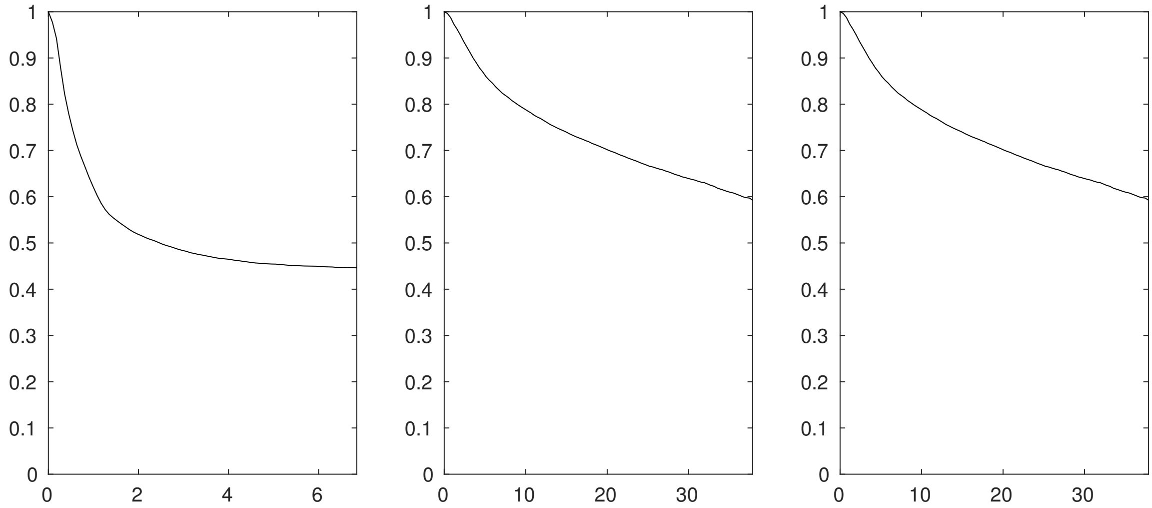
Sample	Total	Unemployment Spells Total	u → e	rc	lc	Employment Spells Total	e → e	e → u	rc	lc
Whole sample	219,448	19,301	8,607	10,694	190	200,147	40,097	21,683	138,367	2,518
Region										
West	185,154	15,396	6,841	8,555	151	169,758	34,306	17,718	117,734	709
East	34,294	3,905	1,766	2,139	39	30,389	5,791	3,965	20,633	1,809
Job classification										
Prod.	81,748	9,183	4,753	4,430	60	72,565	13,541	8,588	50,436	867
White-c.	23,843	943	366	577	13	22,900	4,021	1,611	17,268	324
Sale	12,343	1,288	392	896	13	11,055	2,543	1,466	7,046	82
Office	46,698	2,774	1,137	1,637	20	43,924	9,549	4,213	30,162	682
Service	54,816	5,113	1,959	3,154	84	49,703	10,443	5,805	33,455	563

Note: Arrows (→) indicate that spells end in transitions to another employment spell (e) or to unemployment (u). Spells without an observed transition are right-censored (rc). Additionally, spells might-be left censored (lc).

Table 7: Percentage of Spell Types

Sample	Total	Unemployment Spells Total	u → e	rc	lc	Employment Spells Total	e → e	e → u	rc	lc
Whole sample	100.0%	8.8%	44.6%	55.4%	1.0%	91.2%	20.0%	10.8%	69.1%	1.3%
Region										
West	100.0%	8.3%	44.4%	55.6%	1.0%	91.7%	20.2%	10.4%	69.4%	0.4%
East	100.0%	11.4%	45.2%	54.8%	1.0%	88.6%	19.1%	13.0%	67.9%	6.0%
Job classification										
Prod.	100.0%	11.2%	51.8%	48.2%	0.7%	88.8%	18.7%	11.8%	69.5%	1.2%
White-c.	100.0%	4.0%	38.8%	61.2%	1.4%	96.0%	17.6%	7.0%	75.4%	1.4%
Sale	100.0%	10.4%	30.4%	69.6%	1.0%	89.6%	23.0%	13.3%	63.7%	0.7%
Office	100.0%	5.9%	41.0%	59.0%	0.7%	94.1%	21.7%	9.6%	68.7%	1.6%
Service	100.0%	9.3%	38.3%	61.7%	1.6%	90.7%	21.0%	11.7%	67.3%	1.1%

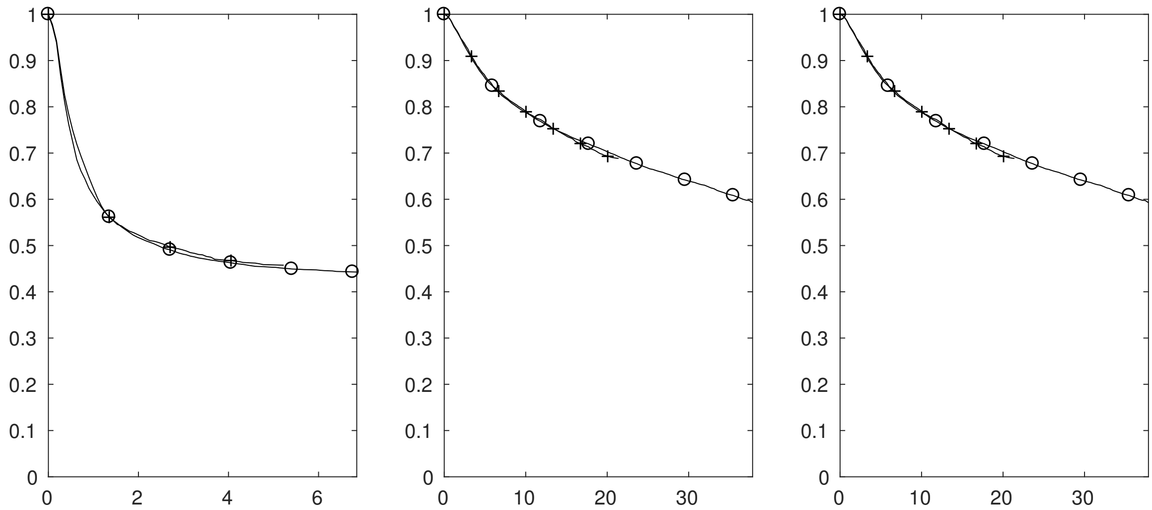
Note: Arrows (→) indicate that spells end in transitions to another employment spell (e) or to unemployment (u). Spells without an observed transition are right-censored (rc). Additionally, spells might be left-censored (lc). Columns Total Unemployment Spells and Total Employment Spells refer to column Total as 100%. Columns u → e , rc and lc refer to Column Total Unemployment Spells as 100%. Columns e → e, e → u , rc and lc refer to Column Total Employment Spells as 100%.



(a) u → e (b) e → e (c) e → u

Note: Plots show Kaplan-Meier survival estimate for durations in years. Arrows (→) indicate that spells end in another employment spell (e) or unemployment (u).

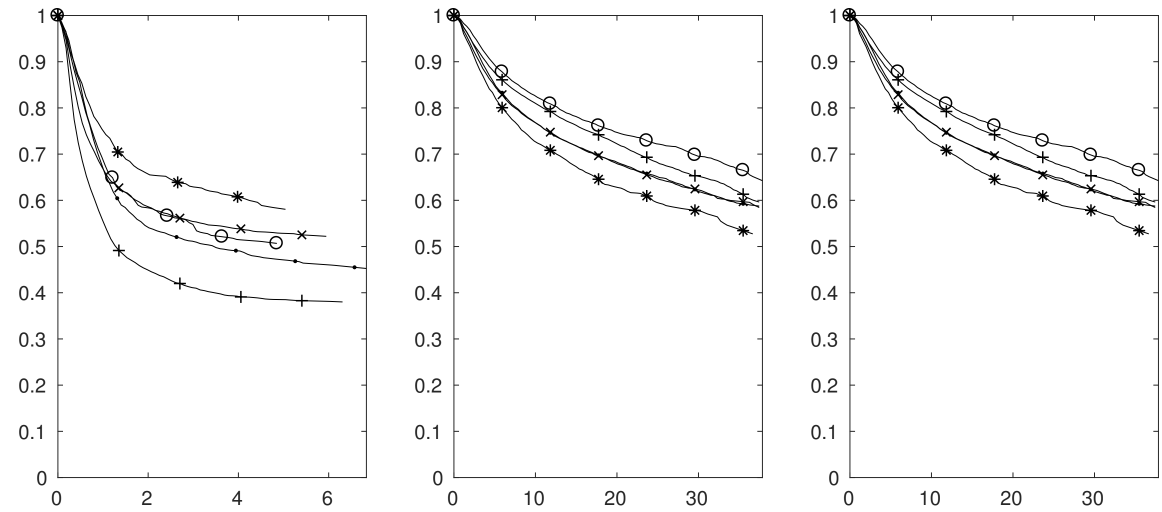
Figure 7: Survival Probabilities – Whole sample



(a) u → e (b) e → e (c) e → u

Note: Plots show Kaplan-Meier survival estimate for durations in years. Arrows (→) indicate that spells end in another employment spell (e) or unemployment (u). *Key:* West (—o—);East (—+—).

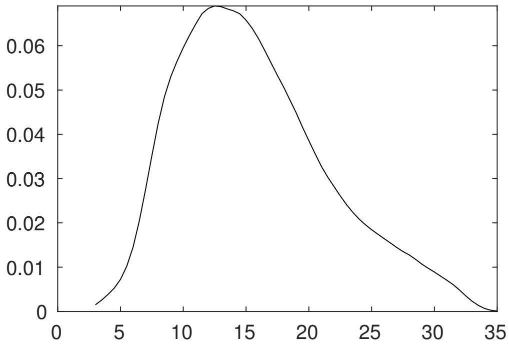
Figure 8: Survival Probabilities – by Region



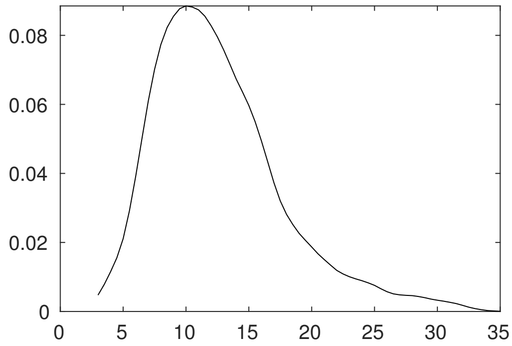
(a) u → e (b) e → e (c) e → u

Note: Plots show Kaplan-Meier survival estimate for durations in years. Arrows (→) indicate that spells end in another employment spell (e) or unemployment (u). *Key:* Production, Craft (—○—);White-collar (—+—);Sales (—∗—);Office (—•—);Service (—×—).

Figure 9: Survival Probabilities – by Job Class

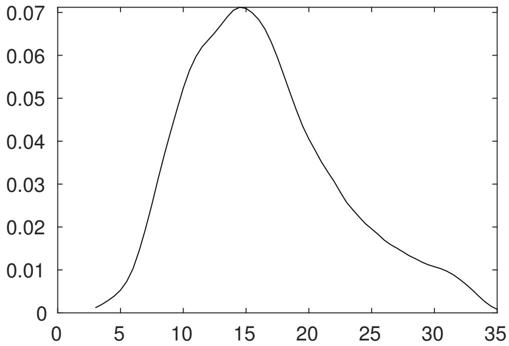


(a) e → e

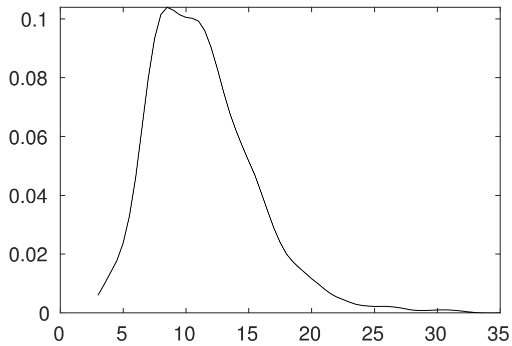


(b) e → u

Panel A – Before Transition

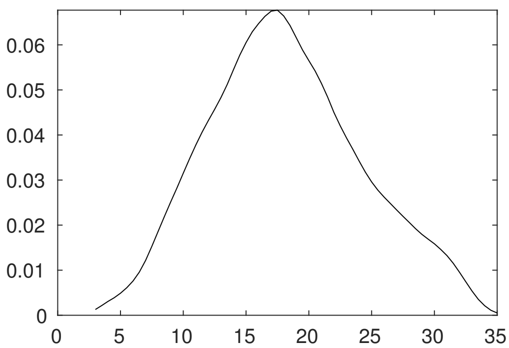


(c) e → e

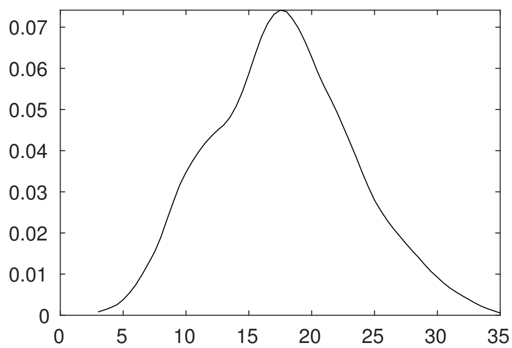


(d) u → e

Panel B – After Transition



(e) right-censored

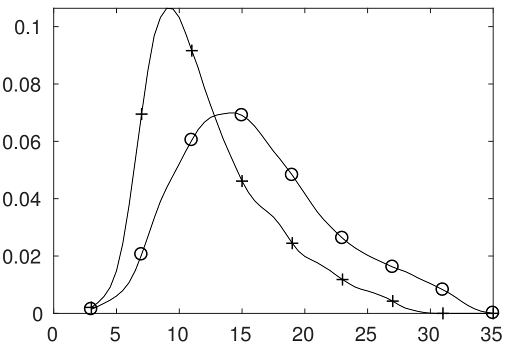


(f) left-censored

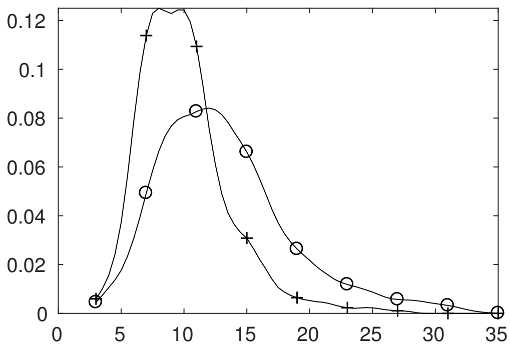
Panel C – Censored Spells

Note: Epanechnikov kernel density estimate. Arrows (→) indicate that spells end in another employment spell (e) or unemployment (u). Spells without an observed transition are right-censored. Additionally, spells might be left-censored.

Figure 10: Density of Hourly Wages – Whole sample

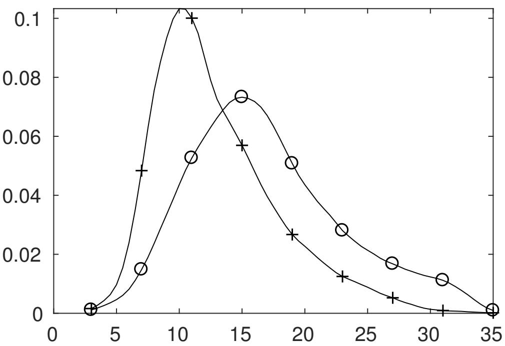


(a) e → e

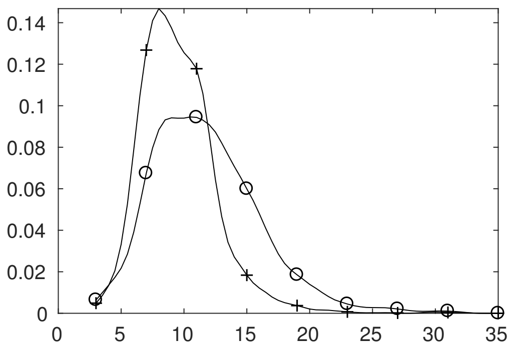


(b) e → u

Panel A – Before Transition

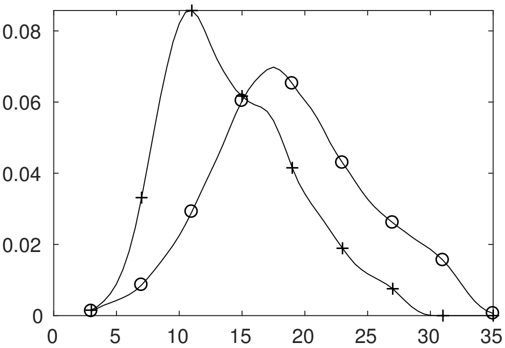


(c) e → e

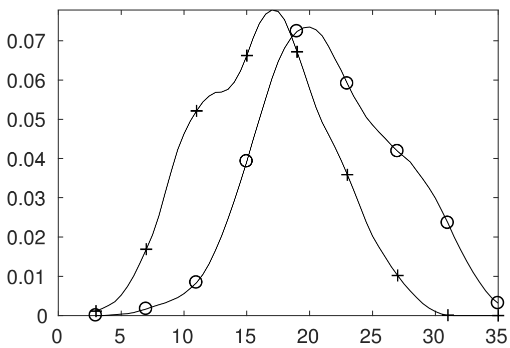


(d) u → e

Panel B – After Transition



(e) right-censored

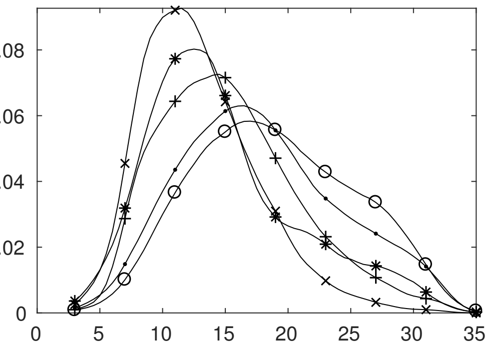


(f) left-censored

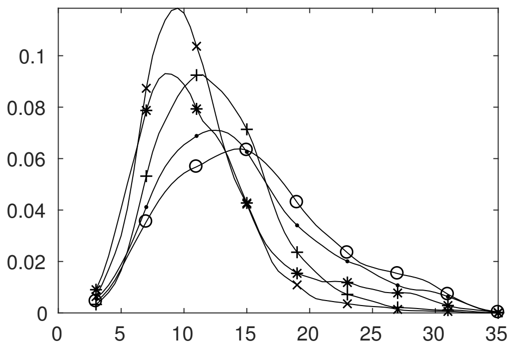
Panel C – Censored Spells

Note: Epanechnikov kernel density estimate. Arrows (→) indicate that spells end in another employment spell (e) or unemployment (u). Spells without an observed transition are right-censored. Additionally, spells might be left-censored. *Key:* West (—o—);East (—+—).

Figure 11: Density of Hourly Wages – by Region

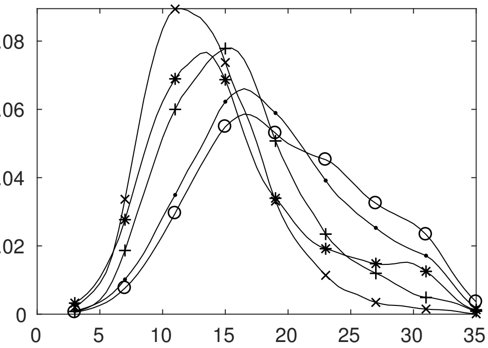


(a) e → e

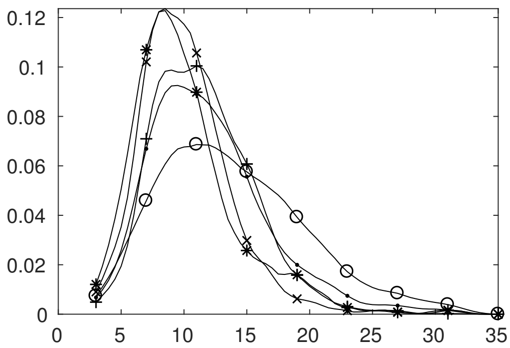


(b) e → u

Panel A – Before Transition

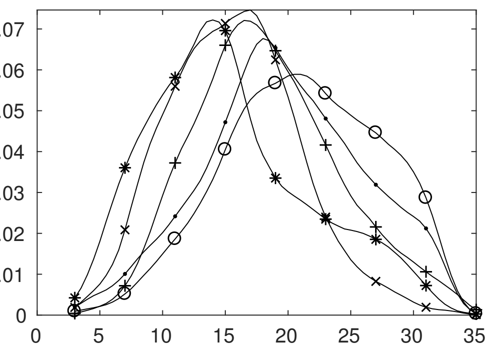


(c) e → e

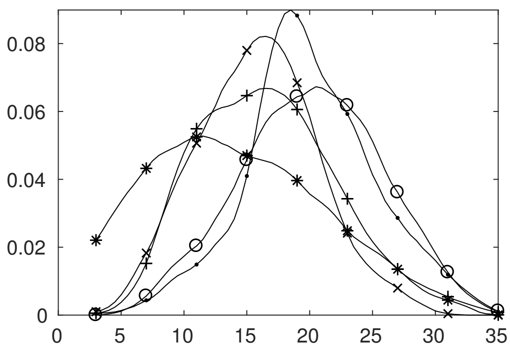


(d) u → e

Panel B – After Transition



(e) right-censored



(f) left-censored

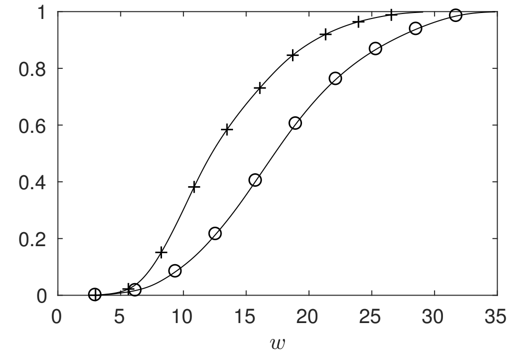
Panel C – Censored Spells

Note: Epanechnikov kernel density estimate. Arrows (→) indicate that spells end in another employment spell (e) or unemployment (u). Spells without an observed transition are right-censored. Additionally, spells might be left-censored. *Key:* Production, Craft (—O—);White-collar (—+—);Sales (—✱—);Office (—•—);Service (—×—).

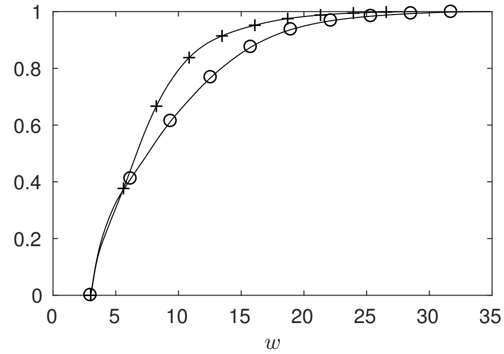
Figure 12: Density of Hourly Wages – by Job Class

A.8. Estimation Results

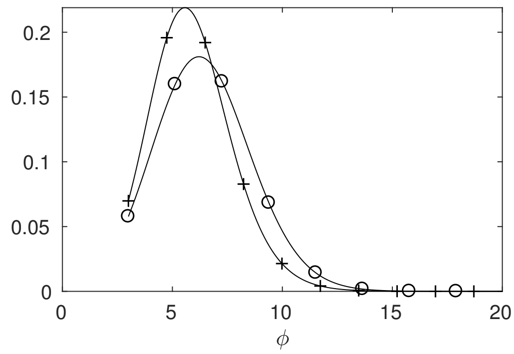
Bootstrapping We report bootstrapped standard errors. In very rare cases we exclude bootstrap runs with extreme outliers according to the following criteria: a) If the likelihood does not converge: occurs in 1 of 51 bootstrap runs in East, in 1 of 51 bootstrap runs in the robustness check with 40 hours per week.



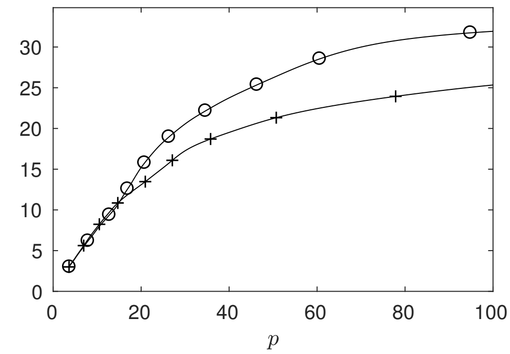
(a) Wage distribution $G(w)$



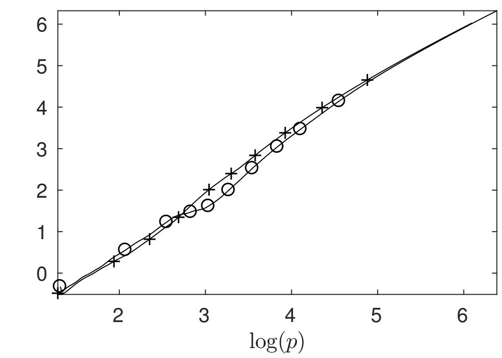
(b) Wage offer distribution $F(w)$



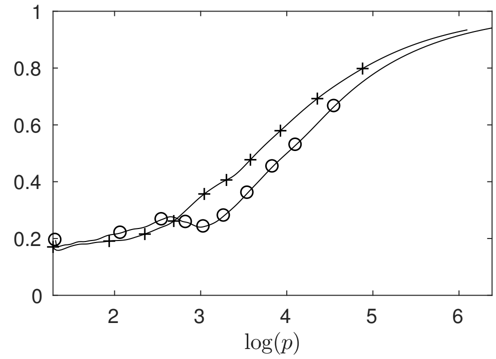
(c) Reservation wage density $A(w)$



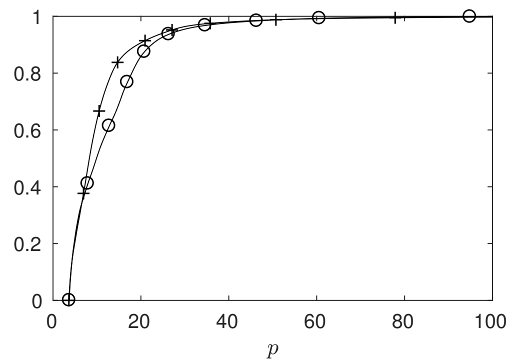
(d) Wage function $K(p)$



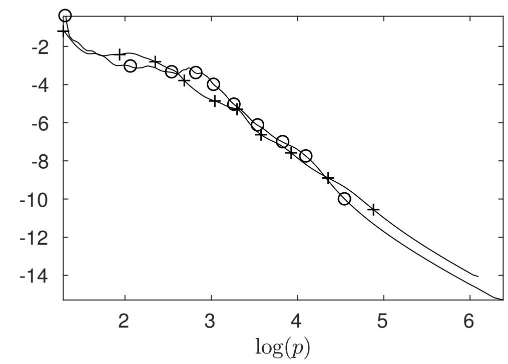
(e) Log absolute markup



(f) Monopsony power $[p - K(p)]/p$



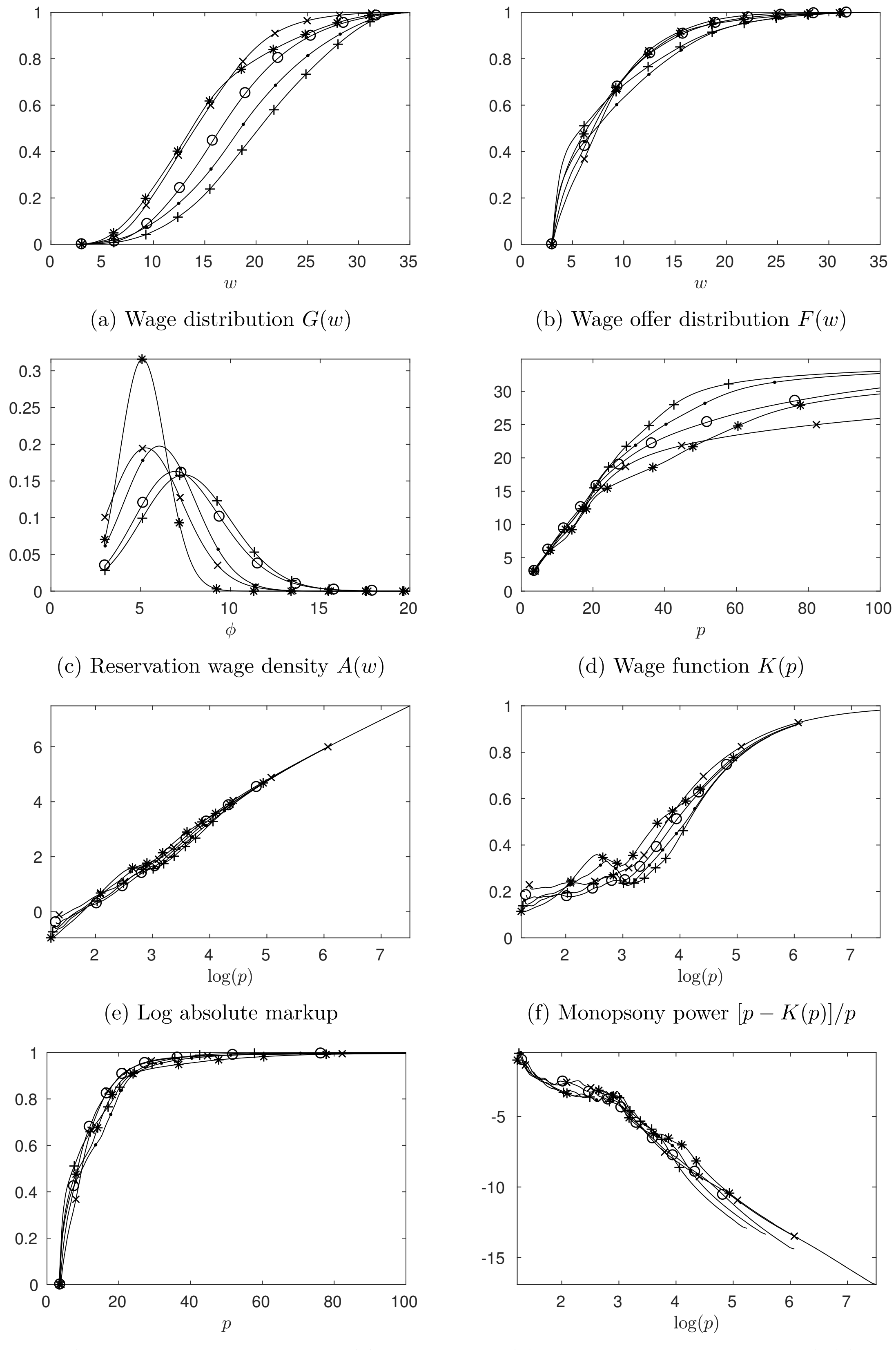
(g) Productivity distribution $\Gamma(p)$



(h) Productivity log density $\log(\gamma(p))$

Key: West (—O—);East (—+—).

Figure 13: Main Equilibrium Functions – by Region



(a) Wage distribution $G(w)$ (b) Wage offer distribution $F(w)$

(c) Reservation wage density $A(w)$ (d) Wage function $K(p)$

(e) Log absolute markup (f) Monopsony power $[p - K(p)]/p$

(g) Productivity distribution $\Gamma(p)$ (h) Productivity log density $\log(\gamma(p))$

Key: Production, Craft (—o—);White-collar (—+—);Sales (—*—);Office (—·—);Service (—×—).

Figure 14: Main Equilibrium Functions – by Job Class

Table 8: Robustness Checks (Whole Sample)

SSC threshold	Hours	Wage measure	Truncation	ρ	N	$\underline{w}$	$\overline{w}$	δ	κ_1	κ_0	μ_ϕ	μ_b	σ_b	u
Censored	Imputed	Avg. one year	3 Euro	0.02	219448	3.00	34.83	0.0063	6.95	18.31	6.11	0.00	3.58	0.0920
								(0.0000)	(0.10)	(0.33)	(0.04)	(0.00)	(0.05)	(0.0005)
Censored	40	Avg. one year	3 Euro	0.02	219604	3.00	33.49	0.0063	6.90	18.18	6.14	0.00	3.64	0.0924
								(0.0000)	(0.09)	(0.27)	(0.03)	(0.00)	(0.05)	(0.0004)
Imputed	Imputed	Avg. one year	3 Euro, 95%	0.02	219311	3.00	33.45	0.0063	6.95	18.37	6.12	0.00	3.60	0.0920
								(0.0000)	(0.09)	(0.25)	(0.02)	(0.00)	(0.04)	(0.0004)
Imputed	Imputed	Avg. one year	3 Euro, 99%	0.02	229302	3.00	49.41	0.0061	7.40	18.70	6.12	0.00	3.44	0.0913
								(0.0000)	(0.10)	(0.29)	(0.03)	(0.00)	(0.04)	(0.0004)
Censored	Imputed	Last and first obs.	3 Euro	0.02	217990	3.00	34.72	0.0063	7.02	18.28	6.01	0.00	3.52	0.0936
								(0.0000)	(0.11)	(0.31)	(0.03)	(0.00)	(0.05)	(0.0005)
Censored	Imputed	Avg. one year	4 Euro	0.02	218625	4.00	34.83	0.0063	6.07	16.96	6.47	0.00	3.46	0.0895
								(0.0000)	(0.07)	(0.25)	(0.03)	(0.00)	(0.06)	(0.0004)
Censored	Imputed	Avg. one year	3 Euro	0.01	219448	3.00	34.83	0.0061	8.15	16.87	5.84	0.00	2.90	0.0995
								(0.0000)	(0.14)	(0.34)	(0.04)	(0.00)	(0.04)	(0.0005)
Censored	Imputed	Avg. one year	3 Euro	0.04	219448	3.00	34.83	0.0065	5.16	18.60	6.10	0.00	5.08	0.0808
								(0.0000)	(0.05)	(0.24)	(0.04)	(0.00)	(0.05)	(0.0004)

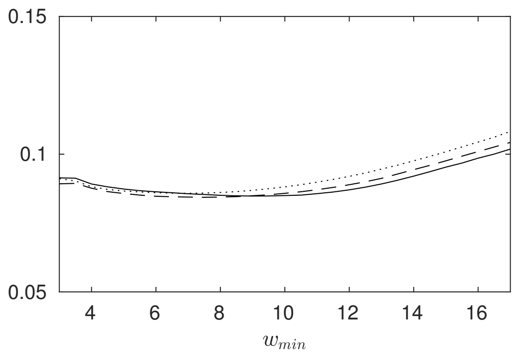
Note: First row: preferred data preparation as reported in Table 1. For alternative data handlings at the SSC threshold, see Appendix A.5. For alternative definitions of weekly hours, see Appendix A.3. For wage variants, see Appendix A.4. Bootstrapped standard errors in parentheses (50 runs).

A.9. Minimum Wage Simulations

Table 9: Unemployment Rate u by Region and Job Classification

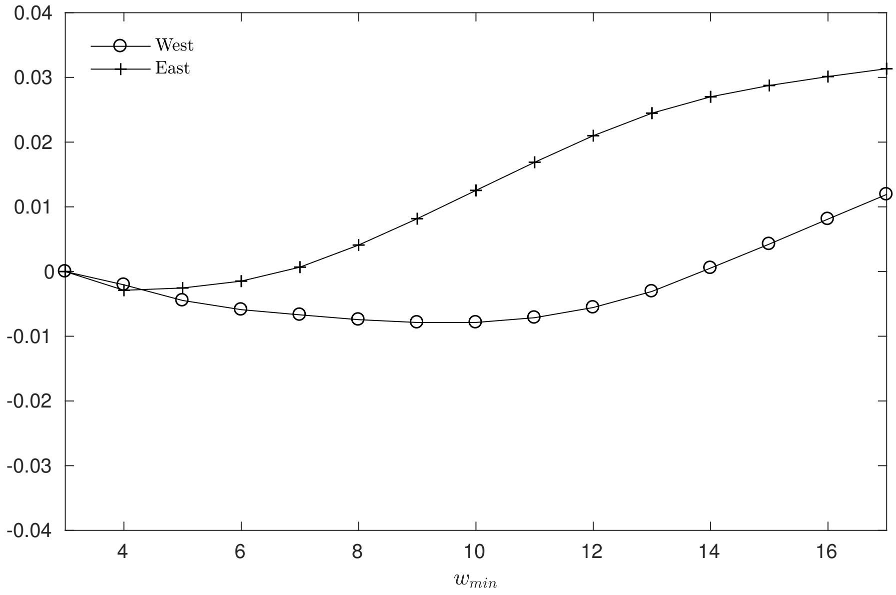
	Level	Change compared to no MW				
Minimum wage	No MW	7.00 euro	8.50 euro	10.00 euro	11.50 euro	13.00 euro
Whole Sample	0.092	-0.006	-0.007	-0.007	-0.006	-0.003
By Region						
West	0.088	-0.008	-0.009	-0.009	-0.007	-0.004
East	0.099	0.006	0.012	0.019	0.025	0.028
Total	0.090	-0.006	-0.005	-0.004	-0.002	0.001
By Job Classification						
Production, Craft	0.085	-0.000	0.001	0.003	0.005	0.008
White-collar	0.078	-0.013	-0.014	-0.016	-0.016	-0.017
Sales	0.131	-0.011	-0.012	-0.012	-0.007	0.001
Office	0.095	-0.012	-0.014	-0.014	-0.012	-0.009
Service	0.096	-0.003	-0.001	0.004	0.009	0.015
Total	0.091	-0.006	-0.005	-0.003	-0.001	0.003

Note: The first row shows simulations based on the whole sample while the rows Total aggregates the minimum wage effects by labour markets.



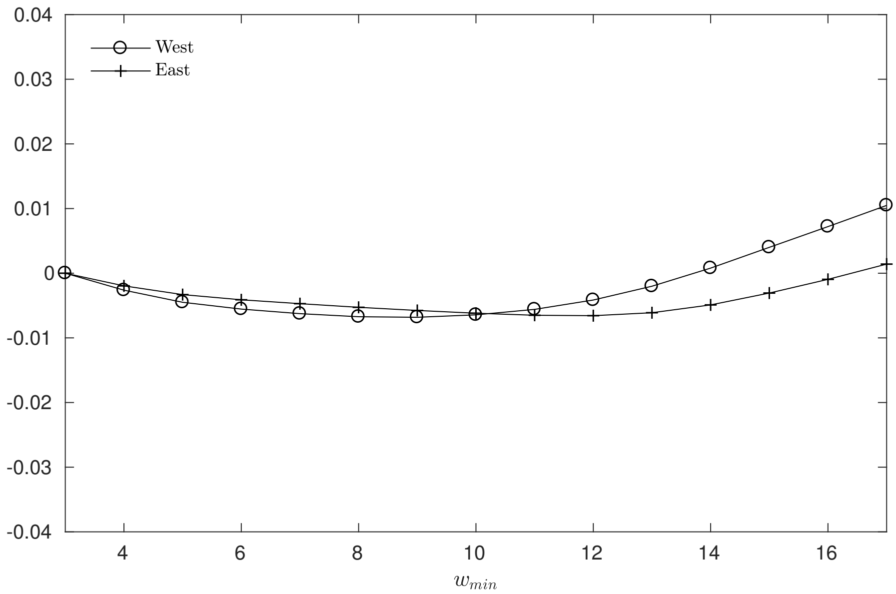
Key: Whole Sample (——); Total over Region (- - - -); Total over Job Class (··········).

Figure 15: Unemployment Rate u for Different Minimum Wages



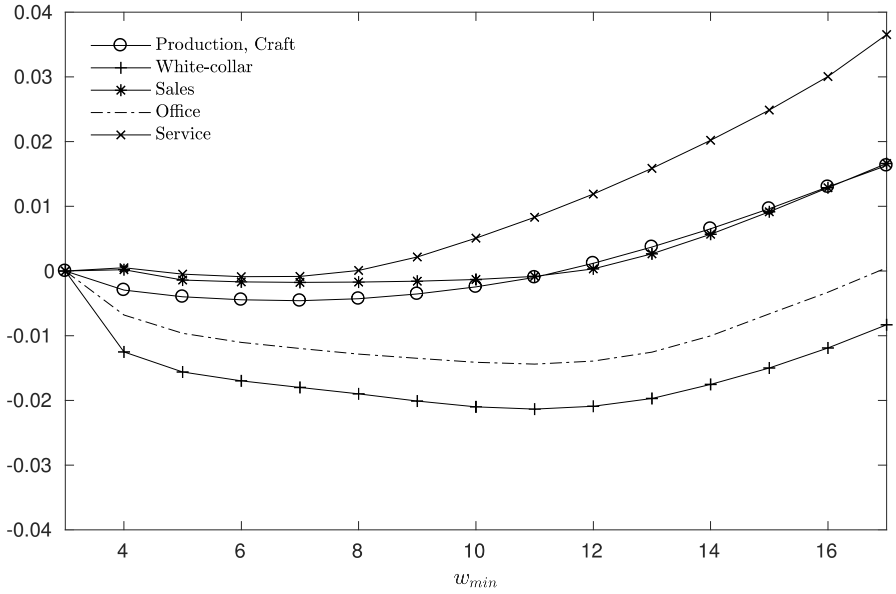
Note: Productivity distributions are taken from the different labour markets and combined with estimated parameters for the whole sample.

Figure 16: Change in Unemployment Rate by Region for Different Productivity Distributions.



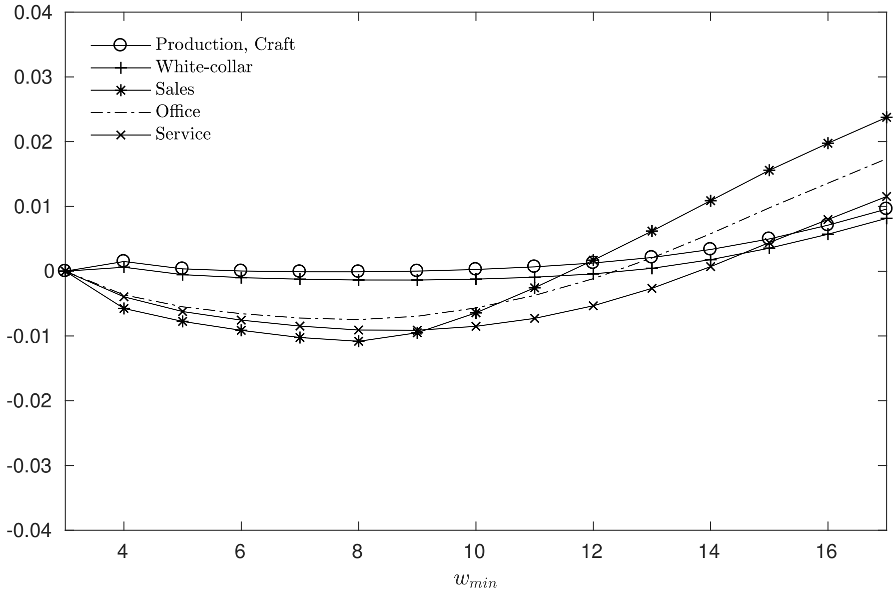
Productivity distributions are taken from the whole sample and are combined with estimated parameters for the different labour markets.

Figure 17: Change in Unemployment Rate by Region given the Productivity Distribution of the Whole Sample.



Note: Productivity distributions are taken from the different labour markets and combined with estimated parameters for the whole sample.

Figure 18: Change in Unemployment Rate by Job Class for Different Productivity Distributions.



Productivity distributions are taken from the whole sample and are combined with estimated parameters for the different labour markets.

Figure 19: Change in Unemployment Rate by Job Class given the Productivity Distribution of the Whole Sample.

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ZEW – Leibniz-Zentrum für Europäische Wirtschaftsforschung GmbH Mannheim

ZEW – Leibniz Centre for European Economic Research

L 7,1 · 68161 Mannheim · Germany
Phone +49 621 1235-01
info@zew.de · zew.de