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Employment effects of introducing a minimum wage: The case of Germany

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Employment Effects of Introducing a Minimum Wage: The Case of Germany

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Employment Effects of Introducing a Minimum Wage: The Case of Germany*

Abstract

This paper contributes to the empirical literature on the employment effects of minimum wages. We analysed the introduction of a statutory minimum wage in Germany in 2015 exploiting cross-sectional variation of the minimum wage affectedness. We construct two variables that measure the affectedness for approximately 300 state-industry combinations based on aggregate monthly income data. The estimation strategy consists of two steps. We test for (unidentified) structural breaks in a model with cross-section specific trends to control for state-industry specific developments prior to 2015. In a second step, we test whether the trend deviations are correlated with the minimum wage affectedness. To identify the minimum wage effect on employment, we assume that the minimum wage introduction is exogenous. Our results point towards a negative effect on marginal employment and a positive effect on socially insured employment. Furthermore, we analyse if the increase in socially insured employment is systematically related to the reduction of marginal employment but do not detect evidence.

Keywords: minimum wage, employment effects, minimum wage affectedness, structural break model

JEL Classification: C21, E24, J38

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1 Introduction

Scholars have argued about employment effects of minimum wages for decades. Yet, it is not clear whether minimum wages have positive, negative or no effects at all on employment. Early empirical time-series studies find negative employment effects (e.g. Brown et al. 1982), panel-data approaches, such as Neumark and Wascher (1992), seem to confirm these findings. On the contrary, case studies (e.g. Card and Krueger 1994) typically find no negative employment effects.¹

We add to the existing empirical literature by supplying new evidence on the employment effects of minimum wages. We analyze the introduction of a statutory minimum wage in Germany on January 1st, 2015.² Because there is neither variation of the minimum wage over time nor spatial variation across federal states, we cannot employ one of the classic approaches. We therefore propose to use cross-sectional variation (state-industry combinations) of the minimum wage affectedness to analyze the effects of the minimum wage on marginal and socially insured employment as well as the interaction between both forms of employment.

We compute the share of affected workers as well as the the minimum wage induced percentage average wage change. In order to identify the minimum wage effect, we firstly estimate idiosyncratic employment trends in a structural break model with endogenous breakpoint determination. This approach allows for a-priori differences between the cross sections. In a second step, we regress the trend deviations on the minimum wage variables in a simple model. Our estimations indicate a negative (positive) effect on marginal (socially insured) employment. Given these results, it seems reasonable to ask if the decrease of marginal employment ("mini-jobs", henceforth: ME) is systemically related to the positive evolution of socially insured employment (henceforth: SIE). We test this hypothesis but do not find statistic evidence.

The remainder of this paper is organized as follows. We briefly discuss the German minimum wage and the relevant literature in section 2. We describe the data including the derivation of the minimum wage affectedness variables in part 3. The following section is devoted to the idiosyncratic trend estimations, the identification of the minimum wage

¹See Neumark and Wascher (2007) for a review of the empirical literature on employment effects of minimum wages.

²Notice that only industry-specific minimum wages were in place prior to 2015. According to the WSI (2015), app. 3.1m employees, i.e. less than 10% of total employment, were covered by sector-specific minimum wages.

effect on ME and SIE as well as the analysis of the relationship between both forms of employment. The paper finishes with a conclusion.

2 The Minimum Wage in Germany

A statutory minimum wage (henceforth: MW) in Germany was subject to controversial debates long before its introduction on January 1st, 2015. Among others, politicians, scholars, unions and various other parties argued about the effects as well as the costs and benefits of a minimum wage. The main subject of their dispute was whether or not the minimum wage would have negative employment effects. The intentions of a minimum wage are mainly concerned with an income poverty reduction as well as an enhancement of societies sense of justice (Federal Ministry of Economic Affairs and Energy, 2014). The minimum wage initially amounted to 8.50€ per hour and applies to the vast majority of employees. In fact, it covers approximately 98% of all employees (Bossler and Gerner, 2016). The initial level of the minimum wage was set by the Bundestag, a minimum wage commission is in charge of adjustments.³

The German MW is an especially interesting research topic because it allows studying the introduction of a minimum wage rather than an increase of existing wage floors. Many economists predicted a severe negative effect on ME (e.g. Projektgruppe Gemeinschaftsdiagnose, 2014). It is useful to understand the most important difference between ME and SIE. The gap between the labour cost per hour and the net wage is a significantly smaller in case of ME compared to SIE. However, the income from ME employment must usually not exceed 450€ per month. If this threshold is exceeded, the mini-job either turns into a job subject to social insurance or the match dissolves.⁴ As pointed out by Henzel and Engelhardt (2014), 40% of all mini-jobbers (i.e. more than 2 millions employees) work more than 53 hours per month and hence, receive less than 8.50€ per hour in 2014. The wage increases for these workers imply that their monthly wage exceeds 450€ after the MW introduction and therefore, the match is no longer eligible for a mini-job. Mini-jobs are therefore expected to be destroyed for two reasons (Projektgruppe Gemeinschaftsdiagnose, 2014). First of all, the increase in labour cost makes some matches unprofitable and

³The commission consists of a chair person, 6 members and 2 advising, non-voting researchers. The chair is jointly suggested by the corresponding umbrella organizations of employers and employees. They also propose the members and advisers. The federal government appoints the commission.

⁴See appendix for a brief discussion on ME vs SIE.

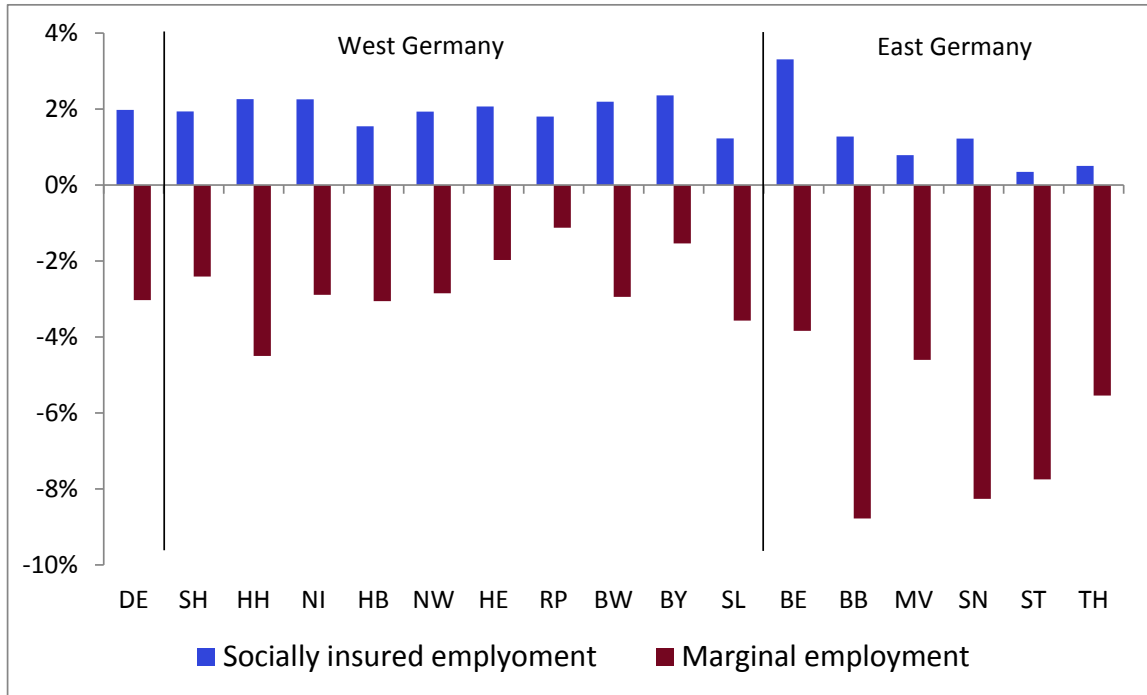


Figure 1: Annual percentage change (06/2015) of socially insured and marginal employment, Germany and all 16 states
Source: Federal Employment Agency.

therefore, they vanish. Secondly, due to the 450€ cap in combination with (minimum wage induced) pay rises, a fraction of existing mini-jobs is additionally assumed to be converted into socially insured jobs, tending to further decrease marginal employment. We refer to this phenomena as the transformation effect or transformation hypothesis. The increased labour cost due the MW is likely to affect employment subject to social insurance through the first channel as well. However, the affectedness is assumed to be significantly lower than for mini-jobs and therefore, the effect is expected to be smaller (Projektgruppe Gemeinschaftsdiagnose, 2014). Notice that the second effect (transformation effect) can only have a positive effect on socially insured employment. For both forms of employment, however, labour market imperfections such as efficiency wages (e.g. Yellen, 1984), models with a monopsony in the labour market (Manning, 1995) or search models with endogenous contact rates (Flinn, 2006) can induce an increase in employment.

The recent development of the German labour markets is depicted in Figure 1. We observe an increase and decrease of SIE and ME in all states, respectively. Furthermore,

the decrease (ME) is more pronounced in East Germany, a region associated with a high minimum wage affectedness. At the same time, the growth rates (SIE) in West Germany exceed those in East Germany (except Berlin). In order to get a better understanding of the labour markets, it is useful to analyze the medium-term evolution of both forms of employment as shown in Figure 2. The number of socially insured exhibits a solid growth

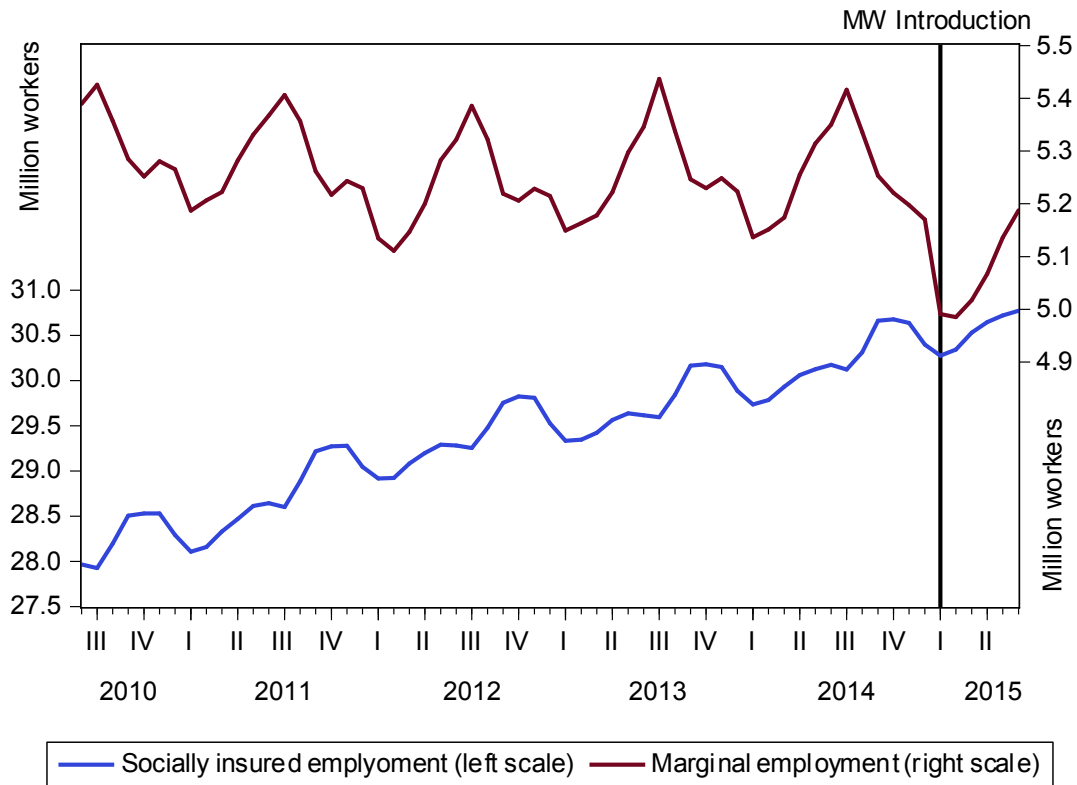


Figure 2: Socially insured and marginal employment 06/2010 - 06/2015 in Germany
Source: Federal Employment Agency.

over the past. It is hence not clear if the growth depicted in Figure 1 is caused by the MW or simply a continuation of the positive trend. Contrary to the development of the latter, we observe a relatively stable (or perhaps slightly declining) path for marginal employment until the end of 2014. Around the time of the minimum wage introduction, however, a clear drop is visible. The question is if this plunge can be attributed to the MW introduction. We aim to disentangle the minimum wage effects on employment from the evolution of the labour markets in general. Given the arguments sketched above, we expect to find a negative (positive) effect for marginal (socially insured) employment. Furthermore, we seek to identify the transformation effect. The fact that high growth rates for SIE are

accompanied with moderate decreases of ME in West Germany and low growth rates with a severe decline in East Germany, casts some doubts on the transformation hypothesis.

Bossler and Gerner (2016) analyze the German minimum wage effect on employment with a DID model that uses establishment level affectedness as distinguishing feature (control group - unaffected establishments, treatment group - affected establishments) and find a small negative employment effect. Schubert et al. (2016) investigate the effects of the minimum wage in Saxony, a state heavily affected by the minimum wage⁵, and do not detect statistically significant effects on employment. Both studies crucially hinge on a common trend assumption. Garloff (2016) exploits cross-sectional variation (region, age and gender) of the minimum wage bite and obtains a negative (positive) effect on ME (SIE). To control for the dynamics of the labour market, he uses cell-specific fixed effects to control for cell-specific growth. Our approach explicitly tackles the trending behavior of each cross section by estimating idiosyncratic trends with endogenous break point determination. This allows us to compute the deviations from a counterfactual which we use to estimate the minimum wage effect on employment as well as the transformation effect.

3 Data

As mentioned above, we exploit cross-sectional heterogeneity to identify the minimum wage effect on employment. We construct a data set that consist of employment (ME and SIE) and wage data for 16 states and 20 industries⁶.

Recall that our intermediate objective is the estimation of idiosyncratic labour market trends. To avoid massive disturbances due the financial crisis, we set the beginning of the observation period to January 2010. The observation period ends in July 2015 (data availability). The employment variable, a workers-to-population ratio, is discussed in the first subsection.

The main part of this section, however, is devoted to the derivation of two different explanatory variables which measure the minimum wage affectedness, i.e. to what extend the wage distribution in each cross section is affected by the minimum wage (bite of the minimum wage). The statutory minimum wage was introduced in January 2015 and

⁵See section 3 or Knabe and Schöb (2014).

⁶Industries according to "Klassifikation der Wirtschaftszweige (2008)", see Table A2 for details.

therefore, we can only meaningfully compute these variables for this particular point in time.

3.1 Employment and Population

The employment variable (henceforth: EV) is the ratio of workers (SIE⁷ and ME) in cross section ij (state-industry pair) over the population at working age (16-65) in state i . We choose the EV as described instead of a simple workers over population ratio because the latter neglects demographic changes. Furthermore, it seems appropriate to use state specific population data to control for demographic variation across states. This approach also captures intra-German migration. In order to find the EV, we require employment as well as population data.

The number of socially insured workers (SIE) and mini-jobbers (ME) for each cross section at a monthly frequency can be obtained from the statistics department of the Federal Employment Agency (henceforth: FEA). It is slightly more cumbersome to obtain the necessary population data. The Federal Statistical Office provides *monthly* population data on a state level until December 2015. To compute the population at working age, we hence need the share of the population at working age for each *month* on the state level. This share on an *annual* basis can be found at regional statistical offices until 2015.⁸ We interpolate these series with a cubic spline to convert annual data into a monthly frequency. To obtain the population at working age in each state we combine the (interpolated) share of the population at working age with the population data. Dividing the number of workers (socially insured and marginal employment) in each state-industry combination by the population at working age in the corresponding state yields the EV.

This ratio for both forms of employment is depicted in Figure 3.⁹ Apart from minor differences, the qualitative interpretation is identical to the picture in Figure 2. Socially insured employment steadily rises whereas marginal employment is constant before it plunges in late 2014.

⁷Full and part-time.

⁸<https://www.statistik.sachsen-anhalt.de/apps/StrukturKompass/indikator/zeitreihe/95>

⁹Notice that the depicted period deviates from our observation period. We choose June as the start and end month to avoid misinterpretation due to the seasonal pattern of the time series.

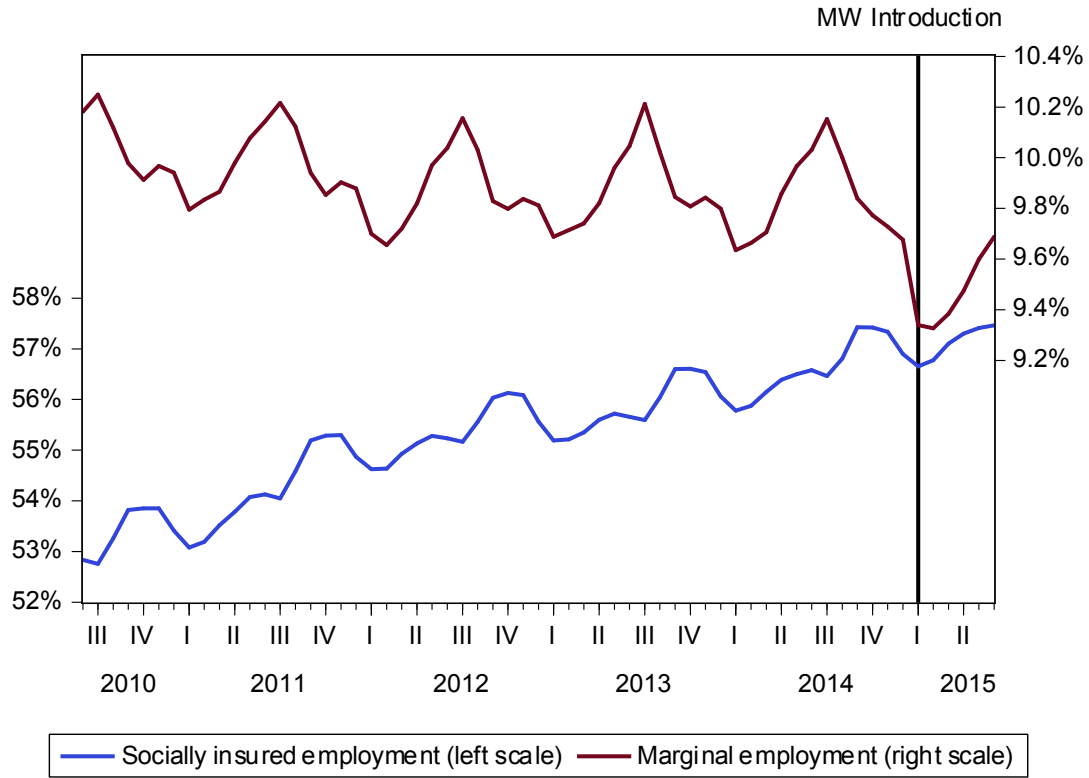


Figure 3: Employment-to-population at working age ratios (socially insured and marginal employment) in Germany.

Source: Statistics Department of the Federal Employment Agency, Federal Statistical Office, Regional Statistical Office (Saxony-Anhalt), own calculations.

3.2 Bite of the Minimum Wage

We aim to analyze if the changes in the EV depicted in the previous section are caused by the minimum wage. To proceed, we need a measurement of the bite of the minimum wage (minimum wage affectedness), i.e. a variable which quantifies to what extend the wage distribution is affected by the minimum wage. To our best knowledge, no such variable that corresponds to the cross sections used here is yet available. Our first contribution is the computation of the share of affected workers and, to overcome shortcomings of this variable, the minimum wage induced percentage average wage change for each cross section. In fact, we develop a method that allows us to compute these variables based on aggregated monthly wage data whereas they are usually inferred from micro data. As mentioned above, we only construct these variables as of December 2014.

Number of Affected Workers

For both, the share of affected workers and the percentage average change of wages due to the minimum wage, the number of affected workers in each cross section is of crucial importance. In order to find the latter, we require hourly wage data whose availability is rather unsatisfactory. We therefore use monthly income data for full time workers, i.e. we deduce the number of workers who receive less than 8.50€ (i.e. affected workers) given monthly wages. The first step is to find a condition which determines, based on monthly income, whether or not *a single worker* receives more or less than the minimum wage. We proceed by pinning down *how many workers* fulfill this condition.

Define a threshold monthly income, TH_{ij} :

$$TH_{ij} = 8.50\text{€} * WH_{ij} * 4.35. \quad (1)$$

where WH_{ij} denotes the average weekly working hours in each state-industry combination. These numbers can be obtained from the Federal Statistical Office Germany (2015). Unfortunately, not for each industry and thus, we use aggregated values for industries.¹⁰ Since we use weekly working hours, we scale it by factor 4.35 to obtain the monthly working hours. This procedure allows us to write down a condition which determines whether or not a worker is affected by the minimum wage. For any income $w_{month,ij} < TH_{ij}$, a worker's hourly wage is below 8.50€.

Let us now answer the question regarding the number of affected workers. We use monthly wage data for full time workers provided by the Federal Employment Agency. This data set contains the number of workers n_{ij} in $k \in \{1, \dots, 18\}$ intervals of increasing income¹¹ with upper (lower) bound UB_k (LB_k) for every state-industry pair. We assume a piecewise linear distribution of workers within each interval. We assume a piecewise linear distribution of workers within each interval. Define l_{ij} as the cross-section specific interval in which the threshold income, TH_{ij} , is located: $l_{ij} = \underset{k}{\operatorname{argmin}} \{UB_k > TH_{ij}\}$.¹²

¹⁰In fact, there are values for three (aggregated) industries for each state (industry A, B-F, G-S). A state's average value replaces an industry's value if it is missing.

¹¹See Table A3 for details.

¹²Notice that l varies over cross sections. For the sake of readability, we skip the index from this point onwards.

This allows us to determine the number of workers with income $x < TH_{ij}$ as follows:

$$n_{ij}^{x < TH_{ij}} = \sum_{k=1}^l n_{ij}^k + n_{ij}^{l+1} \frac{TH_{ij} - LB_{l+1}}{UB_{l+1} - LB_{l+1}}, \quad (2)$$

The first part of the equation above is the sum of all workers in all intervals from $k = 1$ to $k = l$. The second summand is the number of workers in interval $l + 1$ who receive less than the threshold income TH_{ij} . Since we only have the total number of workers in interval $l + 1$, we need to scale it with the fraction in $l + 1$ who receives less than TH_{ij} . A realistic, made up example is provided in the Appendix.

Share of affected workers

The share of affected workers (henceforth: SAW) describes the fraction of workers who receive less than the minimum wage prior to its introduction in January 2015. Since we already know the number of affected workers, we simply need to divide this figure by the number of workers in the corresponding cross section, N_{ij} , to obtain the SAW_{ij} :

$$SAW_{ij} = \frac{n_{ij}^{x < TH_{ij}}}{N_{ij}} \quad (3)$$

The results of this procedure are depicted in Table A4. Industries are ordered in ascending order of affectedness whereas states are ordered alphabetically. Notice that the purpose of the minimum wage variable is to have a measure that quantifies the relative differences regarding the affectedness across cross sections. Therefore, we are not ultimately interested in the absolute value of the SAW . We observe that low-wage industries such as "Accommodation and Food Service Activities" are multiple times as exposed to the minimum wage than other industries. This also holds true for moderately affected sectors. Furthermore, for quite a few industries the minimum wage defacto does not play a role. From a spatial perspective, two facts strike the observer's eye. First of all, there seems to be a significant east-west gap. Within both regions, however, the differences across states are less severe. Therefore, the minimum wage affectedness heterogeneity is driven by industries and, to smaller extent, by regions rather than states.

Percentage average wage change

The share of affected workers (SAW) as described above is an absolute measure of the bite of the minimum wage in a sense that it does *not* account for the distance of a worker's wage to the minimum wage. Two cross sections could be exposed in a similar fashion in terms of the SAW . However, no differentiation is made regarding the intensity of affectedness. Suppose we find comparable values for some cross sections A and B ($SAW_A \approx SAW_B$). They might however be totally different regarding the average wage of affected workers (e.g. $\bar{w}_A = 8.40\text{€}$ and $\bar{w}_B = 5.00\text{€}$). It seems plausible that the impact of the minimum wage is different between these two cross sections.

To account for that possibility, we construct an alternative measure of the bite, the minimum wage induced percentage average wage change (henceforth: AWC). We build on the number of affected workers and the income data explained above and compute the average wage prior to the minimum wage as follows:

$$\begin{aligned} \bar{w}_{ij}^{prior} = & \frac{\sum_{k=1}^l \bar{w}^k n_{ij}^k + \frac{TH_{ij}-LB_{l+1}}{UB_{l+1}-LB_{l+1}} n_{ij}^{l+1} \bar{w}_{ij}^{LB_{l+1} < w_{ij} < TH_{ij}}}{n_{ij}^{x < TH_{ij}}} \\ & + \frac{(1 - \frac{TH_{ij}-LB_{l+1}}{UB_{l+1}-LB_{l+1}}) n_{ij}^{l+1} \bar{w}^{TH_{ij} < w_{ij} < LB_{l+2}} + \sum_{k=17} \bar{w}^k n_{ij}^k}{N_{ij} - n_{ij}^{x < TH_{ij}}}, \end{aligned} \quad (4)$$

where \bar{w}_{ij}^k denotes the average wage in interval k . For all $k = \{3 \dots 17\}$ the average wage is simply set according to $\bar{w}^k = \frac{1}{2}(LB_k + UB_k)$. Since this approach is unlikely to be valid for larger intervals at the lower end of the distribution, we use micro data for $k = 1, 2$. Based on the Socio-Economic Panel (2015) data set, we compute $\bar{w}^1 = \mathbf{E}[w^{k=1} \mid 1\text{€} < w_{month} \leq 500\text{€}]$ and $\bar{w}^2 = \mathbf{E}[w^{k=2} \mid 501\text{€} < w_{month} \leq 1000\text{€}]$.¹³ Notice that the average wage, \bar{w}^k , does not differ across state-industry combinations for all intervals k . It is hard to think of an argument for different average wages within each interval across cross sections. Furthermore, we exclude interval $k = 18$ because it has no upper bound and thus, we cannot compute an average wage. Equation (4) is a weighted average of affected and unaffected workers. We account for the fact that the threshold income TH_{ij} splits interval

¹³There is a trade-off between the number of observations and how well the SOEP income data match the FEA employment data. If we choose only full-time employees from the SOEP sample, the number of individuals with very low wages is too low for valid inference. However, if we decide to include part-time and full-time employees, we face the problem that the FEA data only reports the number of full-time employees. Hence, the comparison of the two data sets becomes somewhat problematic. It turns out that both approaches yield identical results up to the 2nd decimal point. The differences should thus be negligible.

$l + 1$ arbitrary (i.e. not according to the defined boundaries of this interval) by applying the piecewise linear distribution assumption. Hence, we scale the average wage of affected workers in $l + 1$ with the corresponding fraction of workers in interval $l + 1$. The average wage of unaffected workers in $l + 1$ is weighted with the counterpart of fraction of affected workers in $l + 1$.

To compute the average wage after the minimum wage introduction, \bar{w}_{ij}^{post} , we assign a value of 8.50€ to all affected workers whereas we assume that the wages of unaffected workers do not change. The AWC_{ij} is simply:

$$AWC_{ij} = \frac{\bar{w}_{ij}^{post} - \bar{w}_{ij}^{prior}}{\bar{w}_{ij}^{prior}} \quad (5)$$

For detailed results of this procedure, see Table A5. The results are similar to those obtained for the *SAW*. Unless stated otherwise, we refer to the *AWC* as the minimum wage affectedness or minimum variable from this stage onwards.

One could argue that we use income data on full-time regular employees who are usually assumed to be less affected by low wages than part-time workers and thus, our results may be biased. The values (*SAW*) computed by Brautzsch and Schultz (2013) as well as Knabe and Schöb (2014) are based on survey data and therefore, their results do not suffer from the selection problem we face. We compare their findings for each industry-state combination available (i.e. large cross sections and states, respectively) with our estimation and compute the correlation between their values and our findings. The resulting correlation coefficients are 0.99 (Knabe and Schöb 2014) and 0.94 (Brautzsch and Schultz 2013). The fact that the purpose of both minimum wage variables is to measure the difference across cross sections justifies using the variables as a measure of the minimum wage affectedness in case of ME although they are derived from SIE based wage data. Thus, we conclude that our computation serves as a decent proxy for a measure of the minimum wage affectedness.

Exceptions from the minimum wage

Notice that in procedure described above we assume that there are no exceptions from the minimum wage. However, as of January 2015, some industries were exempted from the statutory minimum wage. Since exceptions for agriculture and forestry were in place,

we exclude the industry "Agriculture, Forestry and Fishing" in the estimation procedure. Furthermore, the sector-specific minimum wage for temporary employment was below 8.50€ per hour in East Germany and hence, the corresponding cross sections are excluded in the regressions.¹⁴ The meat industry, the textile industry, horticulture, laundry service and hairdressing were exempted from the statutory minimum wage as well. However, they only make up a small fraction of the corresponding sector and therefore remain in the sample.¹⁵

On the contrary, a high sector-specific minimum wage ($>10\text{€}$) applies to construction workers. Yet, not every employee in the industry "Construction" is a construction worker and therefore, the minimum wage affectedness is not zero.

4 Estimation

As outlined above, our identification strategy of the employment effect consists of several steps. We begin with the estimation of idiosyncratic trends for each cross section and test for structural breaks (ME and SIE). We use these estimates to construct a counterfactual which in turn allows the computation of trend deviations. This approach is illustrated in Figure 4. These trend deviations are the input in the final step of the estimation procedure. We also try to answer the question if the effect on ME is systemically related to the impact on SIE, i.e. test the transformation hypothesis.

4.1 Idiosyncratic Trend Estimation

To analyze whether there is a systematic relationship between the minimum wage affectedness and the changes of the employment variable, one could simply regress the these changes on the minimum wage variable and some controls. However, different cross sections are likely to differ in terms of economic development during the observation period. These differences are transmitted into our employment variable. For example, consider the evolution of the employment variable in the (relatively highly affected) cross sections

¹⁴Industry "Activities of Employment Placement Agencies, Temporary Employment Agency" in Berlin, Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia.

¹⁵The meat and textile industries are part of "Production of largely domestically consumed goods". Horticulture is included in "Administrative and Support Service Activities". Hairdressing and laundry services are included in "Arts, Entertainment and Recreation, Other Service Activities, Activities Of Households As Employers, Undifferentiated Goods- and Services-Producing Activities of Households for Own Use".

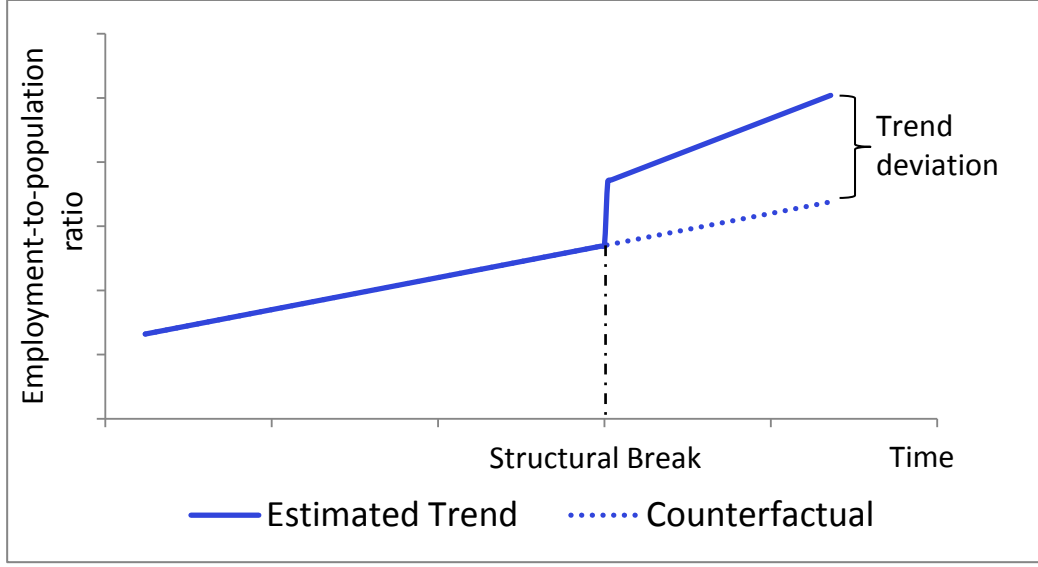


Figure 4: Schematic depiction of the computation of the trend deviations.

"Administrative and Support Activities" in Berlin as well as "Arts, Entertainment and Recreation, Other Service Activities..." in Saxony (see Figure 5). Clearly the depicted cross sections do not follow a common trend and are thus somewhat difficult to compare.

In order to make all cross sections comparable, we estimate idiosyncratic trends with an unidentified structural break in the mean and slope as well as seasonal dummies as follows:

$$y_{ij,t} = \beta_{0,ij} + \beta_{1,ij}t + \beta_{2,ij}DU_{TB_{ij}} + \beta_{3,ij}DT_{TB_{ij}} + \sum_{m=1}^{11} \beta_{Dm,ij}D_{m,t}, \quad (6)$$

where $y_{ij,t}$ denotes the employment variable in cross section ij . This exercise (and the following) are carried out for both forms of employment, i.e. we estimate the coefficients based on $y_{ij,t}^{SIE}$ as well as $y_{ij,t}^{ME}$. For the sake of readability, however, we skip the superscript unless judged beneficial. As indicated by the subscripts in (6), we account for structural differences with cross-section specific coefficients. DU and DT denote the intercept and slope dummy, respectively.¹⁶ The point in time of the structural break, TB_{ij} , is treated as unknown. We endogenously determine the latter for each cross section by maximizing the

¹⁶ $DU_{TB_{ij}} = 1$ and $DT_{TB_{ij}} = t - TB_{ij}$ if $t > TB_{ij}$, 0 otherwise. See, e.g. Perron (1989).

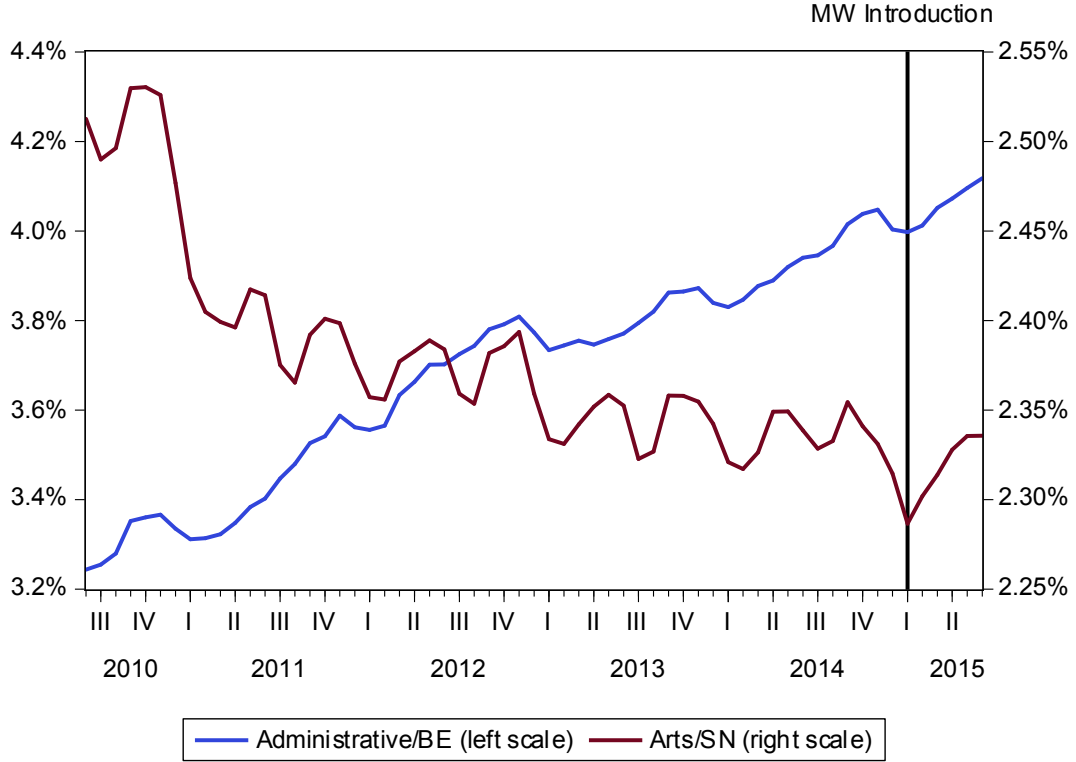


Figure 5: Employment-to-population at working age ratios (socially insured) in selected cross-sections.

Source: Federal Employment Agency, Federal Statistical Office, Regional Statistical Office (Saxony-Anhalt), own calculations.

joint significance of the corresponding dummy coefficients ($\beta_{2,ij,t}$ and $\beta_{3,ij,t}$):

$$H_{0,t} : \beta_{2,ij,t} = \beta_{3,ij,t} = 0,$$

$$TB_{ij} = \operatorname{argmax}_t \{F_{0,t}\}.$$

The time horizon for the break determination is set to lie within 04/2014 (passing of the cabinet resolution in 04/2014) and 03/2015 (three months adjustment period).

We proceed constructing a counterfactual, $\hat{y}_{ij,t}$, by setting the estimated break coefficients equal to zero:

$$\hat{y}_{ij,t} = \beta_{0,ij} + \beta_{1,ij}t + \sum_{m=1}^{11} \beta_{Dm,ij}D_{m,t}, \quad (7)$$

In doing so, we estimate how the employment variable would have evolved if there were no (unidentified) structural breaks. The next step is the computation of the trend deviations,

$\tilde{y}_{ij,t}$:

$$\tilde{y}_{ij,t} = y_{ij,t} - \hat{y}_{ij,t}. \quad (8)$$

This procedure controls for a-priori, structural differences and therefore, helps to make the cross sections comparable.

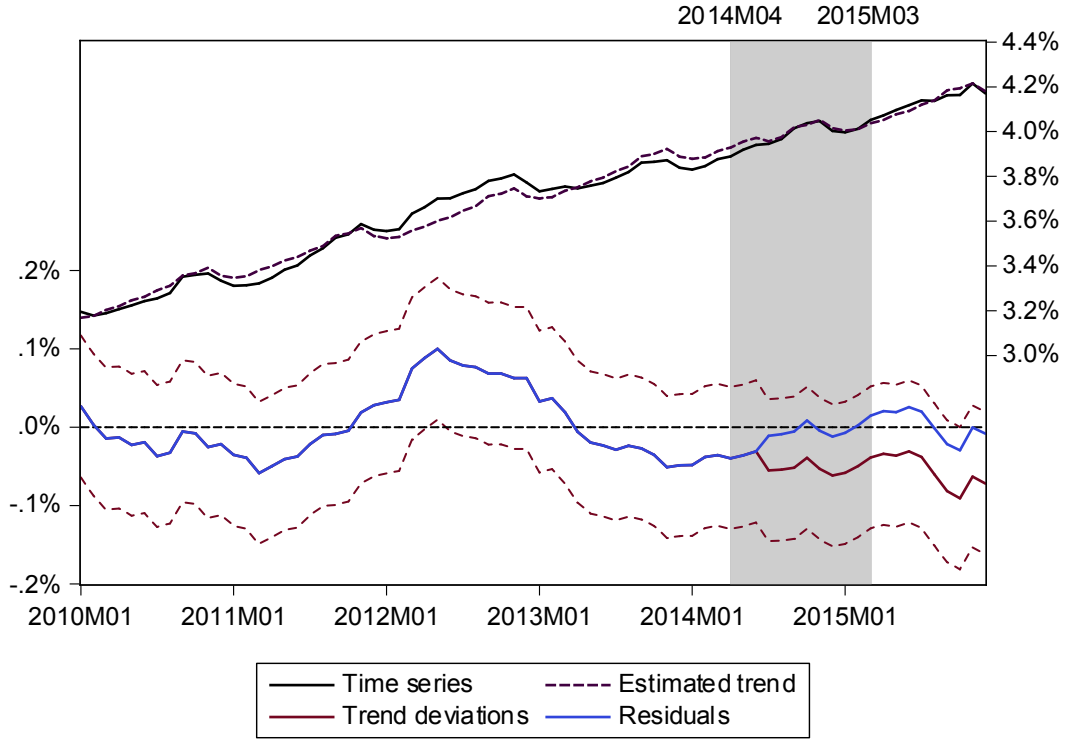


Figure 6: Time series of the employment variable, estimated trend, trend deviations and residuals, Administrative/BE (SIE).

Source: Federal Employment Agency, Federal Statistical Office, Regional Statistical Office (Saxony-Anhalt), own calculations.

Figures 6 and 7 show the time series of the employment variable, the estimated value of the variable according to (6), the trend deviations using (8) with confidence bands¹⁷ as well as the residuals for the same examples from above. The left scale refers to the employment variable and the estimate of it, the right scale to residuals. First of all, we observe that our specification yields a good fit of the data. Secondly, the graphs comprehensibly illustrate that the evolution in Saxony (Arts) is characterized by a positive structural break despite its previous downward path. This is visible through the positive trend deviation. On the contrary, the booming cross section Berlin (Administrative and Support Activities)

¹⁷+/- 2 standard errors.

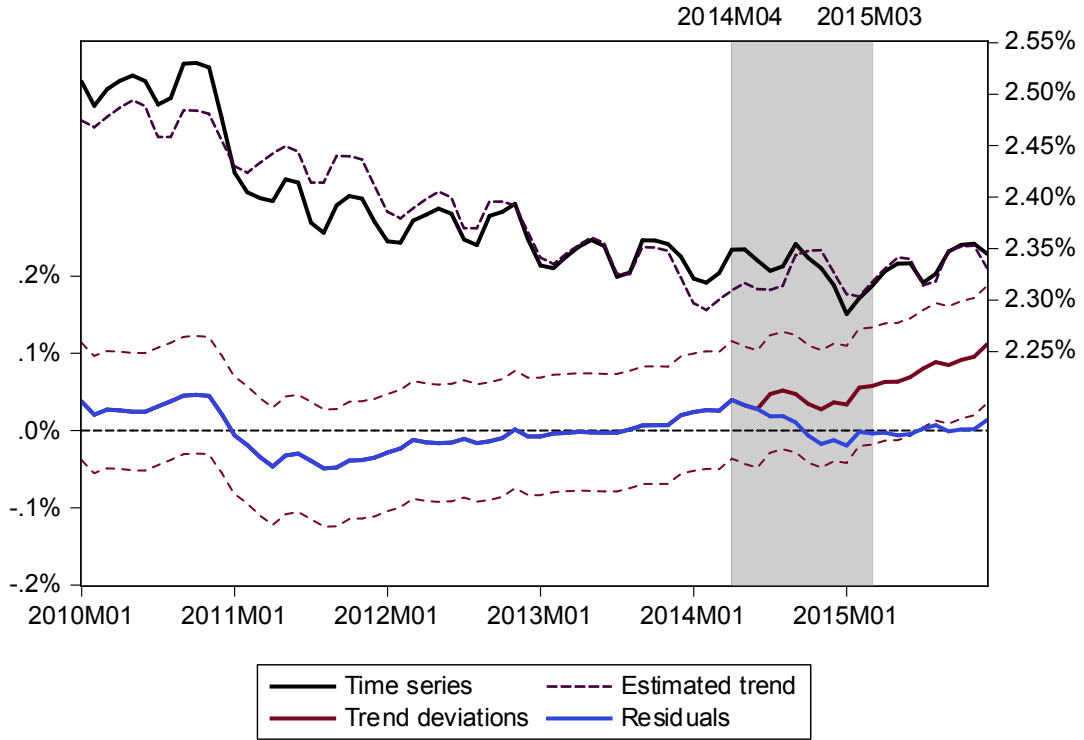


Figure 7: Time series, estimated trend, trend deviations and residuals, Arts/SN (SIE).
Source: Federal Employment Agency, Federal Statistical Office, Regional Statistical Office (Saxony-Anhalt), own calculations.

recently exhibited a slowdown. The question is whether these exemplary differences can be explained with the minimum wage introduction.

4.2 Employment Effects

To identify the minimum wage effect, we use a simple model of the form:

$$\tilde{y}_{ij} = \gamma_0 + \gamma_1 AWC_{ij}. \quad (9)$$

We regress the trend deviations on the minimum wage affectedness (AWC_{ij}) and a constant using OLS.¹⁸ In line with the literature, we assume that the minimum wage introduction is exogenous (see, e.g. Neumark and Wascher, 2007). Hence, we can interpret the coefficient of the minimum wage variable, AWC_{ij} , as the effect of the minimum wage on employment. Based on the Breusch-Pagan-Godfrey test, we do not reject the homoscedasticity

¹⁸The sample contains 272 observations. Recall that we exclude some cross sections for regulatory reasons. Furthermore, we lose a few cross sections due to data unavailability.

assumption.¹⁹ It is not clear at what point in time the minimum wage effect kicked in and therefore, we estimate (9) for various periods (10/2014 to 03/2015). We focus on the sign and, to a smaller extent, the magnitude of the coefficient rather than its absolute value. The interesting coefficient, γ_1 , including the p-values for both, marginal and socially insured employment are reported in Table 1.

Period	γ_1	γ_1
	Marginal employment	Socially insured workers
October 2014	0.0009 (0.1224)	0.0034 (0.0351)
November 2014	0.0011 (0.1549)	0.0043 (0.0109)
December 2014	0.00008 (0.3072)	0.0048 (0.0071)
January 2015	-0.0021 (0.0258)	0.0072 (0.0004)
February 2015	-0.0022 (0.0215)	0.0085 (0.0000)
March 2015	-0.0026 (0.0091)	0.0098 (0.0000)

Table 1: Regression results for the minimum wage affectedness coefficient (marginal and socially insured employment). P-values in parenthesis.

We observe that the minimum wage did not have an effect on marginal employment prior to the minimum wage introduction. However, after its introduction, the minimum wage has a significant negative effect on marginal employment. This is well in line with our hypothesis discussed in Section 2 and the development depicted in Figures 1 and 2. Given the stark plunge in the mentioned figures, one could have expected a stronger minimum wage effect. Pusch and Seifert (2017) argue that more than 40% of all affected workers (ME) still earn less than the minimum wage in early 2015. Furthermore, the fraction of employers that undo the minimum wage, e.g. due to differences between actual and contractually agreed working hours or unpaid overtime, is especially high in low-wage industries. Therefore, our findings potentially underestimate the negative effect. The results are robust with respect to the measure of the minimum wage affectedness, i.e.

¹⁹Both, the p-value of the F-statistic (0.4754) and of the LM-statistic (0.4736) do not call for rejecting the null hypothesis of homoscedasticity. The test is conducted for SIE as of January 2015. For ME, we obtain the same result.

they do not change if we use the share of affected workers as an explanatory variable. On the contrary, the minimum wage introduction has a positive effect on employment subject to social insurance. One could think of anticipating agents as an explanation for the increase in employment prior to the minimum wage introduction. We find that the positive effect (statistically and economically) is more pronounced in 2015. As in case of marginal employment, the choice of the explanatory variable does not influence the qualitative results.

The fact that marginal employment is basically unaffected until 01/2015 makes the transformation of ME into SIE unlikely. However, the stronger effect on SIE combined with the negative effect on ME in 2015 supports the transformation hypothesis. We further evaluate the transformation effect in the next section.

Using a dummy for East Germany does not change the (qualitative) results in case of SIE. However, the results are slightly different for marginal employment (see Appendix, Table A6). While the sign of the minimum wage coefficient does not change, it is significant at the 5% level in October and November 2014. Furthermore, the coefficient is larger in 2015. Hence, the dampening impact of the minimum wage on ME in East Germany appears stronger. Although the dummy coefficient for East Germany is not significant, the negative sign supports this hypothesis. Taking the higher affectedness in East Germany into account, this finding could be the result of nonlinearities. Practically speaking, it might be more than twice as difficult for an employer to raise a worker's hourly wage by 0.50€ as opposed to 1€.

One could argue that it is necessary to use a fixed effects model to account for unobserved effects such as policy differences across states or varying demand elasticities across industries. The inclusion of state fixed effects does not change the qualitative results for both forms of employment. This is not surprising because differences in policy changes across states over the relevant period seem to be neglectable. Estimating a model with industry fixed effects, however, entirely removes the significance from the minimum wage coefficient (both forms). Recall that the minimum wage affectedness is mainly driven by industries. Hence, using industry fixed effects we already include a variable which captures the affectedness to a considerable extent. Therefore, it is not surprising that the actual minimum wage variable loses its explanatory power if industry fixed effects are included.

4.3 Transformation Effect

To analyze whether SIE rose in those state-industry pairs in which ME decreased, we estimate the following relationship:

$$\tilde{y}_{ij,t}^{SI} = \delta_0 + \delta_1 \tilde{y}_{ij,t}^{ME}, \quad (10)$$

where $\tilde{y}_{ij,t}^{SI}$ and $\tilde{y}_{ij,t}^{ME}$ denote the residuals from (8) for socially insured and marginal employment, respectively. Contrary to (9), this specification does not account for the minimum wage at all. Hence, it is possible that a cross section exhibits an increase in socially insured employment and a decrease in marginal employment that is unrelated to the minimum wage. As shown in section 3, a few cross sections are almost unaffected by the minimum wage. We therefore restrict our sample such that only cross sections with an above the (unweighted) German average minimum wage affectedness remain in the sample.²⁰ Recall that we intend to analyze if the effects on both forms of employment are related with each other. Since we only detect a negative employment effect on marginal employment in early 2015, the following estimations are only carried out for the period 01/2015 to 03/2015. If the transformation hypothesis were correct, we would obtain a negative coefficient δ_1 . Our initial suspicion regarding the hypothesis (see Figure 1) is

Period	Coefficient $\tilde{y}_{ij,t}^{ME}$ (restricted sample)
January 2015	0.16 (0.4183)
February 2015	0.12 (0.5456)
March 2015	0.05 (0.8113)

Table 2: Regression results for the transformation coefficient. P-values in parenthesis.

confirmed by the values reported in the second column of Table 2. Despite an increase in employment subject to social insurance and a decrease in marginal employment, we do not find evidence for a relationship between the changes in both forms of employment as indicated by the p-values. We therefore reject the transformation hypothesis. Using the

²⁰That is, $AWC > 1.81\%$. The number of observations decreases to 80.

median as the threshold criteria does not change this finding.

Vom Berge and Weber (2017) argue, based on micro data, that twice as many mini-jobs were transformed into socially insured jobs in January 2015 in comparison to January 2014. However, they also find that for every 100 transformed jobs, 58 (full and part time) socially insured jobs were destroyed and hence, the net effect on socially insured employment is not equal to the increase of transformed jobs. Because our approach only analyzes the net effect, the results do not contradict vom Berge and Weber (2017).

5 Conclusion

Our first contribution to the literature is the computation of two variables which measure the minimum wage affectedness for a large number of cross sections based on aggregate monthly income data. We use these variables to show what many economists predicted. Our results indicate a negative effect on marginal employment and a positive effect on socially insured employment. However, we cannot confirm the hypothesis that the minimum wage induced a transformation of mini-jobs into jobs subject to social security.

A recent report by Bellmann et al. (2016) indicates that a reduction of working hours is the major adjustment channel for affected firms. It is therefore important to study the intensive margin to fully understand the employment effects of the minimum wage introduction. Unfortunately, the data are not readily available for such an analysis. Another reasonable extension is to use micro data on earnings, such as data from the structure of earnings survey, to construct a minimum wage variable. However, the next iteration of this survey is not due before 2018.

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Appendix

Marginal vs. socially insured employment

Let us briefly discuss the two forms of ME (or mini jobs) in Germany at this stage. "Low-paid employment" describes jobs at which a worker earns less than 450€ per month. The other form, short-term employment, is in place if the number of working days does not exceed 50 per year or 2 months. Notice that only certain groups, e.g. unemployed persons, students and others are eligible for this form. It is important to note that short-term employment is not applicable to part or full time workers. We do not distinguish between both forms of ME in the remainder simply because it does not matter for our purpose. Contrary to SIE, ME workers do not have to contribute to the mandatory social security system.²¹ Contrary to SIE, the employee only pays a lump sum for health and retirement insurance. Mini jobs furthermore enjoy some tax benefits. The interested reader is referred to the Federal Ministry of Labour and Social Affairs for a thorough overview.²²

²¹They are generally exempted from health, nursing care and unemployment insurance. Upon request, ME workers do not need to contribute to the retirement insurance

²²See also <http://www.bmas.de/EN/Our-Topics/Social-Security/450-euro-mini-jobs-marginal-employment.html>

German states

Abbreviation	State	
SH	Schleswig-Holstein	} West Germany
HH	Hamburg	
NI	Lower Saxony	
HB	Bremen	
NW	North Rhine-Westphalia	
HE	Hesse	
RP	Rhineland-Palatinate	
BW	Baden-Württemberg	
BY	Bavaria	
SL	Saarland	
BE	Berlin	} East Germany
BB	Brandenburg	
MV	Mecklenburg-Western Pomerania	
SN	Saxony	
ST	Saxony-Anhalt	
TH	Thuringia	

Table A1: Index of German federal states.

List of industries

Number	Sector
1	Mining, Quarrying, Electricity, Gas, Steam and Air Conditioning Supply, Water Supply, Sewerage, Waste Management and Remediation Activities (B,D,E)
2	Public Administration and Defence, Compulsory Social Security, Activities of Extraterritorial Organisations and Bodies (O,U)
3	Metal and Electrical Industry, Steel Industry (24-30, 32, 33)
4	Production of Intermediate Goods, especially Chemical and Plastic Products (16, 17, 19, 20, 22, 23)
5	Financial and Insurance Activities (K)
6	Manufacturing (C)
7	Education (P)
8	Information and Communication (J)
9	Construction (F)
10	Real Estate Activities, Professional, Scientific and Technical Activities (L, M)
11	Human Health Activities (86)
12	Overall
13	Residential Care Activities, Social Work Activities Without Accommodation (87,88)
14	Transportation and Storage (H)
15	Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles (G)
16	Production of largely domestically consumed goods (10-15, 18, 21, 31)
17	Administrative and Support Service Activities (N)
18	Arts, Entertainment and Recreation, Other Service Activities, Activities Of Households As Employers, Undifferentiated Goods- and Services-Producing Activities of Households for Own Use (R, S, T)
19	Activities of Employment Placement Agencies, Temporary Employment Agency Activities (78.1, 78.2)
20	Agriculture, Forestry and Fishing (A)
21	Accommodation and Food Service Activities (I)

Table A2: Index of sectors

Interval k	Monthly income in Euro w_{month}
1	1 - 500
2	501 - 1000
3	1001 - 1100
4	1101 - 1200
5	1201 - 1300
6	1301 - 1400
\vdots	\vdots
12	2001 - 2500
13	2501 - 3000
\vdots	\vdots
17	4501 - 4900
18	> 4900

Table A3: Income intervals for monthly incomes.

Source: Based on data of the Statistical Department of the FEA

Number of Affected Workers - Example

- Weekly working hours $WH_{ij} = 39h$
- Monthly threshold income $TH_{ij} = 1442.03\text{€}$
- Interval $k = l$ below which income x exceeds TH_{ij} for the first time (i.e. $w_{month} < 1400\text{€}$):
 $l = 6$ (see Table A3)
- $\Rightarrow l + 1 = 7, \underline{l+1} = 1401$
- Sum of workers with $w_{month} < 1400\text{€}$ (i.e. $k = 0$ to $k = 6$): $\sum_{k=1}^6 n_{ij}^k = 1000$
- Percentage of workers in interval $l + 1$ with $w_{month} < TH_{ij}$: $\frac{1442.03 - 1401}{100} = 41.03\%$
- Number of workers in interval $l + 1$ (i.e. $1401\text{€} < w_{month} < 1500\text{€}$), $n_{ij}^{l+1} : 100$
- Workers in interval $l + 1$ with $w_{month} < TH_{ij}$: 41.03
- number of affected workers: 1041.03

Industry	Land																	
	BB	BE	BW	BY	DE	HB	HE	HH	MV	NI	NW	RP	SH	SN	SR	ST	TH	
1	2.56	1.26	1.07	1.17	1.36	1.24	0.87	0.76	4.31	1.34	0.88	1.54	1.19	2.53	0.81	3.15	3.10	
2	0.44	3.11	2.93	2.87	1.93	2.88	1.71	2.29	1.19	0.92	1.18	2.87	1.14	3.12	2.02	0.61	0.64	
3	7.39	2.53	1.31	1.27	1.94	1.22	1.33	1.26	6.75	1.33	1.36	1.74	1.58	7.28	0.77	8.11	7.34	
4	8.23	2.56	1.96	1.82	2.66	1.87	1.53	1.35	8.64	1.88	1.55	1.46	1.52	11.01	1.88	7.67	10.85	
5	5.93	1.83	1.73	1.69	2.07	1.50	1.39	0.95	6.53	2.32	1.81	2.52	2.58	6.17	2.08	6.96	5.98	
6	11.63	4.46	2.01	2.20	3.35	1.69	2.02	1.71	14.75	2.64	2.14	2.60	2.57	13.22	1.66	11.10	11.32	
7	4.68	5.60	4.65	5.71	4.59	3.40	4.68	3.76	3.96	3.87	5.37	4.45	4.32	2.50	6.74	2.65	2.53	
8	6.04	4.59	3.22	2.65	3.43	2.03	2.37	3.30	7.50	3.37	2.69	3.01	3.64	8.09	3.73	6.67	9.90	
9	6.53	7.49	3.67	3.31	4.40	4.50	5.26	3.30	6.27	3.28	4.10	4.58	3.16	7.11	3.90	7.08	6.45	
10	11.12	5.98	4.28	4.67	5.71	3.88	3.83	3.65	12.43	6.22	5.07	6.41	3.05	11.64	6.80	14.62	13.51	
11	13.24	8.36	6.51	6.42	8.36	5.90	6.63	4.92	14.88	8.77	7.16	8.04	7.90	16.30	7.45	16.55	14.23	
12	15.79	10.42	5.45	5.79	7.82	5.87	5.80	5.66	18.62	7.43	6.09	7.30	8.26	17.16	6.36	16.74	16.23	
13	15.80	10.38	9.40	7.26	9.49	7.16	8.92	5.36	14.75	11.24	6.76	7.58	9.75	17.97	7.54	17.61	14.11	
14	19.17	17.94	5.98	6.63	9.16	3.81	6.00	5.08	21.15	8.54	6.54	7.93	8.66	21.74	6.89	17.03	18.14	
15	21.82	13.25	6.23	6.64	9.43	6.47	6.65	5.95	25.41	9.60	7.07	8.38	8.00	23.22	8.30	27.48	24.02	
16	31.15	9.77	6.19	6.69	9.74	3.68	4.81	3.87	31.89	7.59	6.07	7.01	5.36	37.32	8.79	22.30	27.17	
17	29.47	20.03	12.49	11.92	17.09	14.98	11.72	10.89	35.66	16.79	12.37	17.01	17.84	34.68	17.93	33.67	30.74	
18	32.59	16.25	17.95	16.88	20.69	17.84	16.06	14.85	32.92	23.89	18.32	24.27	25.00	30.22	26.60	37.81	29.81	
19	52.86	35.97	31.69	24.99	32.16	25.84	27.14	22.26	48.19	26.44	29.44	33.40	36.00	46.59	36.81	49.02	52.72	
20	31.87	19.10	29.60	31.43	27.31	10.11	28.12		22.35	24.13	25.76	25.56	27.21	37.49	32.49	24.64	26.87	
21	57.60	34.95	29.89	28.75	35.74	29.68	24.43	28.19	58.34	33.35	30.31	38.54	33.39	61.96	40.58	68.45	64.03	



Table A4: Share of affected workers in each cross section in percent
Source: Statistics Department of the Federal Employment Agency

Industry	Land																
	BB	BE	BW	BY	DE	HB	HE	HH	MV	NI	NW	RP	SH	SL	SN	ST	TH
1	0.24	0.18	0.20	0.21	0.20	0.00	0.15	0.11	0.36	0.23	0.17	0.26	0.19	0.00	0.25	0.29	0.25
2	0.05	0.55	0.37	0.42	0.28	0.31	0.29	0.51	0.22	0.13	0.15	0.49	0.20	0.29	0.28	0.09	0.10
3	0.65	0.33	0.26	0.25	0.27	0.22	0.22	0.28	0.65	0.21	0.21	0.27	0.25	0.11	0.61	0.78	0.62
4	0.69	0.30	0.28	0.22	0.30	0.00	0.21	0.00	0.92	0.26	0.22	0.24	0.23	0.25	1.03	0.55	0.97
5	0.90	0.38	0.43	0.43	0.48	0.33	0.43	0.25	0.93	0.49	0.44	0.53	0.55	0.43	0.84	1.07	0.87
6	1.17	0.57	0.34	0.34	0.43	0.26	0.31	0.31	1.63	0.35	0.31	0.39	0.35	0.21	1.38	1.16	1.10
7	0.56	0.99	0.57	1.32	0.77	0.51	0.70	0.51	0.70	0.67	0.98	0.55	0.84	1.62	0.28	0.32	0.33
8	0.90	0.97	0.94	0.71	0.77	0.37	0.64	0.91	1.03	0.63	0.66	0.66	0.74	0.78	0.84	0.76	0.95
9	0.92	1.41	0.66	0.58	0.73	0.80	0.95	0.55	0.89	0.58	0.74	0.78	0.55	0.68	0.94	0.92	0.91
10	1.49	1.07	1.04	1.01	1.09	0.74	0.89	0.84	1.53	1.10	1.07	1.22	0.58	1.13	1.38	1.85	1.76
11	1.52	1.06	1.15	1.05	1.25	0.92	1.10	0.85	1.62	1.37	1.21	1.33	1.22	1.15	1.91	2.02	1.71
12	1.96	1.66	0.88	0.91	1.13	0.80	0.96	0.99	2.32	1.06	0.93	1.12	1.21	0.89	2.07	2.12	1.96
13	1.75	1.30	1.56	1.23	1.34	0.92	1.36	0.77	1.76	1.67	1.00	1.19	1.35	1.38	2.08	2.03	1.64
14	2.23	3.78	0.90	0.96	1.31	0.59	1.08	0.88	2.35	1.23	0.99	1.22	1.31	1.12	2.50	2.11	2.07
15	3.20	2.22	1.06	1.09	1.47	0.93	1.12	1.07	3.89	1.45	1.18	1.40	1.17	1.27	3.44	4.48	3.66
16	4.35	1.34	0.87	0.88	1.25	0.00	0.78	0.00	4.19	0.94	0.84	1.06	0.64	1.28	5.63	2.97	3.60
17	3.78	2.80	2.35	1.98	2.65	2.48	2.11	1.84	4.62	2.90	2.15	3.34	2.98	2.91	4.99	4.34	4.46
18	6.27	3.06	2.93	2.70	3.55	2.58	2.73	2.52	5.94	3.89	3.04	4.10	4.15	5.02	5.73	8.31	5.42
19	7.88	4.50	3.26	2.28	3.48	2.41	2.87	2.42	6.95	2.49	3.04	4.22	3.97	4.35	5.90	6.98	7.57
20	4.85	0.00	6.49	7.48	0.00	0.00	5.77	0.00	3.04	5.10	5.52	6.65	6.23	8.14	5.71	3.36	3.52
21	14.47	8.50	6.64	5.54	7.64	5.94	4.99	5.71	11.42	7.33	6.69	8.69	6.83	9.35	15.27	18.92	16.72
<div><div><0.1%</div><div>0.1%1%5%>10%</div></div>																	



Table A5: Average wage change in each cross section in percent
Source: Statistics Department of the Federal Employment Agency

Period	γ_1 Marginal employment	γ_3 Dummy East Germany
October 2014	0.0011 (0.0683)	-0.00004 (0.1406)
November 2014	0.0013 (0.089)	-0.0001 (0.1447)
December 2014	0.0011 (0.1995)	-0.0001 (0.1798)
January 2015	-0.0018 (0.0585)	-0.0001 (0.1664)
February 2015	-0.0019 (0.0464)	-0.0001 (0.2198)
March 2015	-0.0023 (0.0234)	-0.0001 (0.1674)

Table A6: Regression results for the minimum wage affectedness coefficient (marginal employment) including a dummy for East Germany. P-values in parenthesis.

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