The Impact of Minimum Wages on Remuneration and Employment - A Micro Data Analysis for the East and West German Construction Sector

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Abstract

In 1997, minimum wages were introduced in the West and East German construction sector. We use social security panel micro data to estimate their effects on wages and employment. Following a difference-in-differences approach we propose a method to identify the impacts of this quasi-experiment despite the lack of information on working hours in the data. The method determines the size of the treatment and control group by the Maximum-Likelihood criterion. To check for robustness, we test alternative specifications. All results show positive wage growth effects of the minimum wage regulation in both parts of the country. The employment effects are negative for East Germany and positive for West Germany although both are not always statistically significant.

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1 Introduction

The influence of minimum wages on earnings and employment is one of the most frequently analyzed themes in labor economics. Concerning the wage effect there is a broad consensus that the traces of a binding minimum wage can be found in the earnings distribution. By contrast, the impact on employment is controversial, both from a theoretical and an empirical point of view. According to the traditional neoclassical labor market model, a binding minimum wage should always have a negative employment effect as low-productivity workers are simply priced out of the market. Since the influential work of Card and Krueger (1995), however, the competitive market approach to the labor market model has increasingly been challenged. First, empirical investigations are by no means unambiguously supportive of the neoclassical view. A wealth of studies have analyzed the employment effects of minimum wages for different countries - without any clear-cut answers, not even in regard to the sign of the effect (see section 2). Second, new theoretical developments stressing transaction costs, information asymmetries and intransparencies on the labor market have strengthened the criticism of neoclassical predictions. At least in some segments of the market employers might dispose of a certain market power which they can exert to the disadvantage of workers. An important milestone is Alan Manning's new theory of monopsony (see Manning (2003a), Manning (2003b)).

Given the ambiguity of empirical results one might adduce the importance of the institutional background. Since the impacts of minimum wage regulations are likely to be conditional on institutional settings, transferring results from one context to the other is problematic. In other words, country-specific analyses are required in order to assess the effects of a lower limit to wages.

Germany is one of only six member countries of the European Union without a general minimum wage regulation. In the past, it was often argued that the power of unions and the wide coverage of collective bargaining would make a political regulation unnecessary. However, the decline in unionism strengthens the arguments of those who demand a nationwide minimum wage. Although recent polls indicate that a majority of about 80 percent of the population are in favor of a low-wage limit, the potential introduction of a nationwide minimum wage

remains a hotly debated topic among professional economists. In this context it is of certain importance that, although having no common minimum wage legislation, Germany can look back at a decade of experience with a minimum wage in a specific industry, namely the construction sector. In this industry a generally binding minimum wage was introduced in the second half of the 1990s. The regulation was related to the Worker Posting Law (*Arbeitnehmerentsendegesetz*, AEntG), which was implemented in 1996. The law was valid only for the construction sector.[1]
It forces every foreign firm sending temporary workers from the European Union and from third countries to Germany to comply with the German labor market laws, especially with those concerning minimum wages.[2] Therefore, the newly introduced minimum wage is binding for all blue-collar workers (except for trainees) and firms in the construction sector[3], as well as for posted workers.

The generally binding minimum wage for this industry came into force on January 1, 1997. At that time, the minimum pay was 15.64 DM (8 €) per hour for workers in Eastern Germany and 17 DM (8.69 €) in Western Germany. As from September 1, 1997 it was decreased to 15.14 DM (7.74 €) and 16 DM (8.18 €), respectively.

This paper analyzes the impact of the introduction of this minimum wage in the German construction sector in 1997 on wage growth and employment probability of those low-earning workers whose wages were likely to be affected by the minimum wage using microeconometric methods. Surprisingly, to date no study based on micro data exists for the German case.

As a quasi-experiment the introduction of this sector-specific minimum wage serves as an excellent testing ground for the investigation of economic impacts of

[1] The EU also adopted a similar Act in 1996: the Posting of Workers Directive.

[2] Before the introduction of the Worker Posting Law posted workers were paid according to the regulations of their home country. Therefore, one aim of the law might have been to protect the German workers in the construction sector from cheap competition from abroad.

[3] Statistically, the German construction sector was divided into main construction (*Bauhauptgewerbe*) and subconstruction (*Ausbaugewerbe*) at the time of the introduction of the Worker Posting Law. The subconstruction sector is especially heterogeneous regarding the firms business activities. While the Worker Posting Law applies to all firms affiliated to the main construction sector, some activities in the subconstruction sector are excluded from the general regulations.(Partly they are covered by own different regulations.) Therefore, we focus here on the main construction sector.

the minimum wage. It allows us to compare periods without a binding minimum wage with those after its introduction by means of a difference-in-differences approach in two different variations. For this purpose we use a large social security micro data set (IAB-REG) which is known for its highly reliable earnings information. In contrast to studies for other countries in the literature, we cannot unambiguously assign individuals to the treatment group because there is no quantitative information on working hours in our data set. Therefore, we apply a probability approach to identify the treatment and the control group. Two different estimation approaches based on different assumptions concerning the working hours are used. In contrast to a previous paper (König and Möller (2007)), two alternative specifications of the model are presented here. The first one is a dummy-variable approach employed in the traditional difference-in-differences approach. The second resembles the "wage gap" approach.

The remainder of the paper is structured as follows. The next section gives a brief overview of empirical literature on minimum wages. Section 3 outlines the difference-in-differences estimation strategy for identifying wage and employment effects under the restriction of missing quantitative working time information. We describe our data in section 4 before giving some descriptive evidence in section 5. The estimation results are discussed in section 6 and section 7 concludes.

2 Evidence on Minimum Wages

Since the mid-nineties a growing number of studies have analyzed minimum wage effects, especially for the United States and the United Kingdom. Most of the studies find significant effects on the wage structure: the minimum wage has a considerable positive effect on the earnings of individuals at the lower end of the wage distribution (e.g. see Card and Krueger (1995) for the United States and Stewart (2004) for the UK). A good overview of the corresponding literature is provided by Brown (1999).

Concerning the effect of minimum wages on employment, the predominant result of studies from the 1970s and the 1980s was that minimum wages have a negative impact on employment. These studies were mostly based on aggregate time-series models and reported this effect especially for the low-skilled and young population groups in the United States. On average, a ten percent increase in the minimum wage was found to reduce teenage employment by one to three percent. For a review see Brown et al. (1982).

In the beginning of the 1990s, the discussion on the employment effects of minimum wages arose again mainly due to a number of empirical studies using new estimation methods and micro data. This research work came up with conclusions that are at odds with traditional beliefs. Groundbreaking studies were Card and Krueger (1994) and Card and Krueger (1995). They are significant not only because of their findings but also because of the estimation strategy adopted by the two authors. Based on their own survey data they analyzed the effects of the 1992 minimum wage increase in the fast-food industry in New Jersey by using a difference-in-differences approach. As a result they found evidence of rising employment after lifting the wage floor – puzzling from the traditional perspective. The pioneer work was followed by considerable controversy, culminating in the debate between Neumark and Wascher (2000) and Card and Krueger (2000).

Card (1992) and Katz and Krueger (1992) for the United States, Dickens et al. (1999), Machin and Manning (1994), Dickens and Draca (2005) and Stewart (2004) for the United Kingdom, as well as Dolado et al. (1996) for France, among others, find that an increase in the minimum wage has either significantly positive or no employment effects. In contrast to this, other studies detect evidence of negative (albeit not large) employment effects (see, for instance, Deere et al. (1995) and Burkhauser et al. (2000) for the United States, Abowd et al. (1999) for France, Machin and Wilson (2004) and Machin et al. (2003) for the UK). Surveys on the vast recent literature are given by Brown (1999), Neumark and Wascher (2006) and by Metcalf (2007).
From a different angle, experimental studies have also been conducted to analyze the effects of minimum wages on behavior patterns of affected workers. For instance, Falk et al. (2006) show an asymmetry in the introduction and removal of a minimum wage. According to their findings, the minimum wage could permanently affect the perception of fairness standards and thereby the reservation wage.

3 Empirical Strategy

3.1 A difference-in-differences approach

The use of longitudinal data and the circumstances of the minimum wage introduction as a quasi-experiment allow us to apply the estimation method of difference-in-differences to evaluate the effects of the minimum wage.[4] Especially, we analyze the impact of the new wage floor on wage growth[5] and employment retention probabilities of those who come under the minimum wage regime. Ideally, we would compare this result to a situation in which no minimum wage was introduced. As this is clearly not possible, we need to find a comparison group. The main idea of this approach is to compare the outcome before and after the introduction of the minimum wage of those who are likely to be affected (treatment group) with the before- and after-situation of a group with similar properties but not directly affected (control group). Using individuals for the treatment and control group with otherwise similar characteristics it is straightforward to assume that both groups would have developed equally over time without the introduction of the minimum wage regulation. In the literature workers with payments slightly above the minimum wage are widely used as a control group.

Let the (0,1) dummy variable T denote the treatment group for $T = 1$ and the control group for $T = 0$. A simple form of the difference-in-differences approach has the following structure:

$$y_{it} = \alpha + \beta T_i + \gamma t_i + \delta(T_i t_i) + \varepsilon_{it} \tag{1}$$

where α denotes a constant, β a treatment-group-specific effect which accounts for permanent differences between the treatment and the control group and γ is the coefficient of the time trend t common to control and treatment group. ε_{it} is an error term with the usual properties. The true effect of the treatment is indicated by the coefficient of the interaction variable, δ.

[4] See, for instance, Angrist and Krueger (1999), or Heckman et al. (1999) for a further discussion of this approach.

[5] Despite the inaccuracy it entails in some cases, we will keep using the terms wages and earnings interchangeably for the rest of the analysis.

The coefficient δ can also be obtained by using the raw difference-in-differences estimator which is defined as the difference of two differences. The first is the difference in average outcome of the treatment group before (period 0) and after the introduction of the minimum wage (period 1). The second is the difference in the average outcome of the control group before and after the introduction of the minimum wage. More formally,

$$\delta = \left(y_1^{T=1} - y_0^{T=1}\right) - \left(y_1^{T=0} - y_0^{T=0}\right), \tag{2}$$

where the subscript indicates the period and the superscript the group. Two key assumptions concerning the conventional difference-in-differences approach should be mentioned. First, the time trends have to be common to both groups in the absence of the minimum wage. This crucial assumption would be violated if the evolution of the wage growth or the employment probabilities differed between the treatment and the control group in the case of there being no minimum wage law. Second, it is supposed that the introduction of the minimum wage has no impact on the control group.

3.2 Modeling Working Hours

The usual methodological approach for analyzing the effects of a minimum wage (see, for instance, Stewart (2004)) starts by comparing the reported hourly wage in the previous period with the new minimum wage floor becoming effective in the current period. Following this strategy it is possible to identify the individuals affected by the minimum wage, i.e. those who form the treatment group. In contrast to the data used in studies for other countries, our dataset, IAB-REG, only contains daily earnings, but no quantitative information on hours worked. Analysis of hourly wages requires the assumption of exactly the same actual working time for all workers in our sample. In the construction sector especially this assumption is rather unlikely to hold because of frequent variations in working time due to seasonal weather conditions, the business cycle and other influences specific to this industry. As a consequence, the neglect of individual variation in working time may allocate individuals incorrectly to the treatment or the control group. However, if the amount of misallocation is relatively low, differences between the two groups would diminish but not completely disappear. Hence, we use the admittedly unrealistic equal-working-time assumption in our first modeling alternative

The drawback of this approach is that the degree of contamination in the data cannot be analyzed. As an alternative we therefore take explicitly into account the fact that information on working time is missing. In the following the modeling of the working hours is described in more detail.

The notional hourly wage, W^*_{it}, denotes the payment per hour an individual would get if no minimum wage law were enforced. The condition of coming under the minimum wage regime for individual i at time t is fulfilled if

$$W^*_{it} \leq W^{min}_t, \tag{3}$$

where W^{min}_t is the effective minimum wage at time t. Correspondingly, the notional daily wage can be calculated as $Y^*_{it} = W^*_{it} H^*_{it}$, where H^*_{it} denotes the hours worked per calendar day at wage rate W^*_{it}. From this it follows that an individual is affected by the minimum wage if

$$Y^*_{it} \leq W^{min}_t H^*_{it}. \tag{4}$$

Additionally assume:

A1: The introduction of the minimum wage has no impact on the hours worked:

$$H^*_{it} = H_{it}. \tag{5}$$

A2: The hours worked per calendar day are determined by

$$H_{it} = \bar{H}_t + \tilde{C} + \tilde{\eta}_{it}, \tag{6}$$

where $\bar{H}_t$ denotes the normal working time composed of the standard working hours and a factor for overtime. This information is available in official statistics.[6] The constant $\tilde{C}$ allows for a possible systematic error in the calculation of the aggregate statistic on actual hours worked, whereas the error term $\tilde{\eta}_{it}$ with $\mathrm{E}(\tilde{\eta}_{it}) = 0$ and $\mathrm{Var}(\tilde{\eta}_{it}) = \sigma^2_{\tilde{\eta}}$ absorbs the individual variation in working time along with a potential individual measurement error.

[6]For data used see Table 1.

Inequality (7) results from substituting equation (5) and (6) into equation (4):

$$\begin{aligned} Y_{it}^* \leq W_t^{min} H_{it} &= W_t^{min}(\tilde{C} + \bar{H}_t + \tilde{\eta}_{it}) \\ &= C + \bar{Y}_t^{min} + \eta_{it}. \end{aligned} \tag{7}$$

For the constant C and for the error term we can write $C := \tilde{C} W_t^{min}$ and $\eta_{it} := W_t^{min} \tilde{\eta}_{it}$, whereas $\bar{Y}_t^{min} := \bar{H}_t W_t^{min}$ indicates the daily wage of a minimum wage recipient with normal hours worked.

Now define $Z_{it} := \left(Y_{it}^* - \bar{Y}_t^{min} - C\right) / \sigma_\eta$ with σ_η as the standard deviation of the error term.[7] Let Z_{it} be a realization of a random variable Z with the cumulative density function $F(\cdot)$. It then follows that the individual probability of coming under the minimum wage regime at time t can be calculated as:

$$\pi_{it}^{min} = \Pr\left(Z_{it} \leq Z\right) = 1 - F\left(Z_{it}\right). \tag{8}$$

Concerning the distribution of Z, two alternative assumptions apply:

A3: Additionally to A1 and A2 the working hours are constant and do not differ between individuals.

Under this assumption the error term in equation (7) disappears, i.e. $\eta_{it} = 0$ for all i and t.

Alternatively, a less restrictive assumption allows for individual variation of working time:

A4: Additionally to A1 and A2 the working hours are variable and the random variable Z follows a standard normal distribution.

3.3 Estimation Approach

Note that in our model C is unknown, but fixed. On the basis of an estimate for C, the critical value for the daily wage, Y_t^T, which separates the treatment from

[7] Note that the difference $Y_{it}^* - \bar{Y}_t^{min}$ naturally cannot be calculated as the notional wage is not observable. In a static environment the notional earnings of individual i can be proxied by the daily wage in the previous period, $Y_{i,t-1}$, i.e. the period before the minimum wage law was enforced. A dynamic model requires a projection of the minimum wage in the particular period before the introduction using average wage growth rates.

the control group can be calculated. To determine the size of the control group, a further critical value, Y_t^C, has to be estimated, which is required to mark off the control group from the third group.[8] Under assumption A3 and given these two estimates we have the following classifications for individual i at time period t:

$$\begin{aligned} Y_{i,t-1} \leq Y_{t-1}^T = C + \bar{Y}_{t-1}^{min} &\rightarrow \text{treatment group,} \\ Y_{t-1}^T < Y_{i,t-1} \leq Y_{t-1}^C &\rightarrow \text{control group,} \\ Y_{i,t-1} > Y_{t-1}^C &\rightarrow \text{third group.} \end{aligned}$$

An estimate of the two unknowns Y_t^T (or alternatively C) and Y_t^C is obtained by a maximum likelihood (ML) procedure. The results lead to the group sizes presented in Table 3.[9]

In the following we first consider a dummy variable approach for estimating the treatment effect. *Variant 1* of this approach uses the classification from above (and therefore assumption A3). Note that due to the lack of information on working hours, the assumption of a traditional difference-in-differences approach is violated that the control group is not affected by the minimum wage. With a certain probability individuals from the control group might also come under the minimum wage regime. This fact is neglected in variant 1 of the dummy variable approach, and possibly contaminates the corresponding estimation results. However, as long as the probabilities of belonging to a certain group are high for a sufficiently large number of observations, significant treatment effects should be observable.

Variant 2 of the dummy variable approach is based on the less restrictive assumption A4. In this case, an estimate of the unknown standard deviation σ_η is additionally required. Again, we use the ML criterion for determining the unknown parameters. For every observation we are then able to calculate the individual probabilities of coming under the minimum wage regime or belonging to the control and the third group, respectively. To consider the possible contamination of group classification, these individual probabilities are then appropriately taken into account in a weighted regression.

[8]The third group contains the remaining observations.

[9]In contrast to the approach described above we use here a classification of three groups in order to ensure similar characteristics and job conditions between individuals in the treatment and the control group. Due to discontinuities in the likelihood function we apply a grid search procedure for optimization.

We then consider an alternative to the dummy variable approach, which resembles the "wage gap" approach used in the minimum wage literature (see, for instance, Stewart (2004)). The wage gap denotes the difference between the individual hourly wage in the previous period and the current minimum wage. The latter, however, cannot be calculated exactly given our data restrictions. Therefore we looked for an indicator being correlated with the wage gap. A suitable variable is the individual probability of belonging to the treatment group. Substituting this variable for the wage gap is denoted as the *quasi-wage gap approach* in the following. The quasi-wage gap approach is also estimated in two variants. They are both based on assumption A4 and differ in the way the third group influences wage growth. In *variant 1* we simply use a dummy variable for workers with earnings above the critical level Y_t^C. In *variant 2* the probability of belonging to the third group is included as a regressor instead. Like variant 2 of the dummy variable approach, the latter specification takes into account possible contamination due to misclassification of individuals.

For the estimation of the wage growth equation we restrict the sample to individuals that were employed at the cut-off date June 30 in the years 1994, 1995, 1996 and 1997. Given these observations we calculate the wage growth rates as log differences between consecutive years.[10] Hence, the last growth rate in our sample encompasses the point in time where the wage floor was introduced.

For the dummy variable approach, the wage growth equation is the following:

$$\begin{aligned}\Delta \ln Y_{it} &= \alpha_1 DT_{it} + \alpha_2 D97_{it} + \alpha_3 DTD97_{it} + \\ &+ \alpha_4 D3_{it} + \alpha_5 D95_{it} + \alpha_6 WT1_{it} + \alpha_7 WT2_{it} + \\ &+ \alpha_8 WT1_{i,t-1} + \alpha_9 WT2_{i,t-1} + \boldsymbol{X}_{it}\boldsymbol{\beta} + \varepsilon_{it} \qquad (9)\end{aligned}$$

with $D97$ as a (0,1) dummy variable for the year 1997, when the minimum wage law became effective, and $\boldsymbol{X}_{it}$ denoting a row vector of control variables. The dummy variable DT ($D3$) takes the value of unity if an individual belongs to the treatment group (third group) and zero otherwise. Note that the control group

[10] More precisely, the growth rates were based on the middle of the employment spells. For the years 1995 and 1996 we adjusted the minimum wage by the median growth rate of the earnings. Furthermore, we dropped one percent of observations with the highest and lowest wage growth values, respectively, in order to avoid outlier bias. Moreover, we excluded data with top-coded earnings. Due to the selection of our data, this affects only a minor number of observations. For more details see section 4.

serves as a reference group here. Furthermore, we include control variables for the working time during winter seasons. The variables $WT1$ and $WT2$ describe the individual tenure of employment from January until March, and November until December, respectively.[11] The purpose of including these variables is twofold. On the one hand, they control for effects on the wage growth of those employed during winter time. On the other hand these variables cope with possible wage effects of regulations concerning prevention of unemployment in the winter months.

The treatment effect according to the difference-in-differences method is estimated by the coefficient α_3, which captures the impact of the minimum wage on the wage growth of the treatment group. In comparison to the control group we would expect a higher wage growth for the treatment group in 1997 because firms were forced to comply with the wage floor in the case of a binding minimum wage. More formally, we expect the coefficient α_3 to be significantly positive, which implies that individuals coming under the minimum wage regime experienced a wage boost relative to the control group.

Using a binary indicator variable for the treatment group as in the estimation approach described above, implicitly assumes that the introduction of the minimum wage has the same impact on all individuals in the treatment group. In other words, the extent to which the individual wage must rise in order to comply with the newly introduced wage floor is disregarded. As an alternative we therefore employ a probability approach analogously to the "wage gap" approach as described above. *Variant 1* of the quasi-wage gap approach can be written as

$$\begin{aligned}\Delta \ln Y_{it} \quad = \quad & \alpha_1 PTDT_{it} + \alpha_2 D97_{it} + \alpha_3 PTDTD97_{it} + \alpha_4 D3_{it} + \\ & + \alpha_5 D95_{it} + \alpha_6 WT1_{it} + \alpha_7 WT2_{it} + \alpha_8 WT1_{i,t-1} + \\ & + \alpha_9 WT2_{i,t-1} + \alpha_{10} Y_{i,t-1} + \boldsymbol{X}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \end{aligned} \tag{10}$$

where $PTDT_{it} = PT_{it} * DT_{it}$ denotes the probability of coming under the minimum wage regime multiplied by a dummy for this group.[12] $PTDTD97$ is the variable $PTDT_{it}$ interacted with a dummy for the treatment year. Additionally, we include the wage level of the previous year, $Y_{i,t-1}$, as regressor in the model to control for the *reversion to the mean* phenomenon indicated by the descriptive

[11] For the wage growth approach we included lagged and current variables of WT.

[12] Using the individual probabilities instead of the "gap" variable also reduces the problem of measurement errors at the bottom of the distribution mentioned by Stewart (2004).

evidence.[13] The effect of the wage floor on the wage growth of the treatment group is again indicated by α_3.

In *variant 2* of the quasi-wage gap approach we replace the dummy variable for the third group with the probabilities of belonging to this group. The estimation equation for the wage growth equation can be written in this case as follows:

$$\begin{aligned}\Delta \ln Y_{it} &= \alpha_1 PTDT_{it} + \alpha_2 D97_{it} + \alpha_3 PTDTD97_{it} + \alpha_4 P3D3_{it} + \\ &\quad + \alpha_5 D95_{it} + \alpha_6 WT1_{it} + \alpha_7 WT2_{it} + \alpha_8 WT1_{i,t-1} + \\ &\quad + \alpha_9 WT2_{i,t-1} + \alpha_{10} Y_{i,t-1} + \boldsymbol{X}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \qquad (11)\end{aligned}$$

where $P3D3_{it} = P3_{it} {}^{*} D3_{it}$ describe the probabilities of belonging to the third group given that an individual is member of this group according to the group classification.

For the measurement of the minimum wages employment effects we estimate the employment retention probability of an individual i depending on his group membership. In other words, we analyze the conditional probability that a person i in the treatment group who is employed at date t will still be employed at date $t+1$. Therefore, we select only individuals in our sample who were employed at the cut-off date June 30 in 1994, 1995, or 1996, and whose employment status was observed at the cut-off date one year later.
For the dummy variable approach we specify a Logit model, which has the following form:[14]

$$\begin{aligned}P\left(e_{it} = 1 | e_{i,t-1} = 1\right) &= \Lambda\left[\alpha_1 DT_{it} + \alpha_2 D97_{it} + \alpha_3 DTD97_{it} + \right.\\ &\quad + \alpha_4 D3_{it} + \alpha_5 D95_{it} + \alpha_6 WT1_{i,t-1} + \\ &\quad \left. + \alpha_7 WT2_{i,t-1} + \boldsymbol{X}_{it}\boldsymbol{\beta} + \varepsilon_{it}\right], \qquad (12)\end{aligned}$$

where e_{it} denotes the employment status of individual i in period t and adopts the value 1 for being employed and 0 for being unemployed. The coefficient α_3 then captures the effect of a wage floor according to the difference-in-differences method.

The *marginal* effect of the interaction term gives an answer to the question of whether an individual affected by the minimum wage is more likely to lose the

[13] See section 5.

[14] In the employment equation we only include the lagged variables of $WZ1$ and $WZ2$ to avoid endogeneity.

job than an individual from the control group. As two binary variables are interacted, the marginal effect is calculated by the double discrete difference. The expectation of the interaction effect given the explanatory variables can be written as

$$\begin{aligned} IE_1(\alpha_3) &= \frac{\Delta^2 \Lambda(\cdot)}{\Delta DT \Delta D97} \\ &= \left[\Lambda\left(\alpha_1+\alpha_2+\alpha_3+\boldsymbol{X}^1\boldsymbol{\gamma}\right)-\Lambda\left(\alpha_1+\boldsymbol{X}^1\boldsymbol{\gamma}\right)\right] \\ &\quad -\left[\Lambda\left(\alpha_2+\boldsymbol{X}^1\boldsymbol{\gamma}\right)-\Lambda\left(\boldsymbol{X}^1\boldsymbol{\gamma}\right)\right], \end{aligned} \tag{13}$$

where Λ is the cumulative distribution function of the logistic function.[15] Note that the interaction effect depends on all other regressors due to the non-linear transformation. For this reason the marginal effect, $IE_1(\alpha_3)$, can differ from the estimate of α_3 not only in magnitude but even in sign. The corresponding standard errors are calculated by means of the delta method.[16]

In the quasi-wage gap approach we replace the dummy DT_{it} with the individual probability for the treatment group $PTDT_{it}$, and $DTD97_{it}$ with $PTDTD97_{it}$ in the employment equation for variant 1, whereas the model is otherwise specified as in equation (12):

$$\begin{aligned} P\left(e_{it}=1|e_{i,t-1}=1\right) &= \Lambda\left[\alpha_1 PTDT_{it}+\alpha_2 D97_{it}+\alpha_3 PTDTD97_{it}+\right. \\ &\quad +\alpha_4 D3_{it}+\alpha_5 D95_{it}+\alpha_6 WT1_{i,t-1}+ \\ &\quad \left.+\alpha_7 WT2_{i,t-1}+\alpha_8 Y_{i,t-1}+\boldsymbol{X}_{it}\beta+\varepsilon_{it}\right]. \end{aligned} \tag{14}$$

For variant 2 of the quasi-wage gap approach we then have:

$$\begin{aligned} P\left(e_{it}=1|e_{i,t-1}=1\right) &= \Lambda\left[\alpha_1 PTDT_{it}+\alpha_2 D97_{it}+\alpha_3 PTDTD97_{it}+\right. \\ &\quad +\alpha_4 P3D3_{it}+\alpha_5 D95_{it}+\alpha_6 WT1_{i,t-1}+ \\ &\quad \left.+\alpha_7 WT2_{i,t-1}+\alpha_8 Y_{i,t-1}+\boldsymbol{X}_{it}\beta+\varepsilon_{it}\right]. \end{aligned} \tag{15}$$

Again, in both variants the marginal effect of the interaction term $PTDTD97_{it}$ denotes the impact of the minimum wage on the employment retention probability of the individuals affected. In contrast to the dummy variable approach,

[15] Matrix $\boldsymbol{X}^1$ includes matrix $\boldsymbol{X}$ as well as all other variables of equation (12) besides DT, $D97$ and $DTD97$.

[16] For more details concerning the formula and the calculation see Ai and Norton (2003) and Norton et al. (2004).

the interaction term now consists of one continuous and two binary variables. From this it follows that the marginal effect has to be calculated as the discrete difference with respect to DT and $D97$ of the partial derivative with respect to PT. This leads to the expectation of the interaction effect given the explanatory variables:[17]

$$IE_2(\alpha_3) = \frac{\Delta^2 \frac{\partial \Lambda(\cdot)}{\partial PT}}{\Delta DT \Delta D97} = (\alpha_1 + \alpha_3)\Lambda'[(\alpha_1 + \alpha_3)PT + \alpha_2 + \boldsymbol{X}^2\boldsymbol{\gamma}] - \alpha_1 \Lambda'[\alpha_1 PT + \boldsymbol{X}^2\boldsymbol{\gamma}]. \quad (16)$$

4 Data

In our study we use social security micro data from IAB-REG. IAB-REG is a 2% random sample from the employment register of Germany´s Federal Labor Office with regional information.[18] The data set includes all workers, salaried employees and trainees obliged to pay social security contributions and covers more than 80% of all those employed. Civil servants, family workers and self-employed persons are excluded. The German social security system requires firms to record the stock of workers at least at the beginning and the end of each year. Additionally, all changes in employment relationships within the year (for instance, hirings, quits, dismissals) have to be reported with the exact information on the date the change occurred. Therefore, the employment register traces detailed histories for each worker's time spent in covered employment as well as spells of unemployment for which the worker received unemployment benefits.[19] Because of legal sanctions for misreporting, the information on periods of coverage and the earnings is highly reliable.

IAB-REG also contains several variables describing workers' characteristics (like age, skill level, gender, job status, occupation, nationality, daily gross wage, or unemployment benefits and tenure of drawing) and some information on the

[17] Now matrix $\boldsymbol{X}^2$ includes matrix $\boldsymbol{X}$ as well as all other variables of equation (13) besides $PTDT$, $D97$ and $PTDTD97$.

[18] The establishment of IAB-REG dates back to 1973. The data available span the years 1975 to 2004. The data are described briefly in Bender et al. (2000) and in more detail in Bender et al. (1996).

[19] Spells for which workers have no entitlement to unemployment benefits are not reported and therefore cannot be distinguished from periods of non participation in the labor market.

employer (industry, region). As mentioned above, quantitative information on hours worked is not included. However, the data set comprises a qualitative variable distinguishing between full-time work and two forms of part-time work. No information on posted workers from other countries against whom the Worker Posting Law should protect the German main construction sector are included in this data set. Hence, the data do not allow us to investigate effects of the minimum wage on posted workers.

For the following empirical analysis we use only observations for the main construction sector for a time period before and after the introduction of the minimum wage (1994 to 1997).[20] Because of some data problems for female workers (job instability, coding errors for part-time status), we decided to use observations for male blue-collar worker only.[21] Besides the salaried employees, part-time workers, home workers and trainees are also excluded from the investigation. Moreover, we restrict the analysis to workers aged between 20 and 60.

Due to the contribution ceiling in the German social security system, earnings are censored. Top coding, however, is quantitatively speaking not a serious problem in studies on minimum wages, because it imposes only certain constraints on the third group. Moreover, the share of censored observation in the construction sector is rather low for the groups of workers selected. Therefore, we simply discarded workers with earnings above the contribution ceiling from our sample.

5 Descriptive Evidence

Table 2 contains some basic information on wages and growth rates of the lower deciles of the distribution in the German main construction sector from 1994 to 1998 as well as the relation to the minimum wage.[22] The wage growth rates per year indicate a certain dependence on collective wage agreements. When a new agreement became effective, the wage growth rates per year rose almost equally for all the lower deciles. Reactions of the wages concerning the introduction of the minimum wage should appear in the year 1997, at least for the first decile

[20] See section 3.

[21] Since female workers in blue-collar construction jobs are rare, this limitation is not severe.

[22] The hourly wage rates in the table were calculated based on the data presented in Table 1 including a factor for overtime.

(D1), and possibly also for the higher ones. However, Table 2 does not show a wage growth effect in West Germany as the rates even range from 0 to -1%. In contrast, for the Eastern part of the country, the wages of the first decile grew at a rate of 6.4%, which is the highest rate of all values shown in this table. Moreover, the second decile experienced an above-average growth rate in this period as well. This could be interpreted as the first evidence of an impact of the minimum wage in East Germany.

Substantial differences between the two parts of the country also appear in the magnitude of the minimum wage in percentage of the median wage, and as a percentile of the wage distribution of the previous year. The minimum wage amounted to less than two-thirds of the median wage in the West German main construction sector, and around 4% of the observations included here were affected. In contrast, the minimum wage in the East achieved roughly 82% of the median wage. About 18% of the blue-collar workers earned less than the minimum wage in the previous year. This implies a markedly higher coverage in the East.

Figure 1 shows kernel density estimations of the wage distributions for the years 1995, 1996, and 1997. Between the years 1995 and 1996 only a small shift in the distribution is apparent. Supporting the image drawn above, substantial changes in the lower tail of the East German wage distribution are visible when comparing the years 1996 and 1997. In contrast to 1995 and 1996, the distribution in 1997 is steeper on the left-hand side, and the peak wider, but almost no reaction appears in the right-hand tail. In West Germany, however, only small reactions of the wage distribution, especially around the peak, are observable.

The wage growth rates in relation to the size of the wage gap are shown in Figure 2. The figure for 1996/1997 encompasses the introduction of the minimum wage and should contain possible wage growth effects caused by the new law. The wage gap is defined here as the difference between the individual hourly wage of the previous year and the current minimum wage.[23] Note that the lower the previous hourly wage in comparison to the minimum wage, the higher the wage growth rate. This negative relationship is clearly present in all four sub-diagrams.

[23] For the years 1995 and 1997 we calculated a potential minimum wage taking into account the yearly average wage growth rate. The calculation of the hourly wages are based on assumption A3.

A reference to the effectiveness of the minimum wage can be seen in the graphs for East Germany. The wage growth rates of 1995 and 1996 do not differ substantially in regard to negative wage gaps, whereas for 1997 a considerable upward shift in the wage growth rates for individuals with wage gaps smaller than -3 is obvious. In other words: in 1997 individuals with negative wage gaps experienced higher wage growth rates than in 1996 and 1995. For West Germany no similar development can be observed descriptively.

Figure 3 shows the wage growth rates as well as the employment retention probability dependent on the daily remuneration for the years 1995 to 1997. In general, our data document the "reversion to the mean" phenomenon demonstrated by decreasing wage growth curves in both parts of the figure. Thus, the higher the position in the wage distribution in the previous period, the lower the wage growth rates in the actual period. With respect to the minimum wage effects on wages the above impression is strengthened. In the lower tail of the wage distribution no influences are observable for West Germany, whereas the evidence for East Germany is again very strong in favor of a typical reaction. In this part of the distribution, the wage growth rates up to a daily wage of about 95 DM are considerably higher in 1997 than they were in the two previous years.
Concerning the employment effects, it is worth mentioning that the employment situation in the low-wage segment of the labor market is considerably more precarious than in the middle and the upper parts of the wage distribution. A first indication of a possible effect of minimum wage regulations on employment in East Germany is provided in Figure 3. The intertemporal comparison of retention probabilities reveals that the likelihood of prolonged employment is definitely lower for workers who probably came under the newly introduced minimum wage regime in 1997. By contrast, in the Western part of the country the employment retention probabilities are almost identical for the three different years. Hence, there is no descriptive evidence for a potential employment effect in this case.

6 Estimation Results

Before presenting the wage growth and employment estimations for both parts of the country, we first point out the results of the maximum likelihood procedure.

Table 3 contains the estimated parameters which determine the critical daily wages, which separate the groups, and the respective group sizes. For the East German case, it is remarkable that our method separates the treatment from the control group almost exactly at the position of the wage distribution, where one would have expected the threshold regarding the descriptive evidence. This is true for both modeling approaches and both specification variants.[24] For West Germany, though, the estimated size of the treatment group is more volatile. It varies from around 11% for variant 1 of the first approach and variant 2 of the second approach to around 18% for variant 2 of the dummy variable approach. These values are in contrast to the descriptive analysis, suggesting a treatment group size of only 3%. It should be stressed, however, that there could be significant spillover effects that are not captured by the descriptive evidence.

6.1 Wage effects

Table 4 shows the results of the wage growth estimation in East Germany for both variants of the dummy variable approach. Besides the variables explained in section 3, we use as additional control variables age and age squared, six dummy variables on skill level (SKILL)[25], two on job status (JS: craftsman, foreman)[26] and eight variables on the type of region (RT2 to RT9)[27]. For West Germany we also include a variable for German nationality (NAT).

According to the results in Table 4, the estimated coefficients for age and age squared do not exhibit the expected pattern (which should be negative for age and positive for age squared). However, except for the age coefficient in variant 2,

[24] For variant 1 of the quasi-wage gap approach the grid search procedure indicates a corner solution for the maximum of the likelihood function, where the control group completely disappears. This can be taken as evidence that there is no need to differentiate between the control and the third group. According to a Likelihood Ratio test, however, a specification with only two groups is not adequate. Excluding the corner solution leads to the results shown in the table.

[25] SKILL2 describes workers who have completed their vocational training but have no higher education, SKILL3 and 4 graduates with at least 12 years of schooling (*Abitur*) without and with additional vocational training completed, whereas SKILL5 and 6 indicate graduates of a university of applied science, or university, respectively. We also define a dummy variable for the category "skill missing", SKILLU. The reference group consists of workers with neither higher education nor vocational training completed.

[26] Workers in a non-specialized position serve as the reference group here.

[27] The types of region range from the surroundings of metropolitan cities (RT2) to rural areas in the periphery (RT9). Metropolitan cities (RT1) are chosen as the reference region.

the corresponding coefficients are statistically not significant. The same is true for most of the coefficients for the skill and region type dummies, whereas the coefficients of the job status variables are highly significant, particularly those for the foreman status. Furthermore, the importance of the variables controlling for working time in winter for the wage growth rate is indicated by the significance (high in some cases) of nine (eight) of the twelve variables in variant 1 (variant 2, respectively) of the dummy variable approach.
The time dummies for the year 1995 show a highly significant positive influence on the wage growth rates. By contrast, the estimated coefficients for the dummy variables for 1997 are negative in both variants. Hence, there is a general negative effect on wage growth in 1997 relative to the reference year 1996. This probably reflects the reduction in earnings due to the recession in the construction sector. For the sample period as a whole we observe a statistically highly significant positive effect on wage growth rates for individuals in the low tail of the wage distribution, i.e. for those who probably belong to the treatment group in 1997. For workers at the top of the distribution, i.e. the third group, the corresponding effect is highly significantly negative (relative to the control group). This corroborates the evidence for *reversion to the mean*, which we already described in section 5.

Of special importance for our analysis are the effects on the interaction of the treatment group with a dummy variable for 1997, $DTD97_{it}$. For both variants in Table 4 we observe a highly significant positive coefficient. In other words: according to the dummy variable approach, the introduction of the minimum wage regulation fostered wage growth of low-wage earners in East Germany. Hence, there is evidence for the effectiveness of the measure with respect to the shape of the wage distribution.

Table 5 summarizes the results for the variables crucial for the interpretation of the difference-in-differences approach for all estimation variants and both regions.[28] The coefficients for all variables referring to the individuals from the treatment group (DT and $PTDT$, respectively) exhibit a positive sign and high statistical significance, whereas the influence of the dummy variable $D97$ is negative. The results from the interaction effect which indicates the impact of the

[28] Due to space limitations we do not dwell on the control variables for the remaining estimations. These are available from the authors on request.

minimum wage on the treatment group also give a consistent picture. The estimated coefficients are positive in all cases and in general statistically highly significant. The only exceptions are two out of four cases for West Germany. It is worth mentioning that the larger the estimated size of the treatment group, the more significant the wage growth effect for West Germany.[29] As a possible explanation this can be traced back to the relevance of spillover effects. Although in West Germany only a relatively small group of workers is affected directly - as indicated by the descriptive evidence in section 5 - the minimum wage might influence a larger group indirectly. By nature, this cannot be detected by using descriptive methods only. All in all, one can conclude that, caused by the introduction of the minimum wage regulation, low wage earners experienced a higher wage growth not only in East Germany but also in West Germany.

6.2 Employment effects

Now we turn to the estimation results for the employment function. The coefficients of the dummy variable approach shown in the appendix in Table A1 are the raw effects of the regressors on the employment retention probability of East German blue-collar workers. As these coefficients do not represent marginal effects, their interpretation is not meaningful. A special *caveat* is indicated with respect to the effects of the interaction variables $DTD97$ and $PTDTD97$ because a direct interpretation would be completely misleading. Therefore, Table 6 not only contains the most important "raw coefficients" for all estimated variants but also the marginal interaction effects determined by the method of Ai and Norton (2003).[30] As these authors point out, the correctly calculated marginal effects can deviate dramatically from the raw effects in magnitude and even in sign. This is also the case here. Note that in all estimation results the uncorrected coefficient for the interaction variable is positive. After calculating the marginal interaction effects, the signs differ between West and East Germany. For both

[29] A closer inspection of the likelihood function reveals that there are two local maxima of almost the same magnitude at values of around 11 and 15 percent, respectively. If the lower value is superior according to the likelihood criterion, the wage growth effect ceases to be significant. This is the case in variant 1 of the dummy-variable approach and variant 2 of the quasi-wage gap approach. Enforcing a size of the treatment group of about 15 percent gives a significant wage growth effect also in these variants.

[30] For more details see section 3.

modeling approaches and specification variants the effect of the minimum wage introduction turns out to be consistently negative for the affected workers in the East German case. It should be stressed that for this part of the country the z-statistics are higher in both variants of the dummy variable approach compared to the quasi-wage gap approach. In both variants of the first approach we find a statistically significant negative effect of the minimum wage on employment at the 5 percent level, whereas for the latter the z-statistics are slightly below the 10 percent significance level. To summarize: Through the introduction of the minimum wage, low-wage earners very likely affected by the minimum wage seemed to have a higher risk of losing their job than the control group. This result corroborates the descriptive evidence.

In contrast, the marginal interaction effects are throughout positive in the West German case. Statistical significance is given for all estimates except for variant 2 of the dummy variable approach. According to the consistent positive sign we can therefore exclude the possibility that the newly introduced wage floor exerted harmful employment effects on low-wage construction workers in West Germany. On the contrary, there is evidence for the view that the minimum wage regulation even fostered the employment situation of the affected group.

7 Conclusions

The main purpose of this paper is to study the minimum wage introduction in the German construction sector in January 1997 as a quasi-experiment. The impact of the new regulation on wage growth and employment retention probability of the affected workers can be identified using a modified difference-in-differences method. To the best of our knowledge the effects of minimum wages in Germany have not been investigated by other authors using micro data. The data used here are drawn from a large panel micro-data set, IAB-REG, which is a 2 percent random sample of workers obliged to pay social security contributions.

A difficulty arises from the fact that quantitative information on working hours is not available in the data. In contrast to studies for other countries, we are not able to classify individuals exactly into treatment or control group. We therefore develop a probability approach for the classification of individual observations.

A special feature of the approach is that the sizes of the treatment and control groups are estimated using a maximum likelihood method. Moreover, the probabilities of a person belonging to a certain group can also be determined.
We follow two different modeling strategies for capturing the minimum wage effects. In the first we use a dummy variable approach to estimate the effects of the minimum wage regulation on wage growth and employment retention probabilities of the affected persons. The second is analogous to the wage gap approach, which has often been applied in the literature. As we cannot calculate the wage gap due to the lack of working hours, we replace the wage gap with the probabilities of belonging to the treatment group.
Both approaches are estimated in two different specification variants for East and West Germany separately. The results for the wage growth function show that individuals with a high probability of coming under the minimum wage regime typically experienced a significantly higher wage growth rate than the members of the control group. The wage boost for those who were very likely affected by the newly introduced wage floor is fairly robust across the different specifications.

When it comes to employment effects, the results clearly differ between the two parts of the country. For East Germany we find a (partly) statistically significant negative effect of the minimum wage introduction on employment retention probabilities. The robustness of the negative sign of the coefficients in all specifications for East Germany indicates that the introduced minimum wage "bit" hard. By contrast, for West Germany we find a positive sign of the marginal employment effect which is statistically significant in three of four variants. Keeping in mind that the minimum wage in the East German construction sector was much higher in relation to the median wage than in West Germany (83 vs 60 percent), the results are perhaps not surprising. As a tentative conclusion we suggest that minimum wages become harmful to employment if they surpass a certain critical level in comparison to the median wage. In other words, the trade-off between increasing wages for low-paid workers and the danger of job losses does not exist in the case here if minimum wages are moderate.

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Table 1: Overview of the data used for working time

year					
1994	1995	1996	1997	1998	1999
Standard weekly hours					
West Germany					
38.9	38.9	38.9	38.9	38.9	38.9
East Germany					
39.5	39.2	39.0	39.0	39.0	39.0
Overtime - paid hours per year					
West Germany					
77.7	74.7	54.4	55.1	49.6	52.6
East Germany					
92.0	69.9	49.6	44.4	46.0	51.6

Note:
Based on the average paid overtime we calculate a factor of overtime, which is multiplied by the standard working time to get the normal hours worked. We use data from the Institut für Arbeitsmarkt- und Berufsforschung (2003), Table 2.6.3 and 2.6.4..

Table 2: Lower deciles of the wage distribution and minimum wage in East and West Germany, Main Construction 1994-1999

	West Germany					*East Germany*				
	1994	1995	1996	1997	1998	1994	1995	1996	1997	1998
Deciles	Hourly wage in Euro									
D1	10.28	10.47	10.66	10.57	10.70	6.76	7.06	7.35	7.81	7.81
D2	11.34	11.54	11.74	11.73	11.78	7.55	7.77	8.06	8.26	8.26
D3	12.14	12.33	12.45	12.45	12.50	8.15	8.30	8.60	8.71	8.70
D4	12.67	12.87	13.08	13.08	13.13	8.59	8.83	9.14	9.16	9.06
Median	13.20	13.49	13.62	13.53	13.67	9.02	9.36	9.67	9.70	9.51
	Wage growth per year in %									
D1		1.87	1.83	-0.87	1.24		4.42	3.99	6.36	-0.08
D2		1.71	1.75	-0.03	0.40		2.98	3.77	2.48	-0.08
D3		1.61	0.98	-0.03	0.40		1.81	3.61	1.30	-0.08
D4		1.55	1.67	-0.03	0.40		2.84	3.48	0.25	-1.06
median		2.16	0.98	-0.69	1.06		3.76	3.37	0.25	-1.92
	Minimum wage									
average				8.53	8.18				7.92	7.74
- as % of median				63.1	59.8				81.6	81.4
- as percentile of wage distribution of previous year				4	2				18	9

Note:
The hourly wages and the wage growth rates shown above were calculated based on Table 1 and assumption A3.

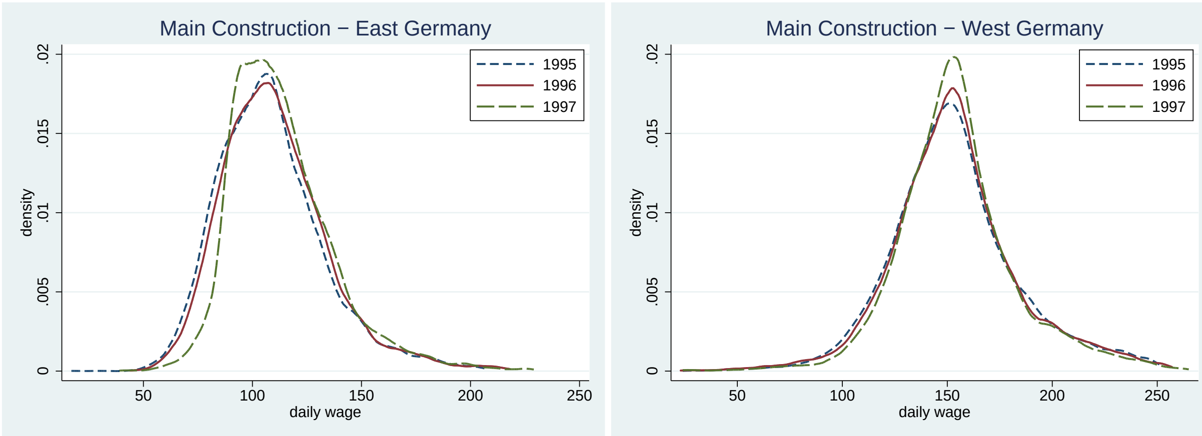

Figure 1: Kernel density estimates for the wage distribution in the main construction sector in East and West Germany (1995-1997)

Table 3: Results of ML Procedure

	Dummy Variable Approach			
	East		West	
	Variant 1	Variant 2	Variant 1	Variant 2
Size of treatment group	17.6%	20.8%	10.8%	18.3%
Size of control group	56.5%	61.8%	55.8%	63.7%
Size of third group	25.9%	17.4%	33.4%	18.0%
σ_η	-	12.6	-	15.0
ln likelihood	20973.95	61974.63	37960.40	113058.17

	Quasi-Wage Gap Approach			
	East		West	
	Variant 1	Variant 2	Variant 1	Variant 2
Size of treatment group	16.8%	16.7%	15.4%	10.8%
Size of control group	80.0%	80.0%	23.4%	27.0%
Size of third group	3.2%	3.3%	61.2%	62.2%
σ_η	13.9	13.7	8.5	7.0
ln likelihood	21143.50	21143.63	38236.18	38240.24

Notes:
The parameters shown above were determined by means of the ML criterion of the wage growth estimation. The optimal values were then adopted for the employment estimation. For a further description see section 3.

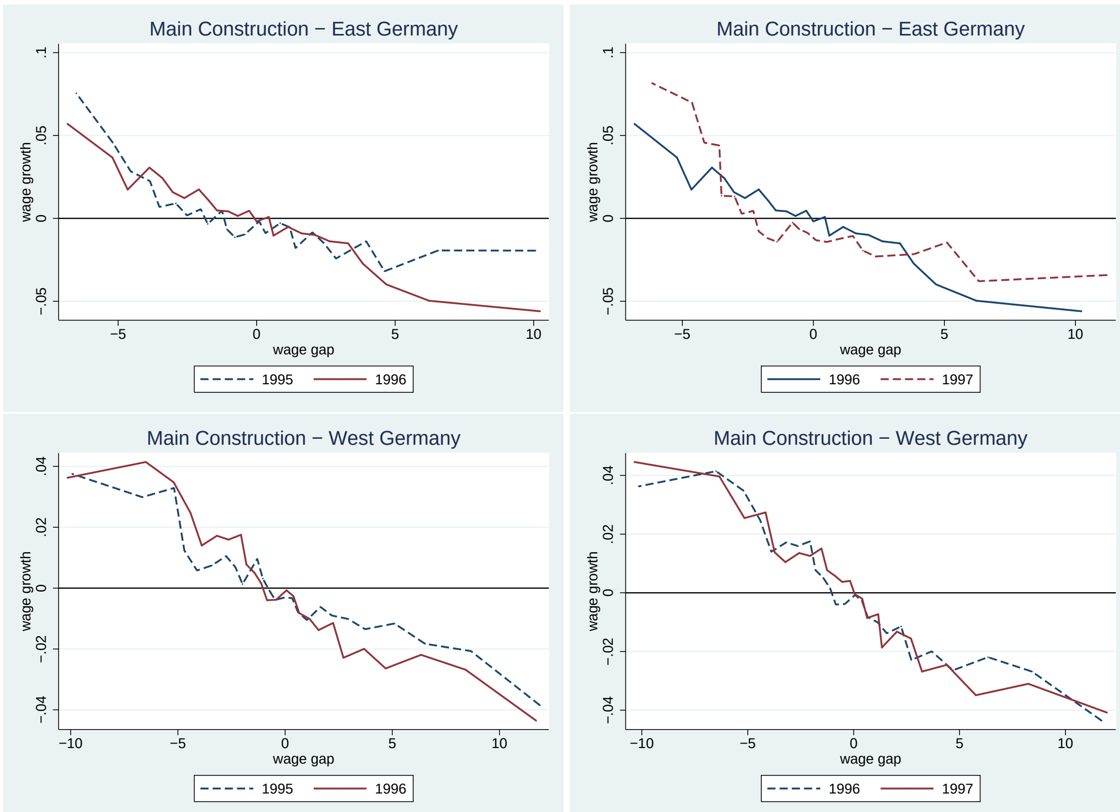

Figure 2: Wage growth rates compared to the previous year in relation to the size of the wage gap (1995-1997)
Notes:
The observations ordered by the daily wage are divided into 25 equally sized groups. Then we determined the average wage and the average wage gap for each group. The hourly wage growth rates and the wage gaps were calculated based on assumption A3. Both are adjusted for the median growth rate and the median wage gap for each year, respectively. For the definition of wage gap see text.

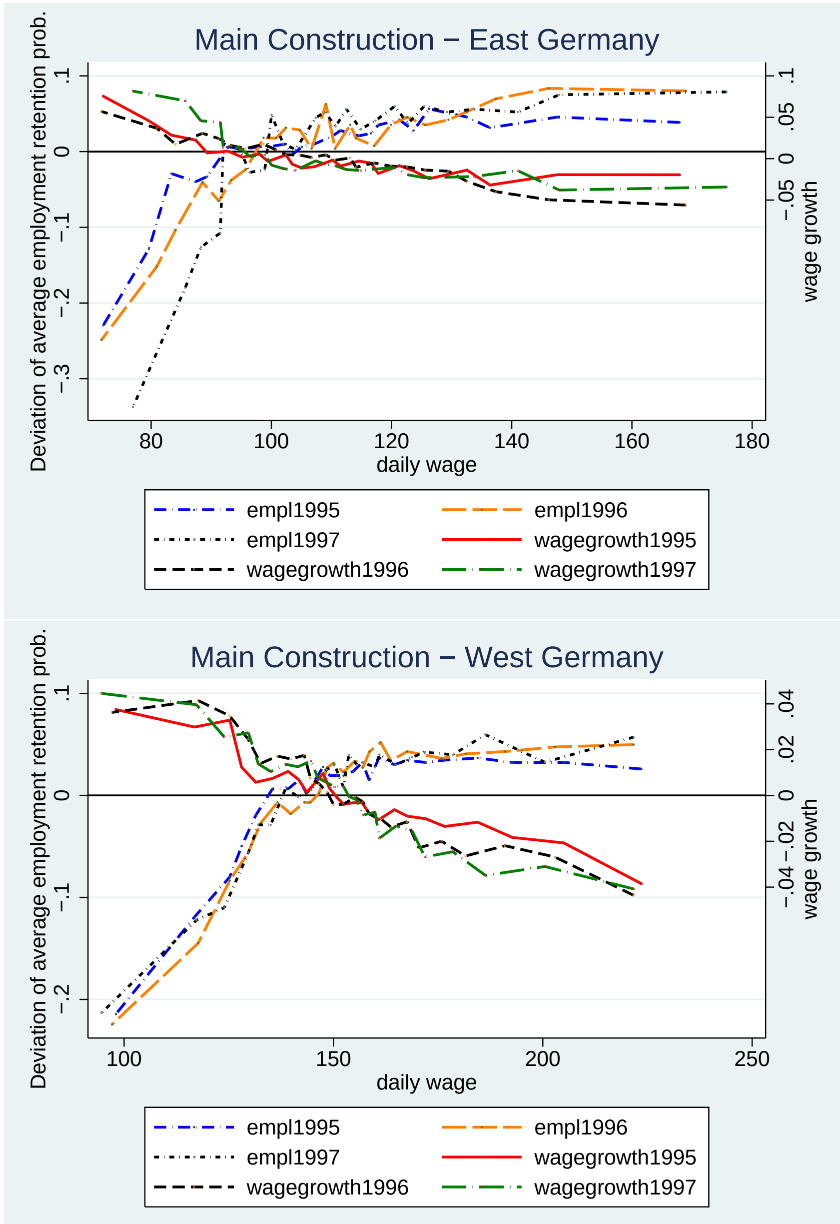

Figure 3: Wage growth rates and employment retention probabilities according to the position in the wage distribution (1995-1997)

Notes:

The curves indicate the deviation of the average wage growth rate and average employment retention probability of the respective years.

The observations ordered by the daily wage are divided into 25 equal groups. Then we calculate the average daily wage, the average wage growth rate, and the average employment retention probability for each group. For the definition of employment retention probability see section 3.

Table 4: Estimates for Wage Growth Equation, East Germany

	Dummy Variable Approach			
	Variant 1		Variant 2	
	Coeff.	t-Stat.	Coeff.	t-Stat.
DT	0.036	19.88	0.027	19.37
D97	−0.022	−2.48	−0.016	−1.45
DTD97	0.030	8.14	0.011	4.13
D3	−0.028	−19.63	−0.025	−18.55
D95	0.067	7.35	0.069	5.94
AGE	−0.000	−0.71	−0.001	−2.49
AGE^2	0.000	0.08	0.001	1.66
DSKILL2	−0.004	−1.49	−0.005	−1.89
DSKILL3	0.009	0.54	0.008	0.38
DSKILL4	−0.014	−1.46	−0.014	−2.01
DSKILL5	0.025	1.73	0.020	1.83
DSKILL6	0.075	2.12	0.070	2.04
DSKILLU	−0.001	−0.30	−0.002	−0.83
DJS2	0.005	3.06	0.002	1.35
DJS3	0.033	8.57	0.028	8.15
DRT2	−0.006	−1.22	−0.005	−1.43
DRT3	−0.008	−2.93	−0.005	−2.41
DRT4	−0.003	−1.39	−0.002	−1.19
DRT5	−0.003	−1.27	−0.003	−1.15
DRT6	−0.010	−4.76	−0.007	−3.96
DRT7	−0.004	−1.70	−0.001	−0.53
DRT8	−0.007	−2.97	−0.005	−2.44
DRT9	−0.000	−0.08	0.002	1.10
LWT1-95	0.027	2.14	0.016	1.13
LWT2-95	−0.235	−11.35	−0.252	−9.72
LWT1-96	0.092	6.85	0.084	5.76
LWT2-96	0.036	1.70	0.030	1.14
LWT1-97	0.071	5.53	0.052	4.02
LWT2-97	0.097	4.02	0.072	2.60
WT1-95	−0.015	−1.12	−0.018	−1.18
WT2-95	0.179	9.77	0.169	8.59
WT1-96	0.008	0.81	0.000	0.01
WT2-96	0.127	7.41	0.113	5.93
WT1-97	0.034	2.87	0.024	2.03
WT2-97	0.071	3.96	0.048	2.66
constant	0.003	0.23	0.022	1.96
N		18733		18733
$\bar{R}^2$		0.126		0.100
RMSE		0.079		0.080
$F(35, N-35)$		76.78		76.71
LR-test		66.32		34.24

Notes:
For the description of the variables and the estimation method see text.
LR-Test: Test of statistical significance of the treatment effects.
The lags of the variables WT were denoted as LWT for reasons of clarity.
For further notes see Table 3.

Table 5: Estimates for Wage Growth Equation

	Dummy Variable Approach			
	East		West	
	Variant 1	Variant 2	Variant 1	Variant 2
	Coefficients			
DT	0.036 (19.88)	0.027 (19.37)	0.034 (20.47)	0.021 (20.12)
D97	-0.022 (-2.48)	-0.016 (-1.45)	-0.052 (-7.73)	-0.052 (-5.99)
DTD97	0.030 (8.14)	0.011 (4.13)	0.004 (1.33)	0.005 (2.85)
	Statistics			
N	18733	18733	30705	30705
$\bar{R}^2$	0.126	0.100	0.116	0.1019
RMSE	0.079	0.080	0.070	0.071
$F(35, N-35)$	76.78	76.71	112.99	116.95
LR-test	66.32	34.24	1.78	18.19

	Quasi-Wage Gap Approach			
	East		West	
	Variant 1	Variant 2	Variant 1	Variant 2
	Coefficients			
PTDT	0.021 (6.90)	0.021 (7.04)	0.010 (5.47)	0.014 (6.75)
D97	-0.021 (-2.31)	-0.020 (-2.29)	-0.050 (-7.53)	-0.049 (-7.37)
PTDTD97	0.044 (8.59)	0.044 (8.53)	0.006 (1.98)	0.003 (0.99)
	Statistics			
N	18733	18733	30705	30705
$\bar{R}^2$	0.140	0.140	0.132	0.132
RMSE	0.078	0.078	0.070	0.070
$F(35, N-35)$	85.50	85.47	119.78	132.04
LR-test	73.74	72.73	3.91	0.99

Notes: t-statistics in parentheses
The estimated equations contain a list of further control variables described in the main text. Due to space constraints we do document the results here. They are available from the authors on request.

Table 6: Logit Regression for Employment Equation

	Dummy Variable Approach			
	East		West	
	Variant 1	Variant 2	Variant 1	Variant 2
	Coefficients			
DT	-1.046 (-14.86)	-0.802 (-14.05)	-1.193 (-16.21)	-0.890 (-15.90)
D97	-0.860 (-4.57)	-0.900 (-5.60)	-0.136 (-0.79)	-0.106 (-0.71)
DTD97	0.076 (0.66)	0.153 (1.71)	0.320 (2.66)	0.201 (2.23)
	Statistics			
N	20825	20825	32785	32785
Pseudo R^2	0.1802	0.1676	0.2061	0.1939
	Marginal Interaction Effect for DTD97			
Interaction effect	-0.041	-0.020	0.022	0.011
Standard error	0.019	0.012	0.012	0.007
Z-Statistics	-2.320	-1.898	1.880	1.530

	Quasi-Wage Gap Approach			
	East		West	
	Variant 1	Variant 2	Variant 1	Variant 2
	Coefficients			
PTDT	-0.647 (-5.21)	-0.646 (-5.21)	-0.828 (-8.13)	-0.807 (-7.62)
D97	-0.856 (-4.53)	-0.857 (-4.53)	-0.209 (-1.19)	-0.202 (-1.17)
PTDTD97	0.041 (0.25)	0.044 (0.28)	0.352 (2.80)	0.400 (2.97)
	Statistics			
N	20825	20825	32785	32785
Pseudo R^2	0.189	0.189	0.213	0.212
	Marginal Interaction Effect for PTDTD97			
Interaction effect	-0.023	-0.023	0.015	0.017
Standard error	0.018	0.018	0.007	0.008
Z-Statistics	-1.589	-1.575	1.818	2.080

Notes:
z-statistics in parentheses
For further notes see Table 5.
For calculation of the marginal interaction effect see section 3.

Table A 1: Logit Regression for Employment Equation, East Germany

	Dummy Variable Approach			
	Variant 1		Variant 2	
	Coeff.	t-Stat.	Coeff.	t-Stat.
DT	−1.046	−14.86	−0.802	−14.05
D97	−0.860	−4.57	−0.899	−5.60
DTD97	0.077	0.66	0.153	1.71
D3	0.687	8.88	0.632	9.72
D95	0.421	2.10	0.340	1.99
AGE	0.118	6.04	0.132	8.00
AGE^2	−0.189	−7.95	−0.205	−10.22
DSKILL2	0.185	1.77	0.204	2.32
DSKILL3	−0.322	−0.45	−0.289	−0.41
DSKILL4	0.088	0.21	0.129	0.36
DSKILL5	−0.231	−0.44	−0.111	−0.26
DSKILL6	0.003	0.00	0.097	0.07
DSKILLU	−0.023	−0.20	0.005	0.05
DSTIB2	0.361	5.52	0.449	8.27
DSTIB3	0.120	0.68	0.269	1.82
DRT2	0.580	2.33	0.600	2.84
DRT3	0.392	3.43	0.321	3.40
DRT4	0.346	3.42	0.337	4.01
DRT5	−0.329	−3.35	−0.336	−4.13
DRT6	0.306	3.40	0.225	3.05
DRT7	0.215	2.24	0.138	1.77
DRT8	0.336	3.13	0.269	3.03
DRT9	0.605	6.08	0.541	6.65
LWT1-95	4.078	9.07	4.297	10.65
LWT2-95	8.958	13.86	9.317	15.71
LWT1-96	2.577	6.58	2.734	8.01
LWT2-96	8.729	15.89	8.899	18.84
LWT1-97	2.851	8.48	3.046	10.69
LWT2-97	11.971	22.39	12.435	27.58
Constant	−1.734	−4.19	−2.084	−5.96
N		20825		20825
Pseudo R^2		0.1802		0.1676
ln Likelih.		−5566.8458		−16920.247

Notes:
The z-statistics shown above are not meaningful as these are the "raw" effects of the estimation and do not denote marginal effects.