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## THE EFFECTS OF MINIMUM WAGES IN THE GERMAN CONSTRUCTION SECTOR - RECONSIDERING THE EVIDENCE

JOACHIM MÖLLER<sup>1</sup> AND MARION KÖNIG<sup>2,3</sup>

We use a 100% sample of social security panel micro data for estimating the effects of minimum wages in the German construction sector. In 1997, a wage floor was introduced at different rates in West and East Germany. For analysing the impact of this natural experiment we conceptually follow a difference-in-differences approach. Since there is only qualitative information on working hours in the data, we propose a probabilistic method for identifying the treatment and control group. The effect of the minimum wage is investigated for wage growth and employment, the latter both from a labor demand and a labor supply perspective.

According to our results, there are significant positive effects of the minimum wage on wage growth in both parts of the country. Although being lower in absolute terms, the bite of the minimum wage, however, is markedly higher in the East. The employment effects of the wage floor turn out to be different in both parts of the country. The minimum wage effect on the employment retention probability is negative and statistically highly significant in the East and positive, but statistically not significant in the West. When it comes to the inflow of workers into the sector we find a positive and statistically significant effect of the minimum wage in East Germany, but an insignificant effect for West Germany.

The highly differentiated results for the two parts of the country point to nonlinearities in the impact of a minimum wage. Rather than supporting clear-cut effects as in the pure neoclassical approach, our analysis tends to corroborate the relevance of market imperfections like the existence of monopsony power in the market.

KEYWORDS: Minimum Wage, Difference-in-Difference Method, Construction Sector

JEL-CLASSIFICATION: J31, J38.

### 1. INTRODUCTION

The effects of the minimum wage on employment are theoretically ambiguous. If one follows the neoclassical approach and assumes competitive labor markets, a binding minimum wage is always detrimental to jobs. By contrast, the new monopsony approach as outlined by Manning (2003, 2010) assumes that firms exert some market power and are able to push the wage below the competitive market equilibrium. In the monopsony underemployment equilibrium workers are forced down to the labor supply curve. Imposing a statutory minimum wage in such a situation would motivate more workers to take up a job which are still profitable to the firm. Hence vacancies would be filled more easily and – up to a certain point – wages and employment would be increasing at the same time.

Given the theoretical ambiguity, the study of minimum wage effects has to rely on empirical work. Unfortunately, the empirical findings are not clear-cut either.

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As documented by various surveys (e.g. [Brown \(1999\)](#); [Neumark and Wascher \(2008\)](#)), the results of countless studies analyzing the effect of minimum wages on employment vary over the full range.

Among labor economists the predominant view on potentially harmful of minimum wages in employment, has changed back and forth over the last decades. The traditional view which more or less followed the neoclassical approach has been challenged by the influential work of [Card and Krueger \(1994\)](#). Their pioneering study constitutes the beginning of a minimum wage research relying on micro data evidence and a control group research design. [Card and Krueger \(1994\)](#) and many of their followers came to the conclusion that a statutory wage floor has no or even positive employment effects. As opposed to this, at least as many analyses testify harmful influence of a minimum wage on the job opportunities of affected workers ([Neumark and Wascher \(2008\)](#)).<sup>1</sup>

Even under the monopsony approach disemployment effects could be prevailing if the minimum wage exceeds a certain critical level. Hence empirical findings of a negative employment effect of a statutory wage floor do not contradict the approach. As [Manning \(2010\)](#) has put it: "... models of imperfect competition are different from models of perfect competition in not making a clear-cut prediction about the employment consequences of raising the minimum wage." The crucial question that distinguishes the competing views is whether or not there is some scope for a binding minimum wage without disemployment effects. If there is such a scope, it would be of uppermost interest from an economic policy perspective to determine its limits empirically.

Although there is a bulk of evidence for the effects of minimum wages in different countries under different circumstances, there are four reasons that motivate us to re-consider the introduction of a minimum wage in the German main construction sector. First we can exploit rich administrative micro panel data for the whole population of German construction workers before, at and after the introduction of a minimum wage on January 1, 1997. Second, according to the ratio of the wage floor to the median of the wage distribution, the so-called Kaitz index, the bite of the minimum wage varied markedly both between East and West Germany and within the different parts of the country. Third, the data contains a detailed work history of each individual, we can study the effects of the wage floor on the inflows and outflows of sectoral employment.

A previous study ([König and Möller \(2009\)](#)) on the same topic was based on rather limited data. Using wage gap as well as a dummy-variable approach for the identification of the treatment and control group, we obtained a positive and a negative effect of a minimum wage within the same country and the same sector revealing a negative employment effect of the minimum wage for the East and a (weakly) positive one for the West. Since the Kaitz index in the West was substantially lower than in the East than, our tentative conclusion was that the wage floor in the East exceeded the competitive equilibrium level and,

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<sup>1</sup>For an earlier comprehensive overview of the literature see [Brown \(1999\)](#).

therefore, caused disemployment effects. By contrast, the minimum wage in the West, although being also binding, did not reduce employment.

Conceptually, the difference-in-differences approach which is fairly standard for analyzing the effects of minimum wages is also employed here.<sup>2</sup> Our empirical method, however, differs in several aspects from the related literature.<sup>3</sup> The basic reason for a modified approach is the lack of quantitative information on hours worked in our data source. This requires a specific identification strategy for the treatment and control group. In comparison to the approach used in our previous work, we suggest a more adequate and robust method.

The remainder of the paper is organized as follows. The next section describes the institutional background. Section 3 outlines our estimation strategy for identifying wage and employment effects when quantitative information on working hours is missing. We then describe our data and present some descriptive evidence in section 4. The estimation results are discussed in section 5. Section 7 concludes.

## 2. INSTITUTIONAL BACKGROUND

Within the European Union 20 out of 27 member states have implemented a statutory minimum wage. In Germany it has traditionally been argued that the wide coverage of collective bargaining would make a general political regulation unnecessary. Due to two factors, however, unionism in Germany has substantially declined over the last two decades. First, re-unification and the fall of the iron curtain have opened a credible option for re-location of production sites to low-wage countries for a broader range of German firms. This has undermined the bargaining power of the unions significantly. Second, although German manufacturing is still relatively strong, the ongoing ascent of service industries – where unionization is generally much weaker – has diminished union coverage. This has strengthened the position of those who demand a general minimum wage. Although recent polls indicate a vast majority of the population being in favor of a wage floor, the potential introduction of a nationwide minimum wage remains a widely debated topic not only among politicians but also among professional economists.

Without having a statutory minimum wage legally binding on the whole of the economy, Germany has now almost 15 years experience with a minimum wage in a specific industry, namely the construction sector. In this industry a generally binding minimum wage was introduced at January 1, 1997. The legal fundament was the Worker Posting Law (*Arbeitnehmerentsendegesetz*, AEntG) being implemented in 1996. The scope of application of this law was the construction sector, only.<sup>4</sup> The Worker Posting Law forces every foreign firm sending temporary workers from the European Union and from third countries to Germany

<sup>2</sup>See, for instance, Angrist and Krueger (1999), or Heckman et al. (1999) for more details.

<sup>3</sup>See for example Thompson (2009) and Stewart (2004).

<sup>4</sup>The EU also adopted a similar Act, the Posting of Workers Directive, in 1996.

to comply with the German labor market laws, also with those setting up a wage floor. The minimum wage being introduced in this context is binding for blue-collar workers (except for trainees) in large parts of the construction sector. Statistically, the German construction sector is divided into main construction (*Bauhauptgewerbe*) and subconstruction (*Ausbaugewerbe*), where the latter is quite heterogeneous regarding the firms' business activities. Some of these are exempted from the minimum wage regulations. From the information in our data set it is not possible to identify those groups of workers for whom the wage floor is applicable or not. Hence we decided to exclude the subconstruction sector from the study and to focus on all firms affiliated to the main construction sector for which the Worker Posting Law applies to without exception.

It is important to note that before the introduction of the new legislation, posted workers were paid according to the regulations in their home country. Undoubtedly, the intention of the law was also to protect German workers and firms in the construction sector from cheap competition from low wage countries. The compliance with this law is supervised by the German Federal Labor Office and the Custom Office. Of course, a complete control cannot be ensured because of resource constraints and the difficulties to oversee workers and firms on frequently changing construction sites. Although there are stiff penalties in case of being caught, unfair practices like false statements of working hours in order to comply with the minimum wage cannot be excluded. Since the construction sector is one of the sectors most affected by illegal employment of national as well as foreign workers, controls were tightened during recent years.

The minimum wage for the main construction sector that came into force on January 1, 1997 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 reduced to 15.14 DM (7.74 €) and 16 DM (8.18 €), respectively. As a quasi-experiment, the introduction of minimum wage in the German construction sector serves as an excellent testing ground for the investigation of economic impacts of a wage floor.

### 3. EMPIRICAL STRATEGY

Due to missing quantitative information on working hours we can assign individuals to the treatment group only with a certain probability. From other data sources like the micro census we have information on the mean and standard deviation of working hours in the construction sector. Assuming that working hours follow a normal distribution, the probability of falling under the minimum wage can be calculated. This probability is used to identify the treatment and the control group.

In the following we employ a probabilistic difference-in-differences approach in various specifications. We investigate the effect of the wage floor on three key

variables: wage growth<sup>5</sup>, employment retention and flows into new employment.<sup>6</sup>

### 3.1. Identifying the Treatment Group without Information on Working Hours

The usual methodological approach for analyzing the effects of a minimum wage using micro data (see, for instance, [Stewart \(2004\)](#)) starts by comparing a reported hourly wage in the previous period with the 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. As described above, our dataset contains daily earnings but no quantitative information on hours worked. Therefore, the standard identification strategy is not adequate. Instead we applied a probabilistic approach for assigning workers to the treatment group. This approach is described in more detail in the following.

Let  $W_{it}^*$  denote the notional hourly wage or the payment per hour an individual would get if no statutory minimum wage law was enforced. The condition of coming under the minimum wage regime for individual  $i$  at time  $t$  is fulfilled if  $W_{it}^* < W_t^{min}$ , where  $W_t^{min}$  is the effective minimum wage at time  $t$ . Correspondingly, the notional daily earnings can be calculated as  $Y_{it}^* = W_{it}^* H_{it}$ , where  $H_{it}$  denotes the hours worked per calendar day which are not observed. From this it follows that an individual is affected by the minimum wage if

$$(3.1) \quad Y_{it}^* < Y_{it}^{min} = W_t^{min} H_{it}.$$

We assume:

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

$$(3.2) \quad H_{it} | W_t < W_t^{min} = H_{it}.$$

**A2:** The hours worked per calendar day are normally distributed with mean  $\bar{H}_t$  and variance  $\sigma_H^2$ .<sup>7</sup>

$$(3.3) \quad H_{it} \sim N(\bar{H}_t, \sigma_H^2).$$

Then the distribution of the daily minimum earnings result from combining eq. (3.1) and (3.3):

$$(3.4) \quad Y_{it}^{min} \sim N(\bar{H}_t W_t^{min}, (\sigma_H W_t^{min})^2),$$

Now define  $Z_{it} := (Y_{it} - \bar{H}_t W_t^{min}) / (\sigma_H W_t^{min})$  where  $Y_{it}$  stands for the observed daily earnings. Under assumption A2,  $Z_{it}$  follows a standard normal distribution.

<sup>5</sup>Despite the inaccuracy it entails in some aspects, we will keep using the terms wages and earnings interchangeably for the rest of the analysis.

<sup>6</sup>The latter has been ignored in our previous work [König and Möller \(2009\)](#).

<sup>7</sup>The first and second moment for the distribution of hours worked are available from other data sources.

Then the probability density that an individual with daily earnings  $Y_{it}$  receives the minimum wage can be calculated as:

$$(3.5) \quad P_{it} = f(Z_{it}),$$

where  $f(\cdot)$  is the density of a standard normal distribution.

Assumption A2 might be considered as too restrictive, especially since the distribution is probably not symmetric. For example, working overtime could appear more frequently than working less than contractual hours. We will allow for the non-symmetry by using two different probability density variables in the regressions

$$(3.6) \quad P_{it}^+ = \begin{cases} f(Z_{it}) \\ 0 \end{cases} \text{ if } \begin{cases} Y_{it} > \bar{H}_t W_t^{min} \\ Y_{it} \leq \bar{H}_t W_t^{min} \end{cases}$$

and

$$(3.7) \quad P_{it}^- = \begin{cases} f(Z_{it}) \\ 0 \end{cases} \text{ if } \begin{cases} Y_{it} \leq \bar{H}_t W_t^{min} \\ Y_{it} > \bar{H}_t W_t^{min} \end{cases}.$$

It should be noted that due to the lack of information on working hours in the data set, 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 erroneously fall in the treatment group and vice versa. This contaminates the results and it can be expected that the treatment effects are biased downwards in absolute value. However, as long as the correct assignment to treatment and control groups stochastically dominates, treatment effects should be significant if the number of observations is sufficiently large.

#### 4. DATA AND DESCRIPTIVE EVIDENCE

##### 4.1. Data

In the following we use social security micro data from the employment register of the Federal Labor Office. 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.<sup>8</sup> Because of legal sanctions for misreporting, the information on periods of coverage and earnings is highly reliable.

The variables in our data set are similar to the IABS scientific use file from the employment register which is briefly described by [Bender et al. \(2000\)](#) and

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<sup>8</sup>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.

in more detail by [Bender et al. \(1996\)](#). However, whereas IABS is a 2% random sample, we can use a special extraction from the employment register with actually *all* workers included who worked in the construction sector at least for one day in the 1990ies. The employment register covers all workers, salaried employees and trainees obliged to pay social security contributions, i.e. more than 80% of all those employed. The rest consists of civil servants, family workers and self-employed persons.

The data set contains several variables describing workers' characteristics (like age, skill level, gender, job status, occupation, nationality, daily gross earnings, or unemployment benefits and tenure of drawing) and some information on the employer like industry, size and region. A major drawback of the data source is that quantitative information on hours worked is missing. At least the data set comprises a qualitative variable distinguishing between full-time work and two forms of part-time work. Unfortunately, no information on posted workers from other countries – against whom the Worker Posting Law should protect the German main construction sector – is included. 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). 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. Since female workers in blue-collar construction jobs are rare, this limitation is not severe. Besides the salaried employees, part-time workers, home workers, those in an apprenticeship and trainees are also excluded. Only individuals who were employed at the cut-off date June 30 were considered. Furthermore, observation with no plausible wage information (daily earnings of full-time workers less than 20 €) were excluded.

Due to the contribution ceiling in the German social security system, earnings are censored. Top coding, however, is not a serious problem for the purpose of our study because only a small fraction of blue collar construction workers is affected. Therefore, we discarded workers with earnings above the contribution ceiling from our sample.

#### 4.2. *Employment and Employment Dynamics*

Table I shows the development of employment in the main construction from 1994 to 1998 on the cut-off day 30th of June. In 1994, 1.47 million males were employed in the main construction sector. This number includes blue-collar and white collar workers as well as trainees and part-time workers – where the latter is a very small group. The employment figures of 1994/1995 are at peak level reflecting the construction boom initiated by German re-unification especially in the East. In the years after, the number of workers in the construction industry shrunk markedly. From 1994 to 1998 employment fell by about 20 percent. In East Germany the relative job loss was even higher. This decrease of employment



TABLE I  
MALE EMPLOYEES IN THE MAIN CONSTRUCTION (MC) SECTOR

All Workers					
Year	1994	1995	1996	1997	1998
<i>Germany</i>					
# Workers	1,469,793	1,467,927	1,369,805	1,262,697	1,157,322
Change in %		-0.13	-6.68	-7.82	-8.35
<i>West</i>					
# Workers	923,399	901,221	840,334	786,062	741,646
Change in %		-2.40	-6.76	-6.46	-5.65
<i>East</i>					
# Workers	546,394	566,706	529,471	476,635	415,676
Change in %		3.72	-6.57	-9.98	-12.79
Fulltime Blue-Collar Workers					
Year	1994	1995	1996	1997	1998
<i>Germany</i>					
# Workers	1,213,208	1,194,991	1,098,289	1,004,010	911,678
Change in %		-1.50	-8.81	-8.58	-9.20
<i>West</i>					
Number	758,935	729,536	669,798	620,357	581,067
Change in %		-3.87	-8.19	-7.38	-6.33
<i>East</i>					
# Workers	454,273	465,455	428,491	383,653	330,611
Change in %		2.46	-7.94	-10.46	-13.83

was caused by a severe recession in the construction sector.

Additionally, Table I gives the numbers of (fulltime) blue-collar workers for whom the minimum wage applies. For this group, which forms the main group of all employees in the sector, the general pattern of employment development is quite similar to the rest. Starting from 1.2 million blue-collar workers in 1994, only 75 percent of the jobs were left in 1998. Both parts of the country were affected by this decline.

The total number of jobs fell also in 1997 when the minimum wage was introduced. The percent loss of jobs was smaller from 1996 to 1997 than from 1995 to 1996 in West Germany. The opposite was the case in East Germany. Since it is unclear which part of the decline can be attributed to the business cycle, no further conclusion can be drawn from this descriptive analysis.

Table II shows the dynamics in the construction labor market from 1995 to 1997 and provides information on the previous and subsequent labor market status of blue-collar workers being employed on the cut-off day 30th of June in 1995, 1996, and 1997. In 1995, a total of 1,194,991 individuals were employed as blue-collar workers in the main construction sector. 77 percent were still employed in the same sector in 1996. About 6 percent found a job in another industry, 8 percent lost their job and received unemployment benefits. Another 8 percent were inactive at the German labor market or not entitled to unemployment benefits.<sup>9</sup>

<sup>9</sup>The dataset only contains individuals who receive unemployment benefits. We cannot distinguish these who are also unemployed but not entitled to benefits from people who leave the

TABLE II  
EMPLOYMENT DYNAMICS FOR FULLTIME WORKERS IN THE MAIN CONSTRUCTION (MC)  
SECTOR

All workers in 1995: 1,194,991			
Status 1996			
empl. in MC	empl. in other sector	unempl.	out of labor force
924,573	66,605	94,147	101,252
77.37%	5.57%	7.88%	8.47%
All workers in 1996: 1,098,289			
Status 1997			
empl. in MC	empl. in other sector	unempl.	out of labor force
827,342	68,882	106,289	88,565
75.33%	6.27%	9.68%	8.06%
All workers in 1996: 1,098,289			
Status 1995			
empl. in MC	empl. in other sector	unempl.	out of labor force
924,573	53,593	36,145	68,664
84.18%	4.88%	3.29%	6.25%
All workers in 1997: 1,004,010			
Status 1996			
empl. in MC	empl. in other sector	unempl.	out of labor force
827,342	59,650	41,242	60,306
82.40%	5.94%	4.11%	6.01%

About 1 percent changed the job position from blue-collar to white-collar status or to a part-time position.

It is informative to compare these figures with the fluctuation patterns after the introduction of the wage floor in 1997. 75 percent of the 1,098,289 workers in 1996 were still employed in the same sector in 1997 – 2 percentage points less than in the year before. 6 percent of the workers changed the industry sector, 10 percent received unemployed benefits and around 8 percent did not participate in the labor market or changed their labor market status.

The second half of Table II shows the previous labor market status of workers being employed in 1996 and 1997. 84 percent of all workers in 1996 were already employed in the construction sector in 1995. About 5 percent switched from another industry. Further 3 percent entered the construction sector after an unemployment period and 6 percent after a period of nonparticipation or different labor market status. In 1997, only 82 percent of the workers were employed in the same sector as in the year before, 6 percent changed the industry and 4 percent received unemployment benefits. Additional 6 percent returned into a labor market status observed in our data.

Compared to 1996, less people stayed employed, more got unemployed and more people moved to another industry in 1997. At the same time, more people switched from another industry to the construction sector and more people got a job in the construction sector after a period of unemployment. These differences

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labor market.

between 1996 and 1997 indicate that there might not only labor demand but also labor supply effects that potentially can be traced back to the introduction of the minimum wage. For instance, it cannot be excluded that, due to the wage floor, working in the construction sector became more attractive for certain workers from other sectors.

#### 4.3. *Effects on the Wage Distribution*

A binding wage floor should affect the distribution of earnings. We therefore compare kernel density estimates of the earnings distribution in the year before and after the introduction of the minimum wage separately for West and East Germany in figure 1.

Especially the wage distribution for East Germany shows the expected effect. Probability mass in the lower tail of the distribution is shifted to the right. The new modal value lies in the region of daily minimum earnings. For the West German earnings distribution the results are less clear cut. Here the modal value is clearly piled-up. The whole distribution in the right tail seems to have shifted to the left, whereas this is not the case for the left tail. Hence one can argue that again probability mass below the mean is shifted to the right relative to the new position of the whole curve.

### 5. ESTIMATION RESULTS

#### 5.1. *Estimation Results for the Wage Growth Equation*

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 1995, 1996 and 1997. Given these observations we calculate the wage growth rates as 100 times the log differences between consecutive years. Persons with top-coded earnings in one of the years were excluded. However, this affects only a minor number of observations.

Under assumption A2 the following specification is used for the wage growth equation:

$$(5.1) \quad \Delta \ln Y_{it} = \alpha_1 D97_{it} + \alpha_2 P_{it} + \alpha_3 P_{it} \times D97_{it} + \mathbf{X}_{it} \boldsymbol{\beta} + \epsilon_{it},$$

where  $D97$  is a (0,1) dummy variable for the year 1997, when the minimum wage law became effective, and  $\mathbf{X}_{it}$  denotes a row vector of control variables. The treatment effect according to the difference-in-differences method is estimated by the coefficient  $\alpha_3$ , 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  $\alpha_3$  to be significantly positive, which implies that individuals coming under the minimum wage regime experienced a wage boost relative to the control group.

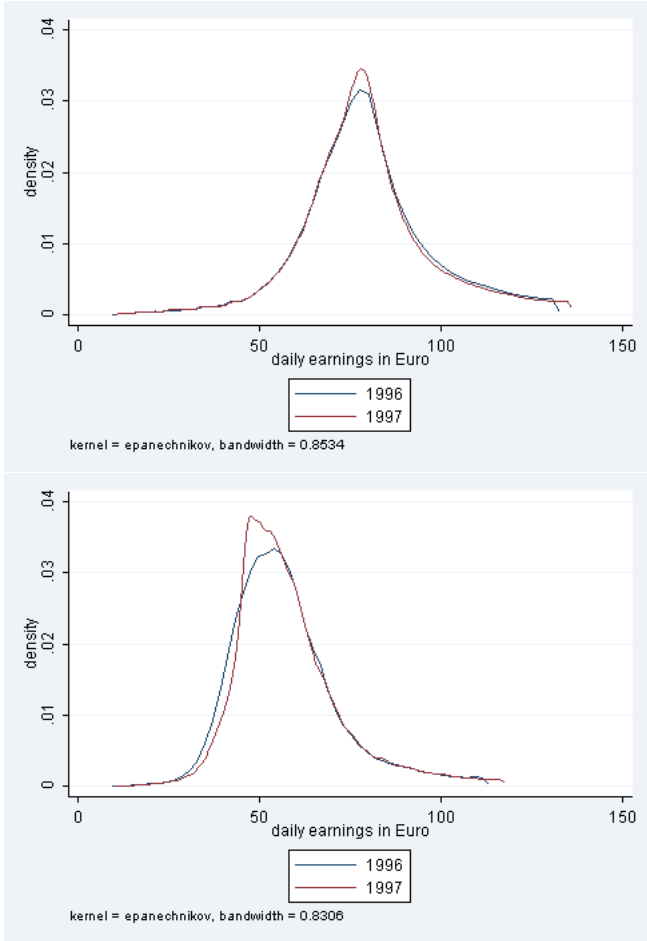


FIGURE 1.— Kernel density estimates of the earnings distribution of West and East German construction workers 1996 and 1997

For the more flexible specification the wage growth equation is:

$$(5.2) \quad \begin{aligned} \Delta \ln Y_{it} = & \alpha_1 D97_{it} + \alpha_2 P_{it}^- + \alpha_3 P_{it}^- \times D97_{it} + \\ & \alpha_4 P_{it}^+ + \alpha_5 P_{it}^+ \times D97_{it} + \mathbf{X}_{it} \boldsymbol{\beta} + \epsilon_{it}, \end{aligned}$$

Here the focus of interest is jointly on the coefficients  $\alpha_3$  and  $\alpha_5$ . In case of a binding minimum wage both coefficients should be positive.

Table III contains the estimation results for the two alternative difference-in-difference specifications of the wage equation. According to the estimates, wage growth is a concave falling curve in age. German nationality has a negative effect on wage growth - more so in the East than in the West. Hence there seems to be a catch-up process for the wages of foreign workers. The dummy variable for 1997 exhibits a significant negative coefficient in all cases. The estimated coefficient indicates a fall in wage growth of between 1 and 2 percent between 1996/1995 and 1997/1996. Independent of the specification and the region, the coefficient of the probability density for the variable  $P_{it}$  is significantly negative. This indicates that the wage growth for the group of workers that likely falls under the minimum wage regime was below the average in the whole observation period. In absolute value the effect is somewhat larger in the West than in the East.

The crucial interaction effect is positive and highly significant in all cases. If the more flexible specification 2 is used, it turns out that the effect for those presumably receiving the minimum wage is quite stronger below the mean of the distribution, i.e.  $\alpha_3 > \alpha_5$ . In specification 1 the coefficient of the interaction effect is higher for the East, whereas the differences between the two parts of the country are relatively small in the more flexible specification 2 (which according to the F-statistic is preferable).

One can conclude from the results that wage growth for the treatment group - i.e. for those who likely fell under the minimum regime - was higher than for the control group - i.e. for those who presumably did not received the minimum wage. Hence the positive treatment effect indicates that the minimum wage was binding in both parts of the country.

### 5.2. Estimation Results for the Employment Inflow Equation

The minimum wage not only affects labor demand but also labor supply. A higher wage in the sector increases the attractiveness of its jobs for workers from inside and outside the sector. Hence a higher labor inflow from other industries or a higher mobilisation of temporarily inactive construction workers can be expected. For investigating the possible effects we created a new dependent variable which describes labor inflow to the main construction sector. The variable takes the value of unity if a person being employed in the main construction sector during the current period was either not employed or employed in a different sector in the previous period and zero otherwise.

For simplicity of interpretation we used a linear probability approach. As for wage growth the regression was run in two analogous specifications. The first

TABLE III  
ESTIMATION RESULTS: WAGE GROWTH EQUATION

dep. var.: wage growth 1996 and 1997				
specification 1				
	East		West	
	coeff.	t-stat.	coeff.	t-stat.
$D1997^{\dagger}$	-1.86	-7.97	-1.06	-8.75
$P_{it}$	-11.86	-18.82	-14.08	-30.32
$P_{it} \times D1997^{\dagger}_{it}$	3.61	5.07	2.72	3.36
age	-0.65	-33.68	-0.65	-46.00
age <sup>2</sup>	0.71	29.36	0.60	38.08
German nat. <sup>†</sup>	-2.80	-3.91	-0.85	-9.42
const.	22.87	24.68	19.59	47.73
$N$	634,611		1,135,059	
$R^2$	0.0174		0.0201	
F-Stat.(21,111)	118.73		256.21	
specification 2				
	East		West	
	coeff.	t-stat.	coeff.	t-stat.
$D1997^{\dagger}$	-1.70	-7.36	-1.05	-8.79
$P_{it}^{-}$	-15.71	-22.1	-24.46	-22.84
$P_{it}^{-} \times D1997^{\dagger}_{it}$	4.50	5.32	4.32	2.30
$P_{it}^{+}$	-9.14	-14.90	-12.01	-27.18
$P_{it}^{+} \times D1997^{\dagger}_{it}$	2.08	3.04	2.42	3.39
age	-0.68	-35.01	-0.65	-45.81
age <sup>2</sup>	0.74	30.60	0.61	37.91
German nat. <sup>†</sup>	-3.02	-4.23	-0.89	-9.73
const.	23.50	25.34	19.62	47.64
$N$	634,611		1,135,059	
$R^2$	0.0199		0.0213	
F-Stat.(23,111)	130.58		237.62	

Notes: The regression also includes dummy variables for type of the region (8), skill group (6) and worker status (1) that are not reported. For explanation of variables see text. The standard errors are robust standard errors clustered by  $r$  regions; the number of regions  $r$  is 111 in East Germany and 326 in West Germany. <sup>†</sup>: coefficients multiplied by 100.

specification is

$$(5.3) \quad P(e_{it}=1|e_{i,t-1}=0) = \Lambda [\alpha_1 D97_{it} + \alpha_2 P_{it} + \alpha_3 P_{it} \times D97_{it} + \mathbf{X}_{it}\boldsymbol{\beta} + \epsilon_{it}],$$

where  $e_{it}$  describes the employment status of person  $i$  in time period  $t$  (1: employed in Main Construction, 0: not employed in Main Construction) and  $\Lambda[\cdot]$  is the logit function.

The more flexible specification 2 is given as

$$(5.4) \quad P(e_{it}=1|e_{i,t-1}=0) = \Lambda [\alpha_1 D97_{it} + \alpha_2 P_{it}^- + \alpha_3 P_{it}^- \times D97_{it} + \alpha_4 P_{it}^+ + \alpha_5 P_{it}^+ \times D97_{it} + \mathbf{X}_{it}\boldsymbol{\beta} + \epsilon_{it}].$$

The results are shown in table IV. As can be expected, the age of the worker significantly lowers their probability for (re-)entering the main construction sector. The same is true for German nationality. Furthermore, the estimates indicate a decreasing concave function in age for all cases.

The coefficient for the  $P_{it}$  variable is positive and does not depend on the region or the specification. When it comes to the interaction effect, we clearly see a difference between the two parts of the country. For East Germany the interaction effect is everywhere positive, but significantly so only in the preferred specification 2. For West Germany the coefficient is lower in absolute value and not significant in specification 1 and for the interaction effect related to  $P_{it}^+$  in specification 2. For the corresponding effect related to  $P_{it}^+$  it is even (weakly) significantly negative.

According to these results, there is some evidence that in East Germany the introduction of the minimum wage led to a higher attractiveness of jobs in main construction so that low-paid flocked into that sector. By contrast, there is no such effect in the West where the labor market conditions were better in general.

### 5.3. Estimation Results for Employment Retention Equation

For measuring the effect of the minimum wage on the employment retention probability we define a (0,1) dummy variable which takes the value of unity if a person who was employed in the previous year in the main construction sector is still employed in that sector in the current year and zero otherwise. More formally,

$$(5.5) \quad P(e_{it}=1|e_{i,t-1,r}=1) = \Lambda [\alpha_1 D97_{it} + \alpha_1 DT_{it} + \alpha_3 DT \times D97_{it} + \mathbf{X}_{itr}\boldsymbol{\beta} + \epsilon_{it}],$$

where  $e_{it}$  denotes the employment status of individual  $i$  in period  $t$  and adopts the value 1 for being employed in the sector and 0 otherwise. The coefficient  $\alpha_3$  then captures the effect of a wage floor according to the difference-in-differences method.

The approach allows to analyze the conditional probability that a person  $i$  being in the treatment group in year  $t$  who is employed at date  $t$  will still be employed at date  $t + 1$ .

TABLE IV  
ESTIMATION RESULTS: EMPLOYMENT INFLOW EQUATION

dep. var.: employment inflow 1996 and 1997				
specification 1				
	East		West	
	coeff.	t-stat.	coeff.	t-stat.
$DY_{1997}^{\dagger}$	0.71	0.71	0.97	3.63
$P_{it}$	0.39	19.47	0.81	56.47
$P_{it} \times D_{1997}^{\dagger}_{it}$	1.70	0.53	-0.42	-0.29
age	-0.05	-51.06	-0.03	-69.55
age <sup>2</sup>	0.05	46.20	0.03	57.10
Germ.nat. <sup>†</sup>	-26.46	-16.28	-1.37	-3.94
const	1.36	53.85	0.75	74.98
$N$	685,935		1,218,480	
$R^2$	0.093		0.1578	
F-Stat.(21, $r$ )	641.50		905.62	
specification 2				
	East		West	
	coeff.	t-stat.	coeff.	t-stat.
$DY_{1997}^{\dagger}$	0.15	0.16	0.92	3.39
$P_{it}^-$	0.68	22.94	1.33	66.44
$P_{it}^- \times D_{1997}^{\dagger}_{it}$	10.84	2.73	-4.61	-2.14
$P_{it}^+$	0.15	7.69	0.67	44.88
$P_{it}^+ \times D_{1997}^{\dagger}_{it}$	6.65	2.25	0.87	0.55
age	-0.04	-45.49	-0.03	-69.09
age <sup>2</sup>	0.05	40.76	0.03	57.22
Germ.nat. <sup>†</sup>	-23.48	-15.69	-1.04	-3.47
const	1.24	52.02	0.73	75.36
$N$	685,935		1,218,480	
$R^2$	0.1290		0.1689	
F-Stat.(23, $r$ )	736.59		1114.62	

Notes: See Table III.



A specific problem in the context here is to identify persons in the treatment group in the previous year. It is quite evident that there is not only the variation of working hours to be taken into account but also contamination effects due, for instance, to reporting errors considering the length of the employment spell (leading to wrong information on daily earnings).

Although there might be more sophisticated solutions, we simply defined a dummy variable being unity if the wage in  $t - 1$  was below the minimum wage in period  $t$  and zero otherwise. Because of contamination effects in this treatment indicator it is likely that the true effect of a wage floor is underestimated.

TABLE V  
ESTIMATION RESULTS: EMPLOYMENT RETENTION EQUATION

	dep. var.: employment retention			
	specification 1			
	East		West	
	coeff.	t-stat.	coeff.	t-stat.
DY1997	0.02	0.15	-0.20	-3.77
$D_M W_{t-1,i}$	-0.66	-2.95	-10.00	-16.18
$D_M W_{t-1,i} \times DY1997$	-0.72	-2.79	0.78	1.40
age	0.11	4.63	0.04	2.88
age <sup>2</sup>	-0.06	-2.19	0.01	0.70
Germ.nat.	8.34	7.48	-0.73	-10.57
const	0.85	66.02	0.98	323.77
$N$	634,611		1,135,059	
$R^2$	0.1578		0.0201	
F-Stat.(21, $r$ )	905.62		256.21	

Notes: The regression also includes dummy variables for type of the region (8), skill group (6) and worker status (1); robust standard errors clustered by 111 (East) and 326 (West) regions.

## 6. A MORE DISAGGREGATED PERSPECTIVE

### 6.1. Outline of the Approach

So far we have used a differentiation between East and West Germany, only. However, there is a considerable regional variation in the wages and the wage distributions in the German construction sector within the two parts of the country. Therefore, the possible effects of a minimum wage might vary significantly between different regions or regional types. In regions with a relatively high wage rate the minimum wage may have less impact, whereas in regions with lower wages possible reaction may be larger. This hypothesis is consistent with the findings of Büttner and Ebertz (2009) illustrating the spatial wage structure in the context of a potential statutory minimum wage in Germany.

A crucial point in this context is the question whether a stable pattern between the Kaitz index and the sign and magnitude of the regional employment effects can be detected. From the (new) monopsony perspective one would expect to find a relationship which is positive and increasing with the level of the minimum

wage. After reaching a peak, the relationship should be decreasing and cross the zero line. The intersection with the zero line would be of high economic policy interest as it marks the level beyond which the wage floor becomes detrimental to employment.

For this purpose we cluster the observation of the 493 NUTS 3 regions (counties) in East and West Germany using the classification scheme developed by the German Federal Office for Building and Regional Planning (*Bundesamt für Bauwesen und Raumordnung*, BBR) for regional classification. This scheme distinguishes between areas with large agglomerations, areas with features of conurbation, and areas of rural character, each of these again being subdivided into different groups. All in all, it differentiates between nine types of regions (districts) according to their population density and accessibility. As the minimum wage differs between the two parts of the country the effects need to be analyzed separately. Additionally, we distinguish between regions in North- and South-West Germany in order to account for further geographical differences. This leaves us with 27 regional clusters, 9 in East and 18 in West Germany.

For these groups we apply the estimation strategy described in our previous paper. The wage growth and the employment effect of the minimum wage are calculated for each regional type. Additionally, we calculate the regional Kaitz index.<sup>10</sup> With these results obtained at the regional level we regress the regional Kaitz indices on the coefficients of the regional employment effects using the inverse the corresponding standard errors of the coefficients as weights.<sup>11</sup> Finding a negative relationship between the ratio minimum/median wage and the employment effect would imply that the higher the Kaitz index the less positive or the more negative is the corresponding employment effect of the minimum wage.

## 6.2. Estimation Results for Types of Regions

Table VI shows some descriptive statistics of the variables used. As described above, we aggregated the observations of the 493 NUTS 3 regions in our data set to 27 groups according to their regional type, 9 in East and 18 in West Germany. The hourly median wage<sup>12</sup> in the north western part of the country ranges only slightly between the regional types from 26.36 to 27.75 DM. Almost the same numbers show up when it comes to South West Germany. Thus, there is no difference in median wage between the northern and the southern part of the old West German federal states. In East Germany the regional variation of the median wage is higher with 18.41 to 22.74 DM. Although the wage floor in absolute terms was higher in West Germany than in East Germany, the corresponding

<sup>10</sup>The calculation of the median wage is based on the assumption of constant working hours based on Table A 10 applies.

<sup>11</sup>We are aware of the fact that this strategy is subject to an attenuation bias problem as the coefficients originate from estimations. This issue is still to be solved.

<sup>12</sup>The calculation of the hourly median wage based on the assumption of equal working hours for all workers and the number of hours worked (see Table A 10)

TABLE VI  
DESCRIPTIVE STATISTICS

Variable	Mean	Min	Max
North West Germany			
No of obs	219976	38719	678575
Median Wage (DM)	26.87	26.36	27.75
Kaitz index in %	62.07	60.13	63.20
South West Germany			
No of obs	184663	20469	414060
Median Wage (DM)	26.60	26.17	27.38
Kaitz index in %	62.66	60.93	63.71
East Germany			
Observations	199815	28031	321261
Median wage (DM)	19.48	18.41	22.74
Kaitz index in %	79.79	68.11	84.09

Kaitz indices, which are determined as the height of the legal wage floor relative to the corresponding median wage, was significantly higher in the eastern part of the country.

While in West Germany it varies between 60 and 64 percent, it spans from 68 percent to 84 percent in East Germany. This descriptive result, that the minimum wage bits further up the wage distribution in the eastern part of the country, is consistent with our findings in König and Möller (2009). The share of blue-collar workers coming under the minimum wage regime according to descriptive evidence was notable higher there.

Table VII gives a summary about the results of the regional estimations. Concerning the wage growth effect on the worker affected by the minimum wage a clear picture arises for East Germany. All but one of the estimates are positive and statistically significant. The introduction of the minimum wage led to a wage boost for workers coming under the minimum regime in almost all regions in the Eastern part of the country. For West Germany no clear pattern shows up. Positive as well as negative wage growth effects can be found. In some regions workers affected by the minimum wage introduction experienced a significantly higher wage growth than workers in the control group. In other regions there was no effect, or even a negative one. This is the case for both parts of West Germany. Most of the coefficients lay on both sides near the zero line or on the right side of the zero line shown in Figure 2. This result is consistent with our findings in König and Möller (2009) where we found a positive wage growth effect for East as well as for West Germany. In the latter region the coefficient was not always statistical significant. The average wage growth effect is slightly positive (negative) in North (South) West Germany. Table VIII contains the results of a weighted regression of the proportion of minimum wage workers on the wage

TABLE VII  
REGIONAL ESTIMATION RESULTS

Variable	Mean	Min	Max
North West Germany			
Treatment Group %	12	1	21
Wage Growth	.0050	-.0049	.0205
Employment (Norton et al.)	.0054	-.0035	.0273
Employment (Puhani)	.0067	-.0037	.0390
South West Germany			
Treatment Group %	10	2	23
Wage Growth	-.0045	-.0387	.0100
Employment (Norton et al.)	-.0003	-.0053	.0053
Employment (Puhani)	-.0006	-.0059	.0053
East Germany			
Treatment Group %	13	5	30
Wage Growth	.0116	-.0019	.0233
Employment (Norton et al.)	-.0052	-.0134	.0033
Employment (Puhani)	-.0039	-.0113	.0061

TABLE VIII  
KAITZ INDEX AND REGIONAL WAGE GROWTH EFFECT (WEIGHTED REGRESSION)

Kaitz index	Coeff	t-value
Coeff wage growth	4.3282	2.40
Constant	.6529	56.19
$N$		27
$R^2$		0.26

growth coefficient. The inverse of the standard errors of the coefficients serve as weights here. We find a significantly positive relationship which was already indicated by Figure 2. The higher the Kaitz index, the higher the wage growth effect caused by the minimum wage.

Table VII additionally contains mean, minimum and maximum value of the effects of the minimum wage on the employment retention probability of affected workers. The results for both calculation methods (Ai and Norton (2003) and Puhani (2011)) are presented here. In both parts of West Germany the effects on the employment retention probability show positive as well as negative signs. Applying the method of Norton et al. for calculation of the marginal interaction effects (see Section 3), only one estimate is slightly positive for East Germany. The findings are very similar for the two estimation methods which is also revealed by Figures 3 and 4. The mean of the employment coefficient is negative for East and slightly also for South West Germany, but positive for North West Germany. The average of the employment effects for West Germany in general is positive which

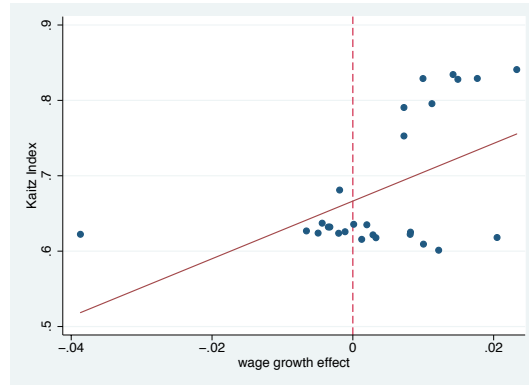


FIGURE 2.— Kaitz index and regional wage growth effect

corresponds to our results in [König and Möller \(2009\)](#) on a more aggregate level. Affected workers in East and South West Germany (North West) had on average a higher (lower) risk to lose their job due to the minimum wage compared to their colleagues. In some regions the opposite was the case.

Table IX gives an answer to the question whether there arises a clear picture between the employment retention probability and the share of workers coming under the minimum wage regime. Using the method of Norton et al. to calculate the interaction effect of the logit model (see section 3) leads to a statistically significantly negative relation between the proportion of affected and the employment effect. The higher the wage floor in relation to the median wage, the lower is the employment retention probability or the higher is the probability of losing the job due to the minimum wage. With the method of Puhani no statistical significance of the negative sign is given. The constant of both weighted regressions, however, are very similar. The resulting value of about 69 percent is the critical level of the share of minimum wage workers above which negative employment effects dominate in this specific sector. Nevertheless, there seems to be still considerable amount of noise in the data which might overlap a possibly clearer picture.

## 7. CONCLUSIONS

From a 100% sample of social security panel micro data we estimate the effects of the introduction of a minimum wage in the German construction sector. We propose a probabilistic method for identifying the treatment and control group. The effect of the minimum wage is investigated for wage growth, inflows into employment and the employment retention probability. According to our results, there are significant positive effects of the minimum wage on wage growth in both parts of the country. Although being lower in absolute terms, the bite of

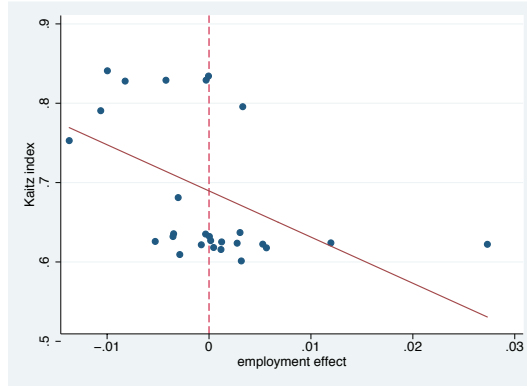


FIGURE 3.— Kaitz index and regional employment effects (Ai and Norton (2003))

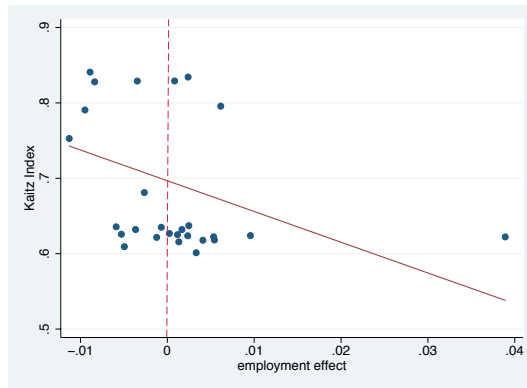


FIGURE 4.— Kaitz index and regional employment effects (Puhani (2011))

TABLE IX

RELATION BETWEEN REGIONAL KAITZ INDEX AND REGIONAL EMPLOYMENT EFFECT OF THE MINIMUM WAGE (WEIGHTED REGRESSION)

	Kaitz index	Coeff	t-value
Coeff employment (Norton)		-5.8172	-2.60
Constant		0.6895	33.56
$N$			27
$R^2$			0.13
Coeff employment (Puhani)		-4.0785	-1.58
Constant		0.6968	34.26
$N$			27
$R^2$			0.08

the minimum wage, however, is markedly higher in the East. The employment effects of the wage floor turn out to be different in both parts of the country. The minimum wage effect on the employment retention probability is negative and statistically highly significant in the East and positive, but statistically not significant in the West. When it comes to the inflow of workers into the sector we find a positive and statistically significant effect of the minimum wage in East Germany, but an insignificant effect for West Germany.

The highly differentiated results for the two parts of the country point to nonlinearities in the impact of a minimum wage. Rather than supporting clear-cut effects as in the pure neoclassical approach, our analysis tends to corroborate the relevance of market imperfections like the existence of monopsony power in the market.

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## APPENDIX 1: DATA FOR WORKING HOURS

TABLE A 10  
OVERVIEW OF THE DATA USED FOR WORKING TIME

		<i>year</i>			
1994	1995	1996	1997	1998	1999
Standard weekly hours					
<i>West Germany</i>					
38.9	38.9	38.9	38.9	38.9	38.9
<i>East Germany</i>					
39.5	39.2	39.0	39.0	39.0	39.0
Overtime - paid hours per year					
<i>West Germany</i>					
77.7	74.7	54.4	55.1	49.6	52.6
<i>East Germany</i>					
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.

APPENDIX 1. APPENDIX 2: CALCULATING MARGINAL EFFECTS FOR THE  
PROBIT AND LOGIT APPROACH

If a probit or logit model is used for estimating a difference-in-difference model with a binary dependent variable a specific problem arises. The *marginal* effect of the interaction term cannot be simply taken from the regression results because of the non-linearity of the logit or probit function. [Ai and Norton \(2003\)](#) state that the marginal effect is calculated by the double discrete difference when two binary variables are interacted. This is given by:

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

where  $\Lambda$  is the cumulative distribution function of the logistic function.<sup>13</sup>

[Puhani \(2011\)](#) questions this way of calculation of the marginal interaction effect. He argues that the interaction effect is not the cross difference, like [Ai and Norton \(2003\)](#) state, but the difference of the cross differences between the factual outcome and the counterfactual outcome. This leads to:

$$\text{(A-2)} \quad IE_2(\alpha_3) = [\Lambda(\alpha_1 + \alpha_2 + \alpha_3 + \mathbf{X}^1 \boldsymbol{\gamma}) - \Lambda(\alpha_1 + \alpha_2 + \mathbf{X}^1 \boldsymbol{\gamma})].$$

<sup>13</sup>Matrix  $\mathbf{X}^1$  includes matrix  $\mathbf{X}$  as well as all other control variables besides  $DT$ ,  $D97$  and  $DTD97$ .

The standard errors for both versions can be calculated by means of the delta method.

For all estimations we clustered the standard errors on the group-time level in order to avoid or at least reduce the influence of group-time specific error terms as discussed by [Donald and Lang \(2007\)](#). Additionally, we conducted the analyses for the two-period sample (one period before, 1995/1996, and one after the minimum wage introduction, 1996/1997) in order to avoid serial correlation in the error terms within groups. For the problem of serial correlation in difference-in-differences models see [Bertrand et al. \(2004\)](#).