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# The Employment Effect of Industry-Specific, Collectively-Bargained Minimum Wages

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## Abstract

This paper estimates the employment effects of industry-specific, collectively-bargained minimum wages in Germany for three occupations associated with the construction sector using a difference-in-differences approach. I propose a truly exogenous control group in contrast to the control group design used in the literature. Additionally, an alternative indicator of the minimum wage bite is employed in addition to the Kaitz index, namely the proportion of workers earning exactly the minimum wage. I do not find a significantly negative employment effect, even though the minimum wage is binding in (East) Germany. This result can be explained by models of monopsonic competition.

**JEL codes:** *J38, J42*

**Keywords:** *Minimum wage, monopsonic competition, difference-in-differences.*

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# 1 Introduction

Germany is one of the few European countries without statutory minimum wages. For decades this fact had remained broadly unquestioned by officials, academics and the general public, because collective bargaining was developed to such an extent that effective minima existed in the absence of any state regulation. However, since the beginning of the 90's an erosion of collective wage agreements can be observed. Consequently, the German labor market finds itself in a unique situation within the European Union, as neither statutory, country-wide minimum wages, nor widely employed extension laws exist, which make collectively bargained rates generally binding. As a consequence, the low-wage sector has increased, leading to a widening of the income distribution. Based on these developments a debate has emerged on the advantages and problems of the introduction of a country-wide or industry-specific, statutory minimum wage. Much of the controversy is caused by different preferences on social equality versus economic efficiency. However, the empirical minimum wage research of the 90's has cast doubt on the existence of this trade-off.

With their study on the employment effect of an increase in minimum wages in the New Jersey fast food industry, Card and Krueger (1994) offered new impulses to the minimum wages discussion by showing empirically that minimum wages do not necessarily lead to negative employment effects. While this result was, and still is, highly controversial, their methodology reformed the manner, in which empirical minimum wage research is conducted. The focus shifted from aggregate time series data to micro data, usually contained in a panel. Even more importantly, instead of trying to separate the effect of the minimum wage from numerous other determinants of employment, minimum wage researches have started to exploit the existence of natural experiments. The findings by Card and Krueger (1994) can be explained by the notion that (some) labor markets are characterized by monopsonic competition (Manning, 2003). The underlying idea is that in the absence of collective organization, market imperfections give employers some discretion for determining wages. Examples of such imperfections include the fact that it is costly for employees to change jobs, that employers are imperfect substitutes for each other, and that workers only possess imperfect information about alternative employment opportunities (Manning, 2004).

Obviously, the employment effect of any minimum wage policy is a question that cannot be answered theoretically. Instead, empirical research is inevitable. Surprisingly, few studies exist for Germany, with the work by König and Möller (2009) constituting an exception.

These authors investigate the minimum wage effect on employment in the main construction sector following a difference-in-differences (DID) approach. While König and Möller (2009) were the first to employ this empirical strategy in Germany, their results are biased due to a poor choice of the control group, which consists of workers in the same industrial branch, earning slightly more than the minimum prior to its introduction. This approach has been criticized, noticeably by Kluve and Schmidt (2007), because such a control group is endogenous to the minimum wage treatment. Therefore, the employment levels of both groups can be expected to react to a change in the minimum wage policy.

On the one hand, a negative employment effect will be overestimated (positive effect will be underestimated) insofar as employment in the control group expands, because these higher productivity workers become relatively cheaper in comparison to workers receiving exactly the minimum wage (substitution effect). On the other hand, a positive employment effect will be overestimated (negative effect will be underestimated), as total economic activity is reduced in the construction sector due to lower product demand caused by higher prices (economies of scale effect). The latter effect might also be explained by a general substitution of capital for labor in response to the increased price of the latter. Especially the substitution effect has been discussed explicitly in the literature in connection to minimum wage research (Brown, 1999). Fitzenberger (2009) argues that the substitution effect will outweigh the economies of scale effect, implying that even though a bias is present, the estimate of König and Möller (2009) is conservative in nature. However, this conclusion hinges on assumptions about the elasticity of substitution between workers with different skill levels as well as the price elasticity of the demand curve in the product market. Even more importantly, while it is already difficult to predict the sign of this bias theoretically, it is impossible to control for it empirically.

The study at hand uses the difference-in-differences approach in order to estimate the employment effect of the minimum wage policy in Germany for three occupational groups (electricians, roofers, painters and varnishers). In order to prevent the bias caused by an endogenous control group, I propose an alternative control group, which is truly exogenous to the treatment. It consists of workers belonging to other industrial branches, in which no minimum wage exists and collective bargaining is characterized by a low coverage rate. Additionally, a second measure for the bite of the minimum wage in addition to the Kaitz index is used, more specifically the fraction of workers employed at the minimum wage.

When minimum wages are bargained over, the Kaitz index might be an inappropriate measure, because average wage growth affects minimum wage growth and employment growth simultaneously. Thus, the employment effect of a change in the minimum wage policy is estimated using two alternative indicators for the minimum wage. The observation period includes minimum wage introductions as well as increases in the minimum wage. As a robustness check, the associated employment effects are estimated separately.

## **2 Previous Research: Theories, Empirical Findings, and Methods**

Much of the research on the employment effects of minimum wages prior to the 90's was conducted in the US. These studies are usually based on aggregate time series or cross-sectional data at state level. Brown, Gilroy, and Kohen (1982) provide an extensive survey covering the insights of these studies. Within the empirical investigations based on time series data (more specifically the US' Current Population Survey), the magnitude of the effect differs according to exact model specification, but the sign is generally negative. These results are confirmed by other authors later on, who exploit the variation to be found in panel data with a special focus on the effect on youth employment (Neumark and Wascher, 2004). This is in line with the theoretical model of perfectly competitive labor markets, which infers that labor market interventions, such as minimum wages, will reduce employment exactly for those worker groups they are supposed to protect (e.g. low-skilled and young workers).

### **2.1 The 'New Minimum Wage Research' and Monopsonic Competition**

The research on minimum wages in the US experienced a revival in the beginning of the 90's, when a number of empirical studies based on establishment level data reported neutral or positive employment effects (e.g. Katz and Krueger, 1992). This research is known today as the 'new minimum wage research' and its most famous representative is Card and Krueger's (1994) study of the New Jersey fast food industry. The authors' choice of the fast food industry is motivated by the same reason as earlier studies' focus on teenage employment rates: to investigate the effect of minimum wages where they can be expected to have the

strongest effect on the wage distribution. However, instead of employing aggregate time series or cross sectional data, Card and Krueger (1994) view the minimum wage increase in New Jersey as a natural experiment. They compare the employment change in New Jersey fast food stores (treatment group) with the employment development in Pennsylvania (control group), where minimum wages remained unchanged. After the increase of the minimum wage, employment grew in low wage stores and contracted at high wage stores. More importantly, a significantly positive employment gain of 2.76 full time employees, equivalent to an average increase of 13%, can be observed in New Jersey stores relatively to their Pennsylvanian counterparts.

Neutral or positive employment effects of a minimum wage introduction or increase can be explained by models of monopsonic competition on the labor market, which in turn can be formalized by matching or wage posting models. These equilibrium models of imperfect competition have in common that they assume that search and recruiting frictions exist, which interact with labor market policies and regulations and thereby determine job and labor turnover (refer to Mortensen and Pissarides (1999) for a survey of the literature). Additionally, they share the property that the market equilibrium is socially inefficient, because wages and employment levels remain below the competitive equilibrium. Thus, if employers are forced to pay higher wages, efficiency will increase. The predicted reaction of employment depends on the specific model used, and ranges from negative over insignificant to positive effects.

## 2.2 The Difference-in-Differences Estimator

The ‘new minimum wage research’ exploits the existence of natural experiments caused by a policy change with an econometric method referred to as the difference-in-differences (DID) estimator. The basic idea is to compare the employment development of two groups of workers that are similar to the highest degree possible, with the only difference that one group is exposed to the minimum wage treatment (treatment group), while the other one is not (control group). This key assumption implies that in the absence of treatment both groups will develop in a similar way. Thus, an unbiased estimate of the employment effect of a minimum wage treatment  $\beta$  can be obtained by difference-in-differences:

$$\hat{\beta} = \Delta \bar{y}^1 - \Delta \bar{y}^0 = (\bar{y}_1^1 - \bar{y}_0^1) - (\bar{y}_1^0 - \bar{y}_0^0) \quad (1)$$

The variable  $\bar{y}$  represents the average employment level in the treatment and control group respectively as well as the average employment level over the observation period prior and after the change in the minimum wage policy. More specifically, the subscript takes the value zero in periods prior to the minimum wage change and the value one afterwards. The superscript takes the value zero for the control groups and the value one for the treatment groups. Thus,  $\beta$  measures the difference in the average change of employment levels between the two groups before and after the introduction/increase of the minimum wage. The DID estimator is appealing, because ideally it is not necessary to specify and include control variables. Time-constant differences between groups, which are not influenced by the explanatory variable, are eliminated by the first difference in Equation 1, while time-varying variables that affect all groups equally disappear when taking the second difference.

Carefully and convincingly chosen control and treatment groups are crucial to the quality of the DID estimator. While the majority of studies in the US have benefited from the simultaneous existence of a federal and individual state minimum wage rates, no such source of variation in the minimum wage is present in any European country. The current development in the German system of collective wage bargaining and sectoral minimum wages offers a unique opportunity in this context. The key to defining treatment and control groups lies in the realization that two groups of workers exist, which are exposed to the same macroeconomic conditions and institutional framework, but are subject to completely different wage regulations. Before exploring the empirical strategy in Section 4 in detail, the following section will shortly review the institutional framework of minimum wages in Germany.

## 3 Institutional Background

### 3.1 Posting of Workers and Union Coverage

In Germany, statutory, country-wide minimum wages do not exist. For decades this fact remained unquestioned, because effective minimum wage rates were ensured by a high coverage rate of collective bargaining. Traditionally, collective wage agreements cover all workers in a specific industry (e.g. metal workers) in a certain region (e.g. North Rhine-Westphalia). The German expression for this type of agreement is ‘*Flächentarifvertrag*’ and will be referred to as *area-wide collective agreement* in what follows. However, as will be discussed

shortly in more detail, the coverage rate of area-wide collective agreements has been declining continuously over the last two decades. As a consequence, a discussion on the necessity of statutory minimum wages has emerged and in some branches sectoral minimum rates have been introduced since the mid-90's through the Posting of Workers Law (*Arbeitnehmer-entsendegesetz*).

The Posting of Workers Law's (PWL) initial aim was not to establish minimum wages for domestic workers, but to protect them from increasing low wage labor competition due to the completion of the EU's Single Market by demanding that foreign workers must be subject to the same minimum wage regulations as domestic workers. Clearly, this requires minimum wages to be present for domestic workers in the first place. Therefore, the PWL allows collectively bargained wage rates to be extended to all workers and firms in an industry, independent of their membership in trade unions or employer associations. However, at least 50% of all employees in the industry of question have to be covered by the initial collective bargaining agreement for the law to be applicable<sup>1</sup>. This is a crucial difference to the general understanding of erga omnes obligation as employed in other European countries without statutory minimum wages, such as Austria or Italy. In these countries, collectively bargained rates are automatically extended to all workers in the associated industrial branches, independent of the coverage rate of the agreement prior to extension. In contrast, the PWL is solely an instrument to stabilize collective bargaining in sectors, where it exists, but has been losing in importance. Workers in industrial branches, in which labor unions have no longstanding tradition, have no possibility to introduce minimum wages through the PWL. Up to date, minimum wages have been introduced through the PWL for the main construction sector (1998), electricians (1998), roofers (2001), painters and varnishers (2003), the commercial cleaning industry (2008), postal services (2008), laundry services (2009), and miners (2009).

At the same time, union density has been falling drastically from 30% in 1990 to 21% in

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<sup>1</sup>In April 2009, a Law on Minimum Working Standards (*Mindestarbeitsbedingungengesetz*) has been modernized to allow minimum wage introduction in economic branches with a coverage rate below 50%. Various state organs as well as the social partners can suggest specific sectors for a minimum wage introduction based on the existence of social exclusion. In such a case, a special committee is supposed to introduce (permanent) minimum wages such that working conditions are appropriate, fair competition is ensured and employment subject to social security payments is sustained. However, up to now this law has not been applied and its practical relevance still needs to be proven.



2004 in West Germany and from 50% in 1990 to 18% in 2001 in East Germany (Biebeler and Lesch, 2006). Naturally, union coverage is considerably higher, but the pattern observed for density applies equally: coverage has been decreasing from 69% in 1996 to 61% in 2004 in West Germany and from 56% to 41% in East Germany during the same time period (Ellguth and Kohaut, 2005). Not surprisingly, the coverage rates differ significantly between industrial branches. As Figure 1 shows, the coverage rate of area-wide collective agreements is especially low for the service sector, communication and transportation, wholesale and retailing, as well as for non-profit organizations. In contrast, the public sector, the banking and insurance sector, as well as mining and energy/water provision are characterized by high and stable coverage rates in East and West Germany alike. Further, coverage is much higher in West Germany than in East Germany for all industrial branches. Finally, while area-wide collective agreements have been decreasing, company-level collective agreements have been increasing in number and importance. However, generally the proportion of workers not covered by any agreement is growing in most sectors, implying that the increase in latter was not large enough to outweigh the decrease in the former.

### **3.2 Implications of the Institutional Background for the Empirical Strategy**

The institutional framework has two crucial implications for any empirical minimum wage study in Germany. First, as minimum wages are collectively bargained at the level of the industry, they will be closely correlated with average wages. At the same time, minimum and average wages are both expected to determine employment from a theoretical perspective. This poses a challenge to the econometric specification to be employed, or more specifically to the minimum wage indicator entered into the estimation. Section 4.2 will deal with this issue in depth.

Second, recall from Section 2.2 that any control group must fulfill two requirements in order for the DID estimator to be credible, namely the control group must not be subject to the minimum wage treatment and its employment development must correspond to that observed in the treatment group if the minimum wage was not introduced. The first requirement implies that the coverage rate of collective bargaining should be as low as possible. As minimum wages in Germany amount to extended collective wage agreements, any area-wide collective agreement with a high coverage rate mimics a minimum wage treatment. Thus,

the control group should consist of workers from industrial branches with a low coverage rate of collective bargaining. Clearly, the fulfillment of the second requirement is doubtful in the case of a comparison of different industrial branches. However, while it is possible to control for time-varying factor that affect employment in the treatment and control group differently, it is impossible to account for bias resulting from a control group that is exposed to the treatment. Therefore, this study will employ industries with a low coverage rate of collective bargaining as control groups, while carefully controlling for and analyzing potential biases in the results.

## 4 Application of the DID Estimator to the Minimum Wage Policy in Germany

### 4.1 Empirical Specification and Included Variables

The treatment groups for the study at hand consist of occupational groups, not specific workers, which are associated with the construction sector. These are electricians, roofers, as well as painters and varnishers. Similarly, two control groups will be employed that consist of industrial branches, completely exogenous to the minimum wage treatment. The sectors in question are transport and communication as well as wholesale and retailing. The choice of these specific control groups is motivated by the low coverage rate of collective agreements as discussed in the previous section (refer to Figure 1).

While the choice of the transport/communication and retailing/wholesale sectors has the advantage of ensuring that treatment is absent in the control groups, the assumption of the DID estimator that no exogenous factor exists that affects the employment level of both groups differently over time is more than risky for a comparison of different industrial sectors. Therefore it is necessary to rely on more traditional panel estimation methods that allow the introduction of controls, such as a fixed or random effects model. Further, these models are able to deal with several treatment and control groups at the same time, which improves the efficiency of the estimation insofar as each group leads to a different bias (Meyer, 1995). The approach applied in this study and most similar to the DID estimator is a fixed effects model with time dummies<sup>2</sup>. The ‘within demeaning’ of the fixed effects

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<sup>2</sup>As Equation 2 shows, the specification includes a time trend instead of individual time dummies. During

model eliminates any time-constant differences between groups, and corresponds to the first difference in the DID estimator. The time dummies capture the effects of any exogenous variable that changes over time, but affects all groups equally. Therefore, they serve the same purpose as the second difference in Equation 2. The regression equation employed in the study at hand can be expressed as:

$$\begin{aligned}
empl_{it} = & \alpha + \beta_1 mw_{it} + \beta_2 w_{it} + \beta_3 g_{it} + \beta_4 mj_{it} + \beta_5 mw_{it} * training_{it} + \beta_6 mw_{it} * young_{it} + \\
& \beta_7 mw_{it} * small_{it} + \beta_8 d_i + \beta_9 trend + \beta_{10} d_{winter1} + \beta_{11} d_{winter2} + \\
& \beta_{12} d_{summer1} + \epsilon_{it}
\end{aligned} \tag{2}$$

Employment is represented by  $empl_{it}$ , while  $mw_{it}$  gives the minimum wage indicator. The controls include average wages ( $w_{it}$ ), sector-specific economic growth ( $g_{it}$ ), as well as the proportion of mini-jobs ( $mj_{it}$ ). Insofar as these variables follow a different development over time for the included groups, it is indispensable to include them in the regression equation. Further, the composition of the workforce of the industrial branches can be differentiated along several individual-level characteristics, which only evolve slowly over time. Examples of such characteristics include educational attainment or age. The fact that these variables are rather time-invariant implies that it is not necessary to include them as control variables. However, previous empirical research suggests that employment of young and/or low skilled workers reacts more heavily to a change in the minimum wage policy (Neumark and Wascher, 2004). Thus, interaction terms of the growth rate of minimum wages and the proportion of workers aged 25 years and younger ( $mw_{it} * young_{it}$ ) as well as the proportion of workers with no vocational training ( $mw_{it} * training_{it}$ ) will be employed as controls. Additionally, a third interaction term focusing on the proportion of workers employed in firms with less than 20 employees ( $mw_{it} * small_{it}$ ) will be included in order to control for the possibility that small firms are affected differently by a change in minimum wage policy than large firms. Next to sector dummies and a time trend, three dummies taking the value one during the two winter quarters and the first summer quarter respectively will be included in order to account for any seasonal pattern.

All variables, except the proportion of low skilled workers, young workers, and workers employed in small firms, are expressed as growth rates. There are two main reasons for the specification search, a time trend has proven to capture the effect of time-varying determinants of employment affecting all groups equally just as well as individual time dummies, but is more efficient.

estimating the equation in growth rates and not in levels. First, when expressed in levels, the independent variables are highly correlated with each other, which renders the coefficients of the estimation unreliable due to multicollinearity. This problem disappears when employing growth rates. Second, employment expressed as a level is subject to serial correlation. This is not surprising, because the employment level is naturally determined by the level in previous periods to a large extent, especially because there are large differences in employment levels between groups. Differencing, or in this case calculating growth rates, is a simple and intuitive manner to solve this problem. As the regressions will show, some autocorrelation in the error term is still left, but the serial correlation is decreased to a manageable level. The sensitivity analysis will return to this issue by presenting a dynamic specification, which shows that the results do not change drastically compared to the static model.

## **4.2 Minimum Wage Indicators: Kaitz Index versus ‘Fraction at’**

The employment effect of any minimum wage policy depends on the bite of the minimum wage, i.e. the amount of workers affected by it. Thus, the indicator used for the minimum wage during the estimation process is crucially important. As Brown (1999) notes, the vast majority of empirical minimum wage studies employs the ‘Kaitz index’ for estimation purposes (Kaitz, 1970), which consists of the ratio of minimum to average wages. This measure is derived theoretically from the neoclassical labor demand function, in which the effect of a minimum wage depends on its level in relation to labor productivity (Lemos, 2004). In the present context, the Kaitz index therefore has the advantage of making the minimum wage rates in different industrial branches comparable. While the Kaitz index is an appealing measure for the minimum wage, three problems exist with its empirical application for the research question at hand.

First, the Kaitz index is unable to separate variation in the minimum wage from variation in average wages. This is desirable as long as the variation in average wages is not caused by a change in minimum wage policy. Unfortunately, this may not be the case, because increases in the minimum wage affect wages in the entire income distribution through spillover effects, even though the impact is decreasing with higher wages (Manning, 2003). Second, and more generally, minimum and average wages are likely to be correlated, with causality possibly running in both directions. Minimum wages may affect average wages through spillover effects, and average wages may determine minimum wages as both wage rates are subject

to collective bargaining in Germany. Thus, the coefficients of both variables are expected to be biased due to multicollinearity. Therefore, it will not be possible to determine to what extent minimum or average wages influence employment. Dropping average wages from the specification will solve the problem, but result in an even more severe endogeneity bias. Therefore, a practical solution is to search for a minimum wage indicator, for which the correlation to average wages is as low as possible. In this context, the Kaitz index might not be the best choice, as average wages enter this indicator in the denominator. Figure 2 clearly supports the concern that minimum and average wage growth are correlated, as both growth rates move together in the majority of periods for all sectors in East and West Germany alike. In addition, for electricians and roofers in East Germany the growth rate of minimum wages seems to follow that of average wages, implying that spillover effects are dominated by the fact that minimum wages themselves are the result of collective bargaining. However, any interpretation of Figure 2 must be undertaken carefully, as neither the direction of causality nor other determinants of the two growth rates are known. Third, Dolado et al. (1996) note that the Kaitz index is not informative about the number of workers affected if the wage distributions of the observational units (here: industrial branches) differ considerably. More specifically, for a given Kaitz index, a more compressed wage distribution implies that fewer workers actually receive the minimum wage.

An alternative minimum wage measure that solves these problems, is a ‘degree of impact measure’ as proposed, next to others, by Card and Krueger (1995). More specifically, an indicator referred to as ‘fraction at’ represents the proportion of workers in the entire labor force earning exactly the minimum wage. Like the Kaitz index, ‘fraction at’ measures the bite of the minimum wage independent of whether the minimum is constant or increasing. Unlike the Kaitz index, this indicator accounts for the relation between the minimum wage and the structure of the wage distribution. Further, no direct connection to average wage growth, independent of the direction of causality, can be expected. “Fraction at is a measure of those workers becoming more expensive, i.e. a measure of the extra (wage) employment costs, and therefore well suited to study wage and employment effects” (Lemos, 2004, p.6). As ‘fraction at’ reduces the multicollinearity problem present when employing the Kaitz index, it is the theoretically preferred measure for minimum wages for the study at hand. In contrast, the Kaitz index heavily dominates the empirical minimum wage literature. In order to analyze possible biases arising from employing the Kaitz index, all specifications

will be estimated with both indicators. Model 1 will employ the Kaitz index, while Model 2 will be using the indicator ‘fraction at’.

Figure 3 compares the three possible minimum wage measures, namely the minimum wage in absolute terms, the Kaitz index, and ‘fraction at’, separately for each treatment group as well as West and East Germany. Three observations are worth noting. First, in absolute terms the minimum wage only increases. Only for painters and varnishers, there are some periods, in which the minimum wage rate decreases in absolute terms. In contrast, the Kaitz index as well as ‘fraction at’ raise and fall in magnitude, even though a general positive trend can be observed for these indicators as well. Second, the differences in minimum wage rates among the treatment groups appear to be larger when expressed in absolute terms compared to the Kaitz index. Stated differently, the advantage of the Kaitz index is that it includes differences in average wages, thereby giving an indication of the bite of the minimum wage. Third, ‘fraction at’ is basically zero for all treatment groups in West, while the indicator is quite large in magnitude in East Germany. This difference is not apparent with the Kaitz index, because it does not account for differences in the income distribution.

## 5 Data

The data employed in the empirical analysis consist of the BA Employment Panel supplied by the Research Data Centre of the German Federal Employment Agency at the Institutes for Employment Research (Schmucker and Seth, 2009). The data are at the individual level and present a 1.92% sample of all employees subject to social security payments. The data are regarded representative for all workers subject to social security payments, which amounted to almost 32 million individuals in 2002. The data are quarterly and cover the time period 1998 - 2007. For each individual, several personal characteristics are included, such as gross wage, type of employment, occupation, age, nationality and educational attainment. Further, information at the establishment level is added, e.g. the economic sector and the composition of the workforce.

In order to aggregate the data to the sectoral level, each individual employee is assigned to one of the six groups. All persons, who do not belong to one of the sectors of interest, are dropped from the data set. Additionally, only regular full-time employees are kept. This

excludes part-time employees, but also apprentices, interns and marginal employment. This latter type of employment, also referred to as “mini-jobs”, frees the employer as well as the employee from social security payments to a large extent, if one of two conditions is met. Either, the monthly wage has to be less than 400 Euros per month, or the employee is not allowed to work more than 50 days per year. After the dataset is scaled down to regular full-time employment, the variables are transformed to the sectoral level. For some indicators this implies simple averages, for others sums or proportions.

Two important variables are not contained in the original data set and are therefore added from an external source. First, information about minimum wage rates is taken from the Federal Bulletin (*Bundesanzeiger*), where each collective bargaining agreement declared generally binding must be published. Second, the indicator for sectoral economic growth consists of gross value added for the control groups and revenues for the treatment groups. These data are obtained from the Federal Statistical Office (*Statistisches Bundesamt*). While it might be problematic to employ two different concepts, namely gross value added and revenues, in order to measure the same variable, the use of these two indicators is the only possibility to account for different macroeconomic situations at the level of the industrial branch or even occupation. Thus, while this measure is imperfect, it is still preferable to ignoring this important control variable altogether. Still, when interpreting the results, this flaw should be kept in mind.

## 6 Empirical Results

### 6.1 Qualitative Analysis of the Bite of the Minimum Wage

A precondition for minimum wages to have any effect on employment is that they are binding. Stated differently, wages at the lower end of the distribution should be increased. While the focus of this paper is not to analyze whether minimum wages are an effective tool to increase the income of low wage workers, it is necessary to gain at least a qualitative insight on their effect on the bottom percentile of the wage distribution. I therefore start with providing some descriptive evidence.

Figure 4 graphs the average wage growth of the bottom percentile as well as the fifth percentile for each treatment group over time. Average wage growth is defined along two dimensions. First, the growth rate concerns the average wage within the respective per-

centiles. Second, and more importantly, the growth rates are averaged over all quarters, in which no change in the minimum wage policy took place. This transformation is the reason for the step-like appearance of the curves. The underlying idea is that the minimum wage might take more than one quarter to affect wage growth. Clearly, other factors besides the minimum wage determine average wage growth. However, if wages in the bottom percentile grow faster than wages in the fifth percentile after a change in the minimum wage, at least part of this growth can be attributed to the minimum wage.

Focusing on East Germany, average wages grow faster in the bottom percentile in all treatment groups directly after the minimum wage introductions (refer to Figure 4 for specific information about the timing of minimum wage introductions). Interestingly, this is also the fact in the period prior to the introduction. This observation can be attributed to an anticipation effect of the collective agreement. Further, wage growth of low-wage workers is generally also higher in periods following an increase in the minimum. Thus, Figure 4 presents some evidence that the minimum wage has been binding in East Germany. This conclusion is supported by the average wage growth after the minimum wage abolition for electricians in wave 21. While wage growth tends towards zero in the fifth percentile, it even turns negative for the bottom percentile. First, this observation can be interpreted as (weak) evidence for the existence of a spillover effect of minimum wages on wages further up the distribution. Second, it clearly shows that the minimum wage increased wages at the lower end of the distribution.

For West Germany, Figure 4 leads to a different impression. Average wage growth in both percentiles is only marginally indifferent from zero for painters and varnishers, with wage growth in the fifth percentile even slightly exceeding that in the bottom percentile at all times. The picture is somewhat more mixed for electricians. In some periods, wage growth is slightly higher in the bottom percentile, but there is no visible effect either of the minimum wage abolition or of its re-introduction. Roofers constitute a notable exception, as the minimum wage in this occupation seems to be more binding in West than in East Germany. While average wage growth in the bottom percentile is lower prior to the minimum wage introduction, it surpasses the growth rates of averages wages in the fifth percentile afterwards. Additionally, each raise of the minimum wage is followed by an increase in the growth rate of average wages in the bottom percentile, with only one exception in period 29. To conclude, minimum wages appear to be binding in East Germany, while the evidence



is mixed for West Germany.

Figure 5 shows the ratio of the averages wages in the top percentile to average wages in the bottom percentile for each industrial branch and time period. Thus, it presents qualitative evidence on the effect of the minimum wage on the compression of the wage distribution. The most obvious characteristic of Figure 5 is the large difference between the treatment and control groups for East and West Germany alike. While the ratio is smaller than three for all treatment groups, it approaches six in the control groups. Partly, the lower compression of the wage distributions of the control groups is caused by the fact that they consist of entire industrial branches. Still, the differences in the compression of the wage distributions may also be interpreted as a consequence of differences concerning the coverage rate of collective bargaining, thereby showing that the chosen industries form valid control groups. Further, the ratio has been increasing for the control groups during the observation period, while it has been stable or even decreasing for the treatment groups. This cannot be explained by different degrees of homogeneity of workers, and therefore must be attributed to either the minimum wage or the wage setting process in general. Finally, note that the ratio has been decreasing for those treatment groups, for which Figure 4 suggested that the minimum wage has been binding, namely roofers in East and West Germany as well as painters and varnishers in East Germany. While Figure 4 also implied that the minimum wage has been binding for electricians in East Germany, it is not surprising that ratio of wages in the top percentile to wages in the bottom percentile has remained rather stable, as a minimum wage abolition took place during the observation period for this treatment group. In conclusion, Figure 4 and 5 present qualitative evidence that the minimum wage has been binding in East Germany, but not in West Germany. Roofers are a notable exception. This result is in line with the estimates reported by König and Möller (2009) for the main construction sector.

## 6.2 The Effect of the Minimum Wage on Employment

The estimation results for East Germany are presented in Table 1 in the appendix, while the results for West Germany are contained in Table 2. The coefficient of minimum wage growth is insignificant throughout all specifications, both samples, and the two indicators. At the same time, average wage growth remains equally insignificant in East Germany, while it exhibits a negative and significant influence on employment growth in West Germany. The

insignificant effect of the minimum wage indicators coupled with the negative influence of average wage growth on employment can be easily explained for West Germany. First, it is not surprising that a minimum wage that hardly binds does not exhibit any significant effect on employment. Second, the traditionally strong unions have induced a relatively high wage level, thereby eliminating the monopsonic power of employers. Indeed, if wages are already higher than the competitive level, any additional increase will have a large and negative effect on employment. This is exactly in line with the estimation results, which predict a decrease of 3.73 percentage points in the growth rate of employment after an increase of one percentage point in the growth rate of average wages.

Up to this point, it might be argued that the discussed results can just as well be explained by neoclassical theory under perfect competition. While this is true, models based on perfect competition are unable to offer an explanation for the insignificant coefficient of the minimum wage growth in East Germany, despite the fact that the minimum wage has been binding. Such models clearly predict that a minimum wage, which affects the wage distribution to such a degree, must decrease employment as the equilibrium wage rate established through market forces is distorted. In contrast, the models of monopsonic competition are less contradictory to the observed results. While the predicted sign of the employment effect varies with different models, an insignificant effect of a binding minimum wage is generally possible as long as employers still possess monopsonic power and wages are therefore below the competitive level. Such a situation is unlikely to emerge in the presence of strong trade unions. However, recall that union coverage is much lower in East than in West Germany, independent of the specific industrial branch in mind (refer to Figure 1). The idea that the employment effect of the minimum wage is insignificant, because it counteracts the monopsonic power of employers, thereby increasing market efficiency, is additionally supported by the insignificant coefficient of average wage growth.

The interaction terms of minimum wage growth and the composition of the sectoral workforce remain largely insignificant. An exception is the interaction with the proportion of workers in the labor force aged 25 years and younger in East Germany. The corresponding coefficient is rather large in magnitude, negative and significant at the 1% level in Model 2. This is in line with previous empirical results and implies that young workers are more likely to suffer negative employment effect as a consequence of a minimum wage introduction or increase. This result can be explained with models based on perfect as well as monopsonic

competition, because the productivity of these workers is generally lower than that of the remaining workforce. Consequently, a minimum wage that does not differentiate between age groups is more likely to exceed the marginal revenue product of these employees, thereby inducing a negative employment effects under both theoretical frameworks. Interestingly, the coefficient of the growth rate of the proportion of mini jobs is significant and negative throughout all specifications. A possible explanation is that this cheaper type of employment crowds out a fraction of regular, full-time employment. However, it should be noted carefully that the coefficient is rather small in magnitude. It does not exceed 0.3 in any specification, implying that an increase of one percentage point in the growth rate of the proportion of mini-jobs leads to a decrease of at most 0.3 percentage points in the growth rate of employment. Additionally, the question of the effect of mini-jobs on regular employment is not central to this study. As other factor might play an important role, not too much inference should be drawn from this result.

## 7 Sensitivity Analysis

This section will provide two sensitivity checks to the main results, namely a dynamic specification of the presented models as well as separate estimations for the employment effect of a minimum wage introduction and minimum wage increases. The first is motivated by the persistence of autocorrelation in the error term in the main models, while the later sensitivity check is based on the notion that an increase of 100% of the minimum wage in the period of introduction might dominate all available variation in subsequent periods. Further, these estimations will exploit the richness of the data fully, which cover the period of introduction as well as several increases of the minimum wage for all included treatment groups.

### 7.1 Dynamic Specifications

The basic specification as presented in Table 1 and 2 are still subject to autocorrelation in the error term, as the Wooldridge test for autocorrelation in panel data and the LBI test statistic show. While it is possible to correct for autoregressive errors up to a certain degree (which is done in the fixed effects estimations allowing for AR(1) errors), it is still important to assess any possible bias the results might be exposed to. Therefore, Tables 3 and 4

present dynamic specifications of the basic models including three lags of the employment growth rates as explanatory variables<sup>3</sup>. The underlying idea is that the current period and three lags always constitute one entire year, implying that the lag structure takes care of remaining seasonal effects as well as a general trend in the growth rate of employment. In addition, in the basic specifications the error term structure is characterized by third degree autocorrelation. All specifications are estimated with panel robust standard errors.

Before turning to the coefficients of the variables of interest, it is useful to examine the sign and significance of the lags in order to fully understand in which ways the dynamic specification differs from the basic one. The effect of the three lags on the current growth rate of employment is negative and highly significant in all specifications for East and West Germany alike. At first sight this result seems odd, especially because one expects employment to be characterized by a high persistence, which would imply that employment in previous periods exhibits a positive influence on current employment. However, the model does not estimate the level of employment, but its growth rate *per quarter*. In contrast to the level of employment, its quarterly growth rate is expected to change its direction continuously. Therefore, the lag structure does not account for the persistence of employment, but rather its seasonality. This interpretation is supported by the fact that the seasonal dummies are jointly insignificant in the dynamic specification, while they are highly significant at the 0.1% level in the basic models.

Compared to the basic specifications allowing for autoregressive errors of first degree, the results of the dynamic models do not deviate significantly. The minimum wage coefficient is less negative for all included models, but remains insignificant. Interestingly, the coefficient of economic growth turns positive and gains statistical significance. In addition, its predicted effect on employment growth is rather large: an increase of one percentage

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<sup>3</sup>Generally, dynamic models need to be estimated with GMM estimators, such as the Arellano and Bond estimator, which use further lags of the dependent variable as instruments for the lag that has been introduced as an explanatory variable. This is necessary because the lagged dependent variable and the error term are correlated by construction. However, as Baltagi and Kao (2000) note, when T is large compared to N this problem becomes negligible small and standard panel estimation methods that only eliminate time-constant, group-specific effects, are sufficient. Therefore, the presented dynamic specifications in Tables 3 and 4 are simple fixed effects models with panel robust standard errors. In order to ensure that these results are not inconsistent, the same specifications were additionally estimated using the Arellano and Bond estimator. Sign, size and significance of the coefficients remain the same independent of the estimation method (these results can be obtained from the author upon request).

point in the growth rate of gross value added will lead to an increase of 2.1 (East Germany) or 1.35 (West Germany) percentage points in the growth rate of employment. A possible explanation why economic growth is significant only in the dynamic, and not in the basic, specification is that the short-term effect of economic growth on employment growth is dominated by the high seasonality of employment. While the seasonal dummies do account for the associated pattern in the growth rate of employment to a large extent, they appear to be less powerful than the lag structure employed in the dynamic specifications. In addition, the dynamic models are able to deal with autocorrelation and heteroskedasticity at the same time. Finally, the  $R^2$  is significantly larger in the dynamic compared to the basic specifications, which is, however, not surprising given that three new and highly significant variables have been added to the model. In conclusion, the dynamic specifications deal with the seasonality of employment more precisely than the seasonal dummies. However, as the main results do not change significantly, the basic models also appear to constitute valid estimation specifications.

## 7.2 Effect of a Minimum Wage Introduction vs. Effect of a Minimum Wage Increase

The second sensitivity analysis consists of a separate examination of the employment effect of a minimum wage introduction and that of a minimum wage increase. For roofers as well as painters and varnishers an introduction is observed at different points in time, while a minimum wage abolition took place for electricians. In order to estimate the employment effect of an increase in the minimum wage, only those periods in which a minimum wage existed are kept for the treatment groups. This implies that the control groups are observed during the entire period, while the treatment groups are only observed for specific sub-periods that differ from each other. No additional changes are made next to this data manipulation compared to basic specification.

In contrast, a new minimum wage indicator is introduced to estimate the effect of a minimum wage introduction or abolition. More specifically, a minimum wage dummy is added that takes the value one in periods, in which a minimum wage exists in each treatment group. This dummy is entered into the estimation replacing the former minimum wage indicators, i.e. the Kaitz index or ‘fraction at’<sup>4</sup>. Thus, the coefficient of the minimum wage

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<sup>4</sup>This specification does not constitute a DID estimator on purpose. First, as discussed in Section 4

dummy estimates the change in employment growth due to the minimum wage introduction compared to the control groups. A crucial difference to the basic specification is that the minimum wage indicator is characterized by zero variation after the introduction and therefore compares only two, instead of several, periods with each other.

The most important result is the positive minimum wage coefficient in the model estimating the effect of a minimum wage introduction. While this effect is insignificant in West Germany, which is not surprising given the weak bite of the minimum wage, it is significant at the 1% level in East Germany. Additionally, the economic significance of this effect is high, as the coefficient implies an increase of 2.3 percentage points in the growth rate of employment after the minimum wage introduction (refer to Tables 5 and 6). A possible interpretation of this finding is that the initial minimum wage introduction raised employment by counteracting the monopsonic power of employers and increasing the labor supply to supply-constrained firms, but later increases in the minimum wage were too strong to preserve this generally positive effect. This interpretation is supported by negative and extremely large coefficient of the Kaitz index in the models estimating only the effect of minimum wage increases. However, the effect is statistically insignificant and therefore not too much inference should be drawn. Further, no such pattern can be observed for the minimum wage indicator ‘fraction at’.

Instead, a more likely explanation of the sudden increase of the coefficient of the Kaitz index is connected to the changing effect of average wage growth on employment throughout the different models. Its sign is consistently negative, but the coefficient changes magnitude and significance in each specification (compare with Tables 5 and 6). The underlying reason is that minimum and average wage growth are strongly correlated (refer to Section 4). However, this correlation differs among the included minimum wage indicators. It will be strongest for the Kaitz index focusing only on minimum wage increases and it will be non-existing for the minimum wage dummy. Generally, the specifications based on the minimum wage indicator ‘fraction at’ are preferable over those using the Kaitz index, because the connection between the growth rate of workers receiving the minimum wage and the growth rate of average wages will be less pronounced. Therefore, multicollinearity is expected to be lowest for the specification focusing on the minimum wage introduction and highest in a DID estimator is not suited for the comparison of industrial branches. Second, the estimations of the sensitivity analysis should be similar to the main specifications in order to ensure comparability

the specification concentrating only on periods of minimum wage increases. Consequently, the coefficients of average and minimum wage growth are more reliable in the former model. This conclusion is supported by the notable increase in the  $R^2$  in the ‘introduction models’ compared to the basic specifications. Indeed, the fact that this improvement is achieved without additional variables shows that the specification fits the data well.

To conclude, the estimation of the effect of the minimum wage introduction suggests that employment reacts positively to the existence of a minimum wage in East Germany. Any contraction of employment is rather a reaction to average, not minimum wage growth. The models based on the Kaitz index are not able to distinguish between these two separate effects. In order to gain insight into the employment effect of average and minimum wage growth during periods of minimum wage increases, one needs to focus on the specifications based on ‘fraction at’. They suggest, as the basic models previously, that both growth rates exhibit no statistically significant effect on employment in East Germany, while an increase in the growth rate of average wages will decrease the growth rate of employment in West Germany.

## 8 Conclusion

I find no significant effect of minimum wage growth on employment growth in East Germany, despite the fact that the minimum has been affecting a significant proportion of the workforce and consequently increased wages in the bottom percentile of the distribution. Additionally, in East Germany average wage growth exhibits no significant influence on employment growth. In contrast, average wage growth affects employment growth significantly and negatively in West Germany, which supports the notion that the relatively strong labor unions have pushed wages above the competitive level. This also explains why the minimum wage has hardly been binding in West Germany. Generally, the results present strong evidence that the labor market segments of the included industrial branches are characterized by monopsonic competition in the absence of collective wage bargaining. In such a situation, a modest minimum wage does not exhibit any negative influence on employment.

This suggests that minimum wages do not necessarily imply an efficiency-equity trade-off. In labor market segments characterized by a relatively low degree of union power, minimum wages have the potential of increasing equity through a compression of the wage

distribution and of raising efficiency by counteracting the monopsonic power of employers. It should be stated very clearly though that any minimum wage must be chosen very carefully, as such positive effects are by no means guaranteed or self-evident. Still, to generally dismiss minimum wages as a useful labor market institution may be just as harmful as to believe a high minimum wage will always be in the interest of low-wage workers.

The proposed control group design is useful, whenever the minimum wage does not vary between geographical locations, but different industrial branches. The empirical results are maintained by carefully selecting a control group that is completely exogenous to the minimum wage treatment. In contrast, the employment level of the control group by König and Möller (2009), which consists of workers in the same industrial branch, earning wages slightly increasing the minimum prior to its introduction, directly depends on the minimum wage. First and generally, theory leads to the expectation that substitution effects will induce the employment level of the control group to react to a change in the minimum wage policy. Second, in the specific case of Germany, minimum wages are bargained over simultaneously with average wages, implying that all workers in the industry of question will to some extent receive a minimum wage treatment, independent of their income. Therefore, it is vital to choose a control group with a low coverage rate of collective bargaining in order to ensure the absence of treatment. Naturally, the choice of different industrial branches as control groups is not free of possible biases. However, an important difference to the set-up proposed by König and Möller (2009) is that these biases can be controlled for. Differences in economic growth among the industrial branches, for example, can be entered into the estimation as a control variable. In contrast, the effect of employing an endogeneous control group is already extremely difficult to predict theoretically and impossible to control for empirically.

The choice of the minimum wage indicator is especially crucial, when minimum wages are bargained over. More specifically, the widely employed Kaitz index may be inappropriate for two reasons. First, as a consequence of collectively-bargained minimum wages, assignment to the treatment groups is not random. Stated differently, the probability of a minimum wage treatment is conditional on an existing high coverage rate of collective bargaining. Consequently, the estimated employment effect of the minimum wage only constitutes an upper bound and is likely to more negative (less positive), if treatment was random. While this line of argument is true for the specifications employing the Kaitz index, the problem



diminishes when the minimum wage indicator ‘fraction at’ is employed. The latter takes into account the compression of the income distribution, which is influenced by the existing coverage rate of collective bargaining, and only estimates the effect of the relative amount of workers actually affected by the minimum wage on employment. Second, collectively bargained minimum wages imply that average wage growth affects the Kaitz index and the employment level simultaneously, thereby creating an endogeneity bias. Again, the problem can be solved by using the fraction of workers employed at the minimum wage as an indicator for the explanatory variable. While the results are robust independent of the indicator, it is crucial to realize that the Kaitz index might bias the results of minimum wages studies in Germany and other countries with collectively bargained minimum rates.

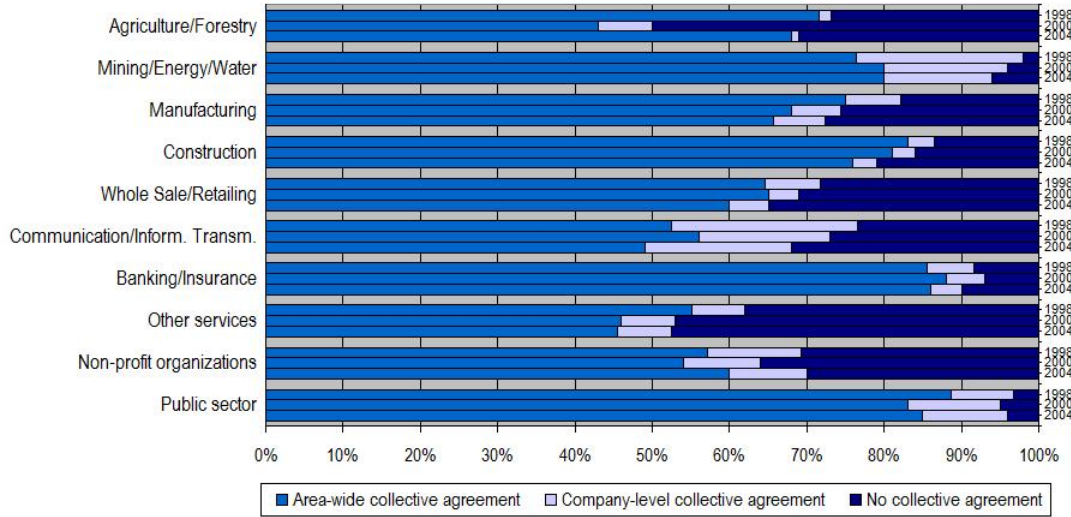
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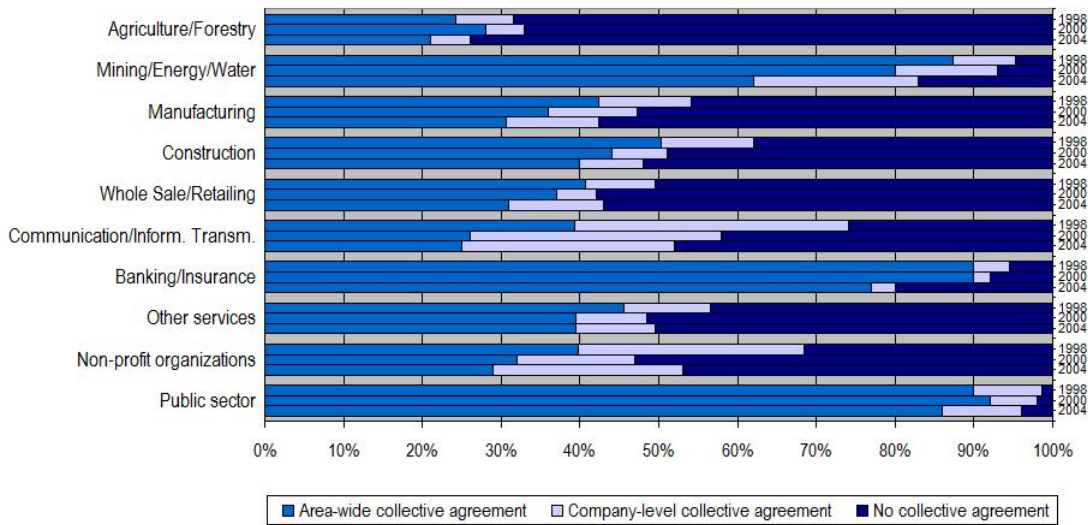
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**Figure 1: Collective Bargaining Coverage per Industrial Sector**

(a) Proportion of Employees Covered in West Germany



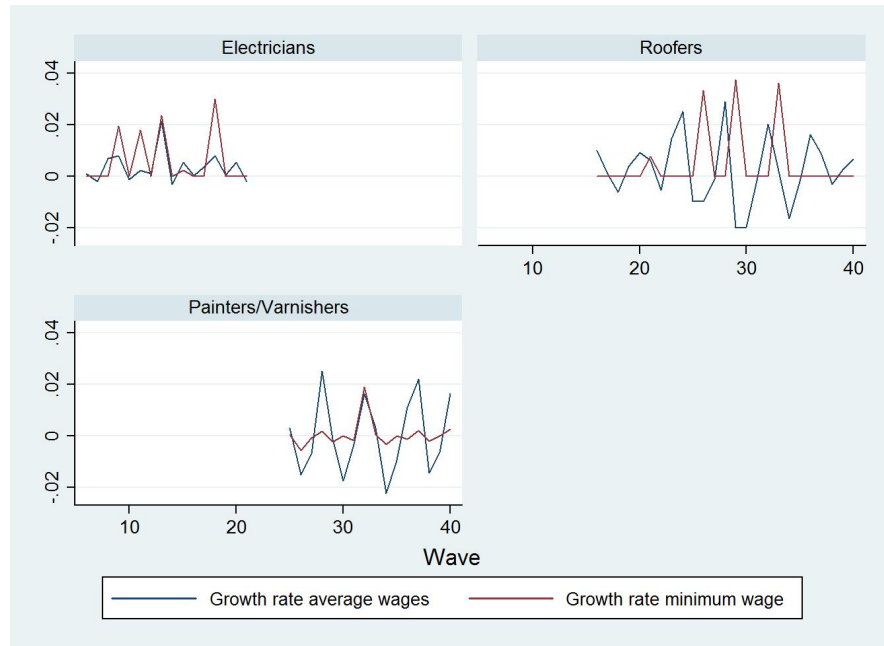
(b) Proportion of Employees Covered in East Germany



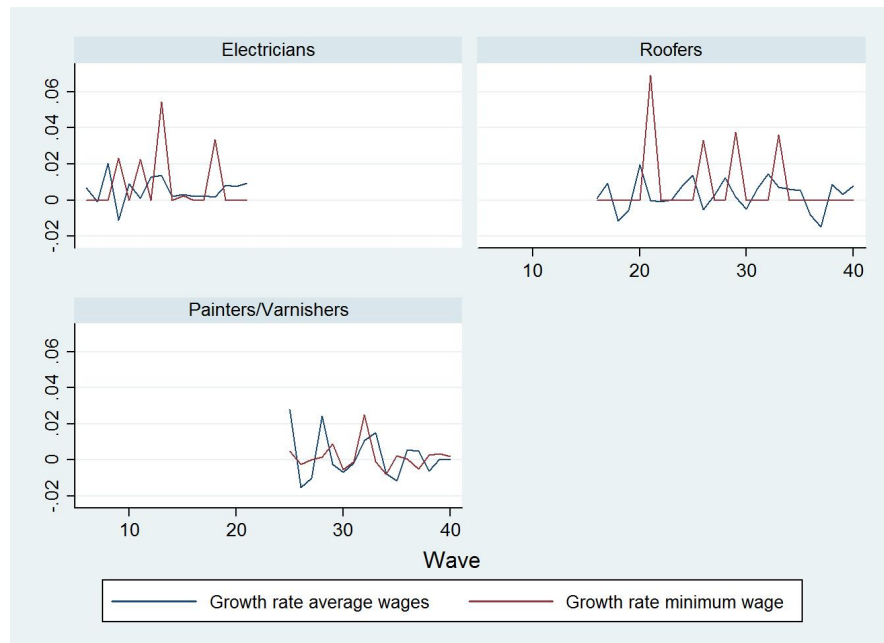
Source 1998/2000: Hans Böckler Stiftung (2008). Source 2004: Ellguth and Kohaut (2005).

**Figure 2: Connection between Minimum and Average Wages**

(a) Minimum and Average Wage Growth in West Germany



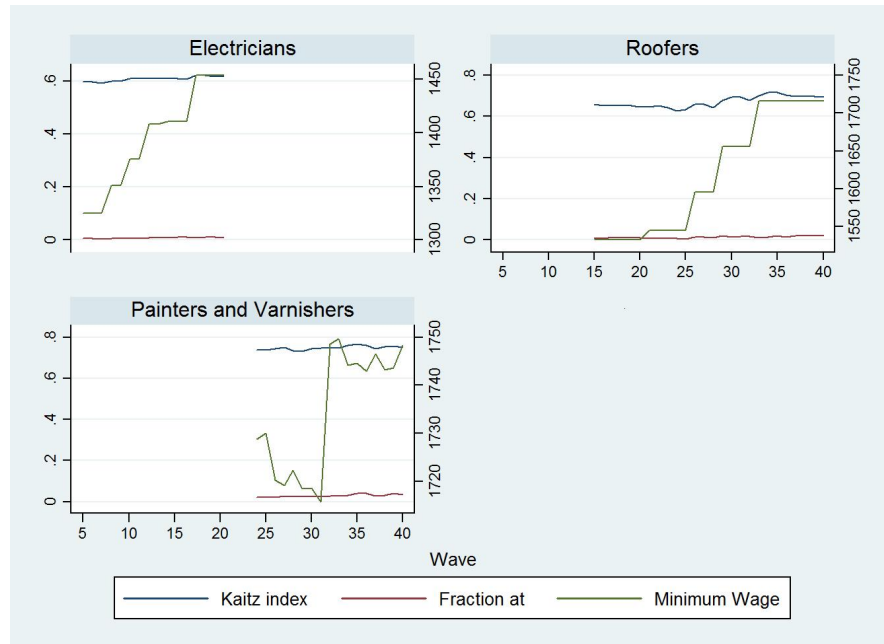
(b) Minimum and Average Wage Growth in East Germany



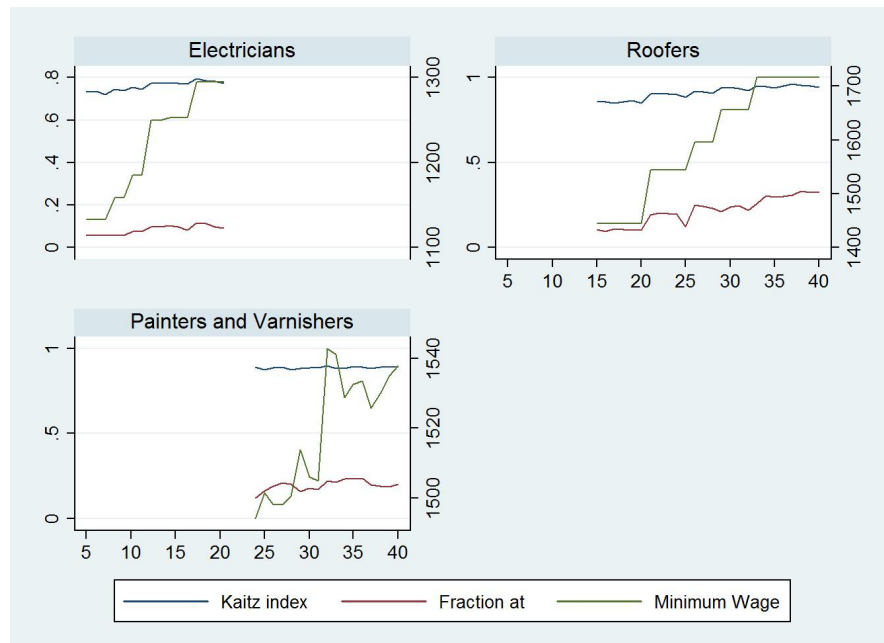
Source: BA employment panel (Schmucker and Seth, 2009). Author's calculations.

**Figure 3: Minimum Wage Indicators - Amount, Kaitz Index, Fraction at**

(a) Development in West Germany



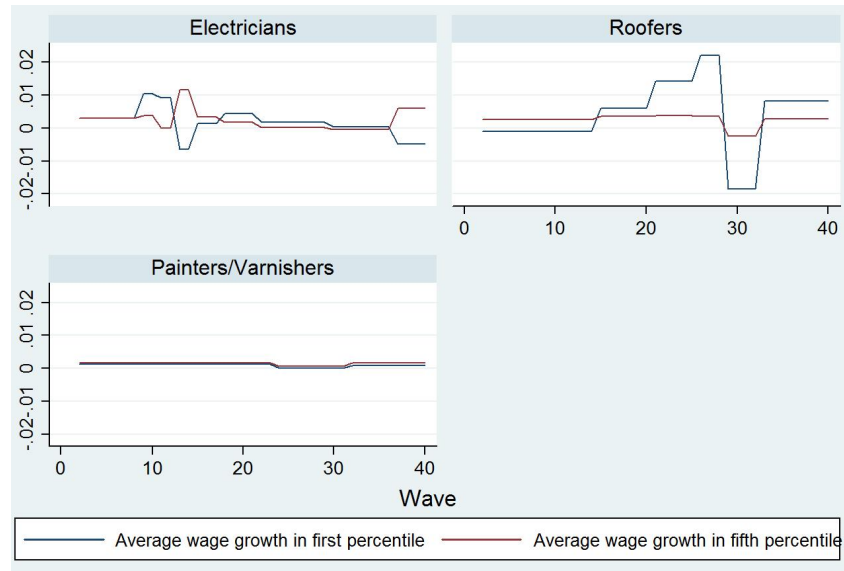
(b) Development in East Germany



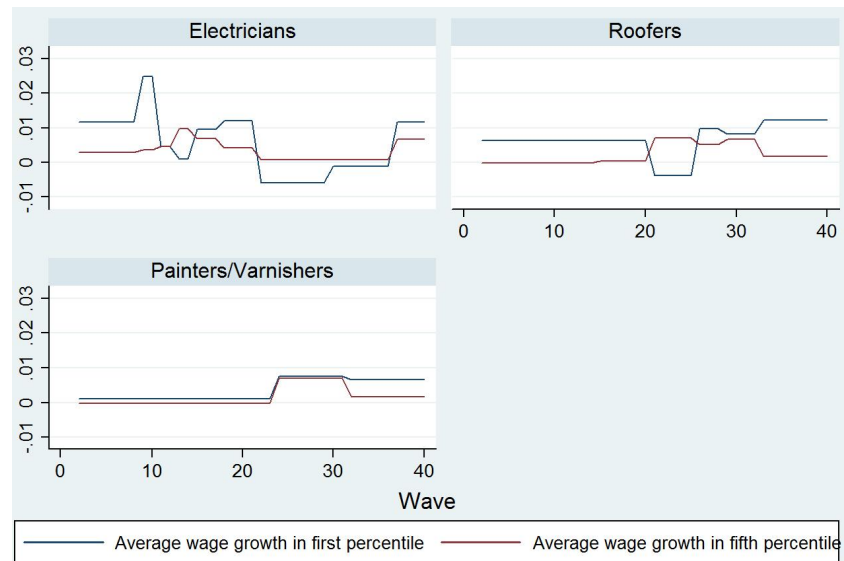
Source: Federal Bulletin (*Bundesanzeiger*). Author's calculations.

**Figure 4: Effect of Minimum Wages on Average Wage Growth**

(a) West Germany



(b) East Germany

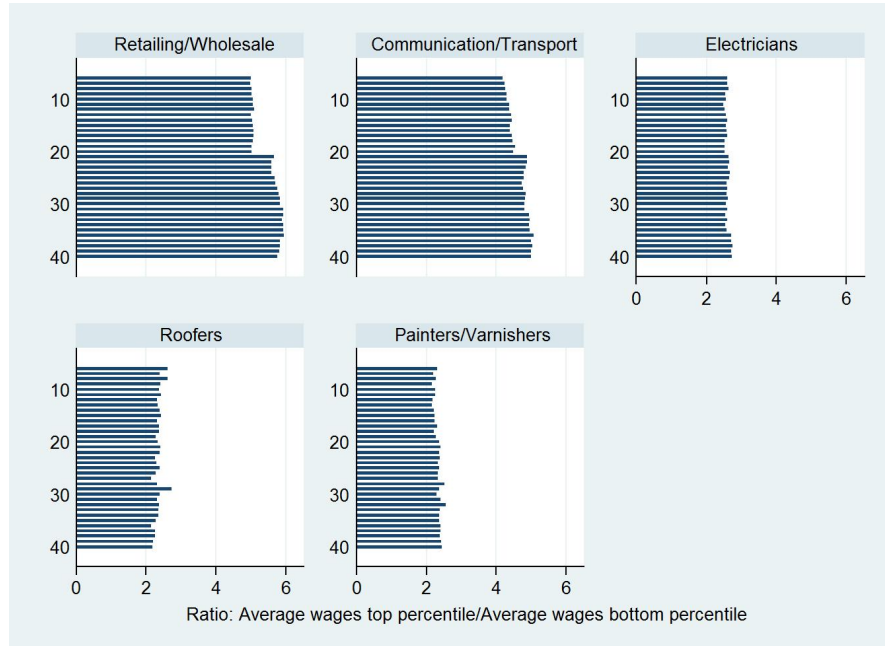


Growth rates of wages are averaged over time periods, in which no change in the minimum wage policy took place. Thus, the first change in the curves marks the minimum wage introduction, while all other changes can be attributed to increases in the minimum wage. The only exception are electricians, for which a minimum wage abolition took place in wave 21 and the minimum wage has been reintroduced in wave 37.

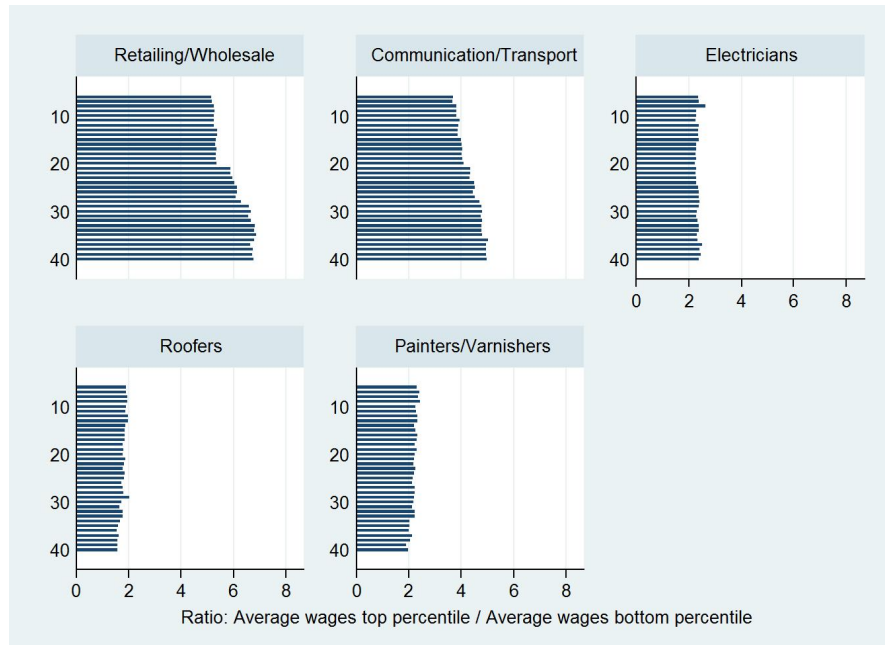
**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.

**Figure 5: Effect of Minimum Wages on the Wage Distribution**

(a) West Germany



(b) East Germany



**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.



**Table 1: Results of the Estimation of Model 1 and Model 2 - East Germany**

	Model 1 - Kaitz Index				Model 2 - Fraction at			
	Fixed Effects		FE with		Fixed Effects		FE with	
	Model		AR(1) errors		Model		AR(1) errors	
Kaitz index	-0.73	(2.20)	-0.45	(2.26)				
(Panel robust se)		(3.53)						
Fraction at					-0.095	(0.32)	-0.039	(0.33)
(Panel robust se)						(0.26)		
Average wages	-0.89	(0.99)	-1.19	(1.02)	-0.90	(0.90)	-1.23	(0.93)
(Panel robust se)		(1.01)				(0.86)		
Economic growth	0.76	(0.76)	0.77	(0.88)	0.84	(0.75)	0.84	(0.94)
(Panel robust se)		(0.51)				(0.48)		
Mini jobs	-0.28***	(0.029)	-0.28***	(0.029)	-0.27 ***	(0.028)	-0.26 ***	(0.029)
(Panel robust se)		** (0.051)				** (0.050)		
Kaitz*unskilled	-29.60	(42.0)	-27.70	(43.3)				
(Panel robust se)		(80.8)						
Kaitz*young	5.49	(6.75)	6.14	(6.86)				
(Panel robust se)		(8.35)						
Kaitz*small	1.18	(5.24)	0.46	(5.36)				
(Panel robust se)		(7.60)						
Fraction at*unskilled					1.60	(8.56)	0.19	(8.94)
(Panel robust se)						(5.91)		
Fraction at*young					-2.93	(1.76)	-2.60	(1.82)
(Panel robust se)						** (0.61)		
Fraction at*small					0.90	(0.58)	0.79	(0.61)
(Panel robust se)						(0.67)		
Trend	yes		yes		yes		yes	
Seasonal dummies <sup>1</sup>	yes***		yes***		yes***		yes**	
Heteroskedasticity? <sup>2</sup>	yes***				yes***			
Autocorrelation? <sup>3</sup>	yes**				no			
Baltagi Wu LBI <sup>4</sup>	2.26				2.37			
R(2)	0.634		0.633		0.656		0.648	
Observations	162		157		162		157	

Legend: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . FE model with panel robust SE preferred specification. Standard errors in brackets.

<sup>1</sup> Two dummies for the winter quarters and one dummy for the first summer quarter are included. The reported significance level refers to a test statistic for joint significance of the seasonal dummies.

<sup>2</sup> Significance level of Breusch-Pagan test for heteroskedasticity with the null hypothesis of constant variances.

<sup>3</sup> Significance levels of the Wooldridge test for autocorrelation in panel data.

<sup>4</sup> Test statistic for autocorrelation in the error term.

**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.

**Table 2: Results of the Estimation of Model 1 and Model 2 - West Germany**

	Model 1 - Kaitz Index				Model 2 - Fraction at			
	Fixed Effects		FE with		Fixed Effects		FE with	
	Model		AR(1) errors		Model		AR(1) errors	
Kaitz index	0.074	(0.70)	-0.0051	(0.70)				
Fraction at					-0.23	(0.35)	-0.22	(0.36)
Average wages	-3.77	***(0.48)	-3.73	***(0.48)	-3.81***	(0.49)	-3.73	***(0.49)
Economic growth	0.16	(0.38)	-0.025	(0.44)	0.14	(0.38)	-0.044	(0.45)
Mini jobs	-0.26	***(0.034)	-0.28	***(0.034)	-0.27***	(0.033)	-0.28	***(0.033)
Kaitz*unskilled	0.19	(0.88)	0.16	(0.88)				
Kaitz*young	0.031	(2.53)	0.23	(2.54)				
Kaitz*small	-0.17	(0.62)	-0.10	(0.62)				
Fraction at*unskilled					-0.25	(0.53)	-0.24	(0.53)
Fraction at*young					0.74	(0.97)	0.62	(0.98)
Fraction at*small					0.21	(0.38)	0.22	(0.39)
Trend	yes		yes		yes		yes	
Seasonal dummies <sup>1</sup>	yes***		yes***		yes***		yes***	
Heteroskedasticity? <sup>2</sup>	no				no			
Autocorrelation? <sup>3</sup>	yes**				yes**			
Baltagi Wu LBI <sup>4</sup>	2.34				2.37			
R(2)	0.700		0.705		0.700		0.703	
Observations	162		157		162		157	

Legend: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . FE model allowing for AR(1) SE preferred specification. Standard errors in brackets.

<sup>1</sup> Two dummies for the winter quarters and one dummy for the first summer quarter are included. The reported significance level refers to a test statistic for joint significance of the seasonal dummies.

<sup>2</sup> Significance level of Breusch-Pagan test for heteroskedasticity with the null hypothesis of constant variances.

<sup>3</sup> Significance levels of the Wooldridge test for autocorrelation in panel data.

<sup>4</sup> Test statistic for autocorrelation in the error term.

**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.

**Table 3: Dynamic Specifications - East Germany**

	Model 1 - Kaitz Index				Model 2 - Fraction at			
	Dynamic specification <sup>1</sup>		FE with AR(1) errors		Dynamic specification <sup>1</sup>		FE with AR(1) errors	
Kaitz index	-0.016	(2.73)	-0.45	(2.26)				
Fraction at					0.074	(0.15)	-0.039	(0.33)
Average wages	-1.06	(0.43)	-1.19	(1.02)	-1.07	(0.49)	-1.23	(0.93)
Economic growth	1.99*	(0.64)	0.77	(0.88)	2.15*	(0.66)	0.84	(0.94)
Mini jobs	-0.14*	(0.044)	-0.28***	(0.029)	-0.13*	(0.042)	-0.26***	(0.029)
Kaitz*unskilled	-18.9	(61.6)	-27.7	(43.3)				
Kaitz*young	5.91	(6.19)	6.14	(6.86)				
Kaitz*small	-0.64	(5.78)	0.46	(5.36)				
Fraction at*unskilled					5.23	(3.60)	0.19	(8.94)
Fraction at*young					-2.36*	(0.63)	-2.60	(1.82)
Fraction at*small					0.30	(0.42)	0.79	(0.61)
Employment (lag 1)	-0.43***	(0.023)			-0.43***	(0.026)		
Employment (lag 2)	-0.61***	(0.067)			-0.60***	(0.068)		
Employment (lag 3)	-0.35**	(0.044)			-0.38**	(0.045)		
Trend	yes		yes		yes		yes	
Seasonal dummies <sup>2</sup>	yes		yes***		yes		yes**	
Heteroskedasticity? <sup>3</sup>	yes***		yes***		yes***		yes***	
Autocorrelation? <sup>4</sup>	no		yes**		no		no	
Baltagi Wu LBI <sup>5</sup>	1.81		2.26		1.91		2.37	
R(2)	0.813		0.633		0.820		0.648	
Observations	152		157		152		157	

Legend: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . Dynamic FE model with panel robust SE preferred specification. Standard errors in brackets.

<sup>1</sup> Estimation with panel robust standard errors.

<sup>2</sup> Two dummies for the winter quarters and one dummy for the first summer quarter are included. The reported significance level refers to a test statistic for joint significance of the seasonal dummies.

<sup>3</sup> Significance level of Breusch-Pagan test for heteroskedasticity with the null hypothesis of constant variances.

<sup>4</sup> Significance levels of the Wooldridge test for autocorrelation in panel data.

<sup>5</sup> Test statistic for autocorrelation in the error term.

**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.

**Table 4: Dynamic Specifications - West Germany**

	Model 1 - Kaitz Index				Model 2 - Fraction at			
	Dynamic specification		FE with AR(1) errors		Dynamic specification		FE with AR(1) errors	
Kaitz index	0.0084	(0.44)	-0.0051	(0.70)				
Fraction at					-0.027	(0.22)	-0.22	(0.36)
Average wages	-0.41	(0.39)	-3.73***	(0.48)	-0.40	(0.40)	-3.73***	(0.49)
Economic growth	1.32***	(0.28)	-0.025	(0.44)	1.36***	(0.28)	-0.044	(0.45)
Mini jobs	-0.15***	(0.024)	-0.28***	(0.034)	-0.15***	(0.024)	-0.28***	(0.033)
Kaitz*unskilled	-0.33	(0.55)	0.16	(0.88)				
Kaitz*young	0.26	(1.58)	0.23	(2.54)				
Kaitz*small	-0.056	(0.39)	-0.10	(0.62)				
Fraction at*unskilled					-0.31	(0.34)	-0.24	(0.53)
Fraction at*young					0.11	(0.61)	0.62	(0.98)
Fraction at*small					0.052	(0.24)	0.22	(0.39)
Employment (lag 1)	-0.30***	(0.073)			-0.32***	(0.073)		
Employment (lag 2)	-0.73***	(0.051)			-0.74***	(0.051)		
Employment (lag 3)	-0.25***	(0.072)			-0.27***	(0.073)		
Trend	yes		yes		yes		yes	
Seasonal dummies <sup>2</sup>	yes		yes***		yes		yes***	
Heteroskedasticity? <sup>3</sup>	no		no		no		no	
Autocorrelation? <sup>4</sup>	no		yes**		no		yes**	
Baltagi Wu LBI <sup>5</sup>	1.89		2.34		1.93		2.37	
R(2)	0.891		0.705		0.892		0.703	
Observations	152		157		152		157	

Legend: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . Dynamic FE model preferred specification. Standard errors in brackets.

<sup>1</sup> Two dummies for the winter quarters and one dummy for the first summer quarter are included. The reported significance level refers to a test statistic for joint significance of the seasonal dummies.

<sup>2</sup> Significance level of Breusch-Pagan test for heteroskedasticity with the null hypothesis of constant variances.

<sup>3</sup> Significance levels of the Wooldridge test for autocorrelation in panel data.

<sup>4</sup> Test statistic for autocorrelation in the error term.

**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.

**Table 5: Seperate Employment Effect of Minimum Wage Increase and Introduction - East Germany**

	Joint Effect				Increase		Introduction	
	Kaitz		Fraction at		Kaitz		MW dummy	
Kaitz index	-0.73	(3.53)			-8.32	(7.93)		
Fraction at			-0.095	(0.26)			-0.025	(0.77)
Minimum wage (d)								0.023** (0.0037)
Average wages	-0.89	1.01	-0.90	(0.86)	-0.91	(1.07)	-1.60	(1.49) -1.50* (0.38)
Economic growth	0.76	(0.51)	0.84	(0.48)	1.40*	(0.44)	0.85*	(0.21) 0.41 (0.84)
Mini jobs	-0.28**	(0.051)	-0.27**	(0.050)	-0.35**	(0.041)	-0.33**	(0.039) -0.22*** (0.026)
Kaitz*unskilled	-29.60	(80.8)			-75.0	(182.4)		
Kaitz*young	5.49	(8.35)			31.9	(14.5)		
Kaitz*small	1.18	(7.60)			9.04	(16.8)		
Fraction at*unskilled			1.60	(5.91)			-16.2	(25.8)
Fraction at*young			-2.93**	(0.61)			-7.60***	(0.87)
Fraction at*small			0.90	(0.67)			2.70	(2.40)
Minimum wage*unskilled								-0.18 (0.069)
Minimum wage*young								0.49* (0.14)
Minimum wage*small								-0.58 (0.73)
Trend	yes		yes		yes		yes	
Seasonal dummies <sup>1</sup>	yes		yes		yes		yes	
Heteroskedasticity? <sup>2</sup>	yes***		yes***		yes***		yes***	
Autocorrelation? <sup>3</sup>	yes***		no		yes*		no	yes*
Baltagi Wu LBI <sup>4</sup>	2.26		2.37		2.28		2.47	2.14
R(2)	0.634		0.656		0.667		0.695	0.740
Observations	162		162		116		116	162

Legend: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . Standard errors in brackets. All models are estimated with panel robust standard errors.

<sup>1</sup> Two dummies for the winter quarters and one dummy for the first summer quarter are included. The reported significance level refers to a test statistic for joint significance of the seasonal dummies.

<sup>2</sup> Significance level of Breusch-Pagan test for heteroskedasticity with the null hypothesis of constant variances.

<sup>3</sup> Significance levels of the Wooldridge test for autocorrelation in panel data.

<sup>4</sup> Test statistic for autocorrelation in the error term.

**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.

**Table 6: Seperate Employment Effect of Minimum Wage Increase and Introduction - West Germany**

	Joint Effect <sup>1</sup>		Increase <sup>2</sup>		Introduction <sup>1</sup>	
	Kaitz	Fraction at	Kaitz	Fraction at	MW dummy	
Kaitz index	-0.0051	(0.70)	-34.5	(22.6)		
Fraction at		-0.22	(0.36)		-0.23	(0.40)
Minimum wage (d)					0.0015	(0.0098)
Average wages	-3.73***	(0.48)	-3.73***	(0.49)	-3.20	(1.49)
Economic growth	-0.025	(0.44)	-0.044	(0.45)	0.19	(0.23)
Mini jobs	-0.28***	(0.034)	-0.28***	(0.033)	-0.31*	(0.072)
					-0.34*	(0.087)
Kaitz*unskilled	0.16	(0.88)			-44.9	(24.3)
Kaitz*young	0.23	(2.54)			99.5	(41.3)
Kaitz*small	-0.10	(0.62)			35.9	(28.2)
Fraction at*unskilled		-0.24	(0.53)		-0.69	(0.64)
Fraction at*young		0.62	(0.98)		0.56	(0.90)
Fraction at*small		0.22	(0.39)		0.35	(0.51)
Minimum wage*unskilled					0.13	(0.10)
Minimum wage*young					0.36***	(0.055)
Minimum wage*small					0.025	(0.36)
Trend	yes	yes	yes	yes	yes	
Seasonal dummies <sup>1</sup>	yes***	yes***	yes	yes	yes***	
Heteroskedasticity? <sup>2</sup>	no	no	yes**	yes*	no	
Autocorrelation? <sup>3</sup>	yes**	yes**	yes*	yes*	yes*	
Baltagi Wu LBI <sup>4</sup>	2.34	2.37	2.22	2.25	2.34	
R(2)	0.705	0.703	0.765	0.727	0.780	
Observations	157	157	116	116	157	

Legend: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . Standard errors in brackets.

<sup>1</sup> Model is estimated with errors allowing for AR(1) disturbance.

<sup>2</sup> Model is estimated with panel robust standard errors.

<sup>3</sup> Two dummies for the winter quarters and one dummy for the first summer quarter are included. The reported significance level refers to a test statistic for joint significance of the seasonal dummies.

<sup>4</sup> Significance level of Breusch-Pagan test for heteroskedasticity with the null hypothesis of constant variances.

<sup>5</sup> Significance levels of the Wooldridge test for autocorrelation in panel data.

<sup>6</sup> Test statistic for autocorrelation in the error term.

**Source:** BA employment panel (Schmucker and Seth, 2009). Author's calculations.