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Abstract

In this study we investigate the minimum wage (MW) effects for a German sub-construction sector where the MW bites extraordinary hard by international standards. Within a quasi-experiment we estimate the Quantile Treatment Effects of the MW on the conditional and unconditional distribution of earnings. For Eastern Germany, the results indicate significant real (nominal) wage increases that ripple up to about the 0.6th quantile. However, the MW also led to declining real wages (stagnating nominal wages) among upper-decile workers, thus reducing the average pay reward for high-skilled labour in the sector. We provide evidence that a rising labour cost burden for firms together with an increased bargaining power of employers over workers still employed in the sector led to wage moderation at the upper decile, particularly among smaller East German firms. Overall this paper demonstrates how a MW geared towards the lower rank may render unexpected side effects for other workers located higher up in the wage distribution and who are mostly assumed to be unaffected by such policy interventions.

Keywords: unconditional quantile regression, minimum wages, wage effects, wage moderation, labour shortages

JEL: J31, J38, C21

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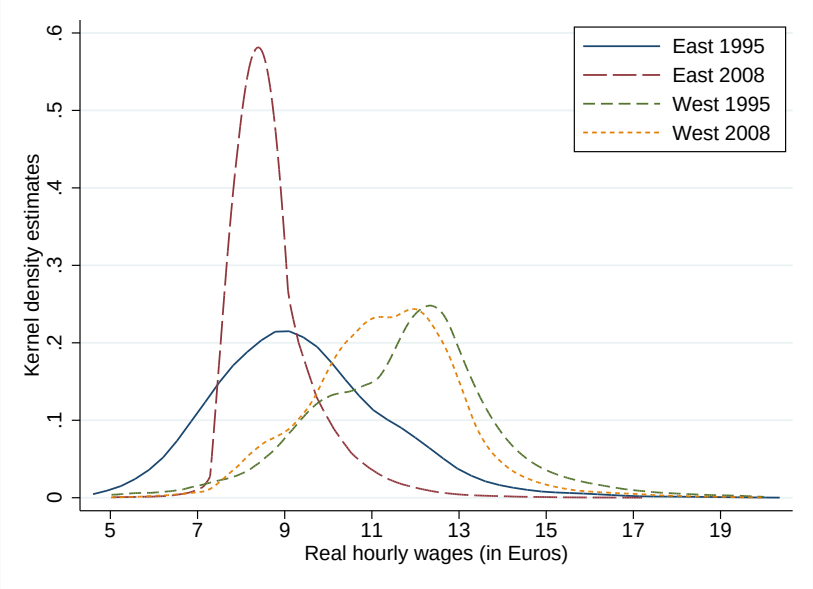
1 Introduction

The way a minimum wage (MW) affects the overall distribution of earnings still remains a contested research question. Most evaluation studies focus on whether the programme improved the outcomes of particular subgroups such as (treated) low-wage workers. Such approaches primarily assume upper-decile workers to be unaffected by the policy reform and in some cases even use these workers as a counterfactual for a Difference-in-Differences type evaluation. However, these findings might not be meaningful if unexpected distributional effects appear. In fact, existing studies on MW spillovers have stated that workers with earnings above the MW may be positively affected. According to this research, wage floors create a spike in the wage distribution at the MW and boost wages of workers who earn somewhat more than the threshold. Depending on the bite, the effects then ripple up to wages at about 20% above the MW level (Neumark and Wascher, 2008). The study by Manning (2003) finds that positive spillovers can reach up to about the median worker. The conventional explanations for these findings is that firms (1) substitute low-skilled with high-skilled labour as a reaction to the change in relative input prices (Pettengill, 1981), (2) adjust their wage structure to maintain an internal wage hierarchy and hence motivation and effort among their highly paid employees (Grossman, 1983) and that (3) firms that previously paid relatively high wages to attract workers must increase wages too in order to recruit enough new employees (Manning, 2003). All these mechanisms lead to an increasing demand and thus increasing wages for workers earning a wage above the MW.

Whereas these theories are well able to explain the phenomenon of positive wage spillovers, they do not by themselves provide a complete picture of distributional aspects of MWs. For instance, recent empirical studies for the German roofing sector find a strong wage compression not only at the lower but also at the upper tail of the wage distribution, thus suggesting negative wage spillovers on high-wage earners (Aretz et al., 2012, 2013). In particular, the descriptive findings suggest that workers in Eastern Germany with high earnings experienced deteriorating real wages in the aftermath of the policy reform (see Figure 1). Similar findings have been provided for the German main construction sector (Apel et al., 2012). It stands out to be tested, whether this effect is causally related to the MW or rather the result of other occurrences in the sectors. In this article we argue that in a competitive market that is facing a downward economic trend and an extraordinary and increasing MW bite, firms may start compensating increasing labour costs for MW workers with wage moderation among their highest paid employees. Such

Figure 1: Distribution of real hourly wages before and after the policy reform (LAK data)



Notes: The figure shows kernel density estimates of real hourly wages between 5 and 20 Euros based on a full sample of all roofers (see Section 4). Hourly wages are adjusted to prices in 1994. Bandwidths are set to 0.4.

wage policies become possible due to an increasing bargaining power of firms over upper-decile workers as a result of their deteriorating employment chances caused by a scale effect dominating the substitution effect. In particular, small firms that are price-takers on the market and face a less capital-intensive production technology may start exploiting such strategies to cope with the increasing labour cost burden.

The aim of this paper is to shed light on the MW effects on the distribution of earnings and wage inequality by exploiting the interesting case of the German roofing sector. For this we go beyond estimating average effects and rather focus on the heterogeneities along the wage distribution by using recent methods of quantile regression analysis. This will allow conclusions on whether the observed real wage compression in the sector is causally related to the MW policy or rather reflects an overall trend. Beyond the German case, the findings might yield important insights into possible unexpected distributional impacts of MWs (and institutions in general) on upper decile workers that have mostly been neglected in the literature so far.

This paper makes four contributions: First, we are able to study the MW effects in a context where the MW bites extraordinary hard: the roofing sector in Germany. Its MW was introduced in 1997 and was subsequently raised several times. With a Kaitz Index, i.e. the ratio of the MW level and the median wage, that is near 1 in East Germany, the bite has to be considered

exceptionally high, even by international standards (Machin et al., 2003; Dolton and Bondibene, 2011). The German roofing sector thus comprises an ideal setting to study wage effects along the entire wage distribution since its bite is likely to have indirect effects on workers for whom the MW is non-binding (i.e. who have a wage above the minimum wage level). Second, we are able to exploit a quasi-experiment since, for institutional reasons, the MW was introduced only in parts of the construction sector, one of which was the roofing sector. The wage distribution of uncovered, yet comparable, sub-sectors may thus serve as a counterfactual for the earnings of roofers in the absence of the policy reform. Third, we apply an unconditional quantile regression approach recently developed by Firpo et al. (2009) that allows to investigate Quantile Treatment Effects (QTE) on the distribution of earnings. In particular, the method enables us to study the effect of the policy reform on the overall (unconditional) distribution of wages, while keeping other factors constant. To yield further insights into whether a between or within-group effect is able to explain the overall wage compression effect, we further contrast unconditional with traditional conditional quantile regression methods as proposed by Koenker and Bassett (1978) and Koenker (2005). As a final contribution, we are able to exploit two rich administrative data sets for the analysis, one of which contains a full sample of all roofers including detailed information on hours worked and the other containing a rich set of worker and firm characteristics for the treated and several untreated control sectors.

Overall, we find that the mean impact of the MW seems to miss a lot. In particular, our results suggest significant real wage increases of about 12% for lower-decile workers that ripple up to the 0.6th quantile in Eastern Germany, whereas the weaker wage effects in Western Germany (5% at the lower tail) pillar up to about the median worker. However, the estimates also reveal some unexpected side effects of the reform. According to the estimates, the MW caused a reduction in real wages by up to 5% in Eastern Germany (stagnation of nominal wages) for the highest quantiles that mostly comprise skilled and experienced workers. The wage compression effect thereby not only reflects lower entry wages, but rather indicates wage restraints among upper quantile workers, particularly within smaller firms. Contrasting conditional with unconditional quantiles further reveals that the overall wage-compression effect is solely driven by a reduction in upper tail between-group inequality, thus suggesting deteriorating returns to observable skills in the sector. The findings might explain the recent labour shortages as reported by sector insiders in separate expert interviews and/or the increase in sole-traders as reported by Kraft et al. (2012).

The structure of the paper is as follows. In Section 2, we give a short literature review on recent studies dealing with MW spillovers. Section 3 describes the German roofing sector and discusses potential control groups for a quasi-experiment. In Sections 4 we discuss the data base before providing descriptive evidence on the MW bite as well as on wage developments by quantile in Section 5. In Section 6, we discuss the estimation approach and provide both conditional and unconditional quantile regression estimates of the MW effect on the earnings distribution. Finally, Section 7 concludes.

2 Literature on Minimum Wage Spillovers

There are several studies that discuss how a MW affects the earnings of workers higher up in the wage distribution. Overall, the existing empirical studies suggest that MWs create a spike and boost wages for workers who earn somewhat more than the MW. The effects then fade out higher up the wage distribution, depending on the bite. Theoretically, the literature offers several explanations for these findings.

First, firms may substitute unskilled with high-skilled labour as a reaction to the change in relative input prices as suggested by Pettengill (1981). In turn, the demand for higher skilled services and therefore wages of high-skilled workers increases. The substitutability thereby decreases, the further away workers are in the skill distribution. The underlying idea is that high-skilled workers cost a lot more than low-skilled workers, but are only marginally more productive in tasks otherwise performed by low-skilled labour. Spillover effects should therefore be stronger for workers earning a wage just above the MW (and who are close substitutes), whereas workers further up the wage distribution should be unaffected.

A second mechanism has been put forward by Grossman (1983) who argues that firms adjust their wage structure to maintain an internal wage hierarchy as a result of the wage floor. In particular, they raise wages of workers earning above the MW in order to keep up their incentive schemes and maintain motivation and effort. The model leads to the same predictions as in Pettengill (1981). Empirically, Grossman (1983) looks at the wage effects of subsequent increases in the US federal MW for workers in different occupations. She finds significant positive wage effects in the short run not only for low-paid occupations, but also for occupations that pay slightly more than the MW. The effects in the long-run are less clear in her study.

As a third explanation, Manning (2003) argues that firms that previously paid relatively high

wages to attract workers must also increase wages in order to recruit enough new employees. According to his model, the effects are strongest for firms that pay just above the MW, hence spillovers will again be strongest for earnings just above the MW. For their empirical analysis, the author extends the model by Lee (1999) to include a spillover parameter for each decile. The size of the spillover effect thereby depends on the gap between the wage at a certain decile and the MW. The model predicts that the spillover effect is largest for those just affected by the MW and declines as one moves away from these wages. To identify the spillover parameter, he compares a latent and observed wage distribution. The estimates show that the maximum spillover effect is 11% for workers whose wages are near the MW. The effect then declines as one moves up the distribution and fades out at about the median wage.

An alternative explanation put forward by Falk et al. (2006) is that positive MW spillovers may reflect firms reactions to changes in the workers reservation wages and fairness perceptions. In their laboratory experiment, 91% of the workers reported reservation wages that were below the MW, whereas 59% (41%) reported an equal (higher) reservation wage after the introduction. The authors argue that workers become used to receiving a relatively high wage and develop claims such that workers think they have a right to receive higher wages and are willing to defend them. Spillover effects then arise because reservation wages of higher skilled workers depend on the actual wages of unskilled workers who earn more after a MW increase.

Finally, there is a further study that stresses the importance of wage-setting institutions in this context. For instance, Rattenhuber (2014) investigates the distributional impacts of MWs in the German construction sector and thereby distinguishes between different bargaining regimes. In particular, she finds that wage spillovers were relatively large for middle rank workers under a collective agreement compared to individually bargained contracts which, in turn, helped keep the gap to wages of the lowest paid workers stable. In line with this argument, one could argue that a moderate wage policy of unions, for instance in an economic downturn phase, might lead to a wage moderation also among higher-wage workers.

All studies discussed sofar suggest upper-decile wages to be unaffected or may even benefit if the spillovers reach far enough up the wage distribution. However, as Neumark et al. (2004) suggest, a MW may also deteriorate wages of the upper wage deciles. In particular, the authors estimate the MW effects along the entire wage distribution, distinguishing between short- and long term effects (i.e. allowing for lagged effects). The authors compare workers in US states in which the MW was raised to workers in control states where the MW stayed unchanged.

The authors find elasticities of about 0.8 in the short run for worker groups earning slightly more than the MW. The elasticities are smaller for higher wage groups, but still amount to 0.15 for workers that earn between 1.5 and 2 times the MW. In the long run, the effects are much weaker and even become negative for high-wage earners. According to the authors, the finding might be driven by the scale effect resulting from higher overall labour costs that outweighs the substitution effect. The reasoning is as follows. In a simple neoclassical setting with two labour inputs, the scale effect implies a lower use of all inputs, which puts downward pressure on the demand for skilled labour (see also Neumark and Washer, 2008). On the other hand, the substitution effect implies a shift towards high-skilled labour as a reaction to the chance in relative input prices, as long as the two inputs are perfect substitutes. If however, higher costs cannot be forwarded to consumers by increasing prices or if skilled and unskilled workers are complements, the scale effect might outweigh the substitution effect, thus resulting in a lower demand for skilled labour.

This mechanism might be explaining the deteriorating employment effects among skilled workers in the German roofing sector as suggested by Aretz et al. (2013). The author investigate the employment chances of roofers along the wage distribution by comparing roofers with counterfactual outcomes of plumbers in a control group design. The authors find deteriorating employment perspectives for upper-decile workers in the sector, arguing similar to Neumark et al. (2004), that the scale effect resulting from higher overall labour costs outweighs the substitution effect. As an alternative explanation, the authors argue that the MW induced some capital-labour substitution, assuming that it did not change the relative demand for skilled and unskilled labour much. Interviews conducted with sector insiders suggest that new roofing systems provided roofing firms with possibilities to reduce MW induced labour costs in all skill-groups. In both cases the reduction in demand for higher-skilled workers might have put pressure on the salaries of these workers and thus decreased the returns to skills in the sector. The authors however did not investigate the implications for pay rewards, as their main focus was on employment effects.

3 The German Roofing Sector

3.1 Market structure

The roofing sector is a sub-sector of the construction sector and constitutes a traditional craft that provides services including the installation of roofs on new buildings for public and private clients, repairing of roofs including energy-efficient upgrading and the installation of solar collectors. Compared to other sectors it is very capital intensive, labour costs amount to about 40% of total costs. Most firms operating on this market are relatively small and offer their services locally, thus facing a limited number of competitors[1]. There are only a few large firms with more than 100 employees that specialize in public contracts and that offer their services on a more competitive national market. A more recent trend in the sector is the increasing number of self-employed suppliers. Compared to other sectors, the craft is highly regulated as reflected by the master craftsman's diploma that is required for offering services on the market. Moreover, with a share of craftmens and skilled workers of around 70%, roofing companies operate with a relatively skilled staff. Possibilities for substituting roofing services are rather limited on this market, since they require specific skills and equipment. With competition rather driven by quality than prices, the demand for roofing services can be considered as rather inelastic.[2] Also noteworthy, according to sector insiders, technical advances such as new techniques for simplified installation and laying are very important in the roofing sector, although this is presumably mainly true for larger firms.

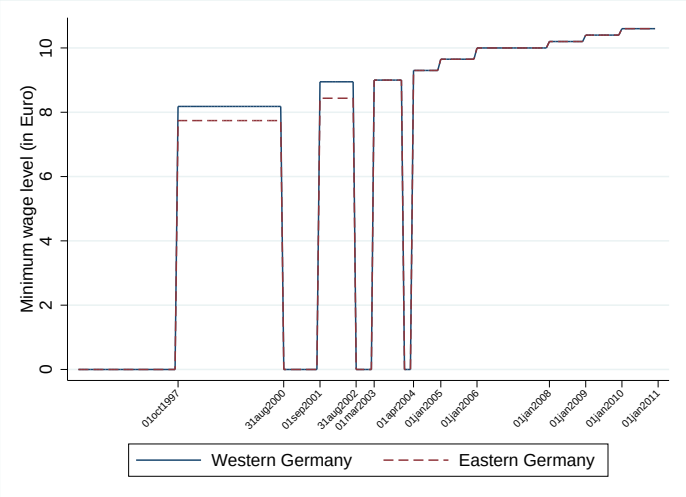
3.2 Minimum wage regulations

The MW in the German roofing sector was introduced in October 1997 within the Posted Workers Act (Arbeitnehmer-Entsendegesetz). The reason for the new regulation was the European agreement on the free movement of labour that allows Eastern European firms to send workers to construction sites in other member states while paying home country wages. In order to protect the traditional craft in Germany against the increasing cost pressure from cheap Eastern European labour, the responsible trade union (Trade Union for Building-Agriculture-Environment, IG BAU) and the association of employers (National Association of Roofers, ZVDH) agreed as

[1] According to interviews, firms in the roofing sector face on average 11 competitors in their local market (Aretz et al., 2011)

[2] Based on interviews with 250 roofers, 55 (33) East (West) German roofing firms declared price increases as their preferred strategy to account for MW induced cost increases.

Figure 2: Minimum wage level in the German roofing sector



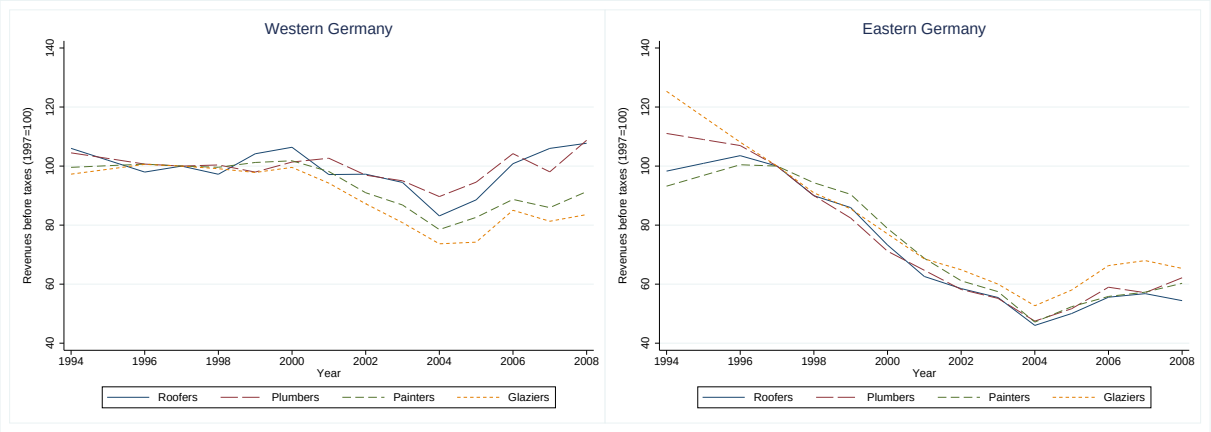
part of a general collective bargaining agreement on a MW of 8.2 Euros in Western and 7.7 Euros in Eastern Germany. However, since tariff agreements are negotiated on a sectoral level in Germany, not all sub-sectors implemented a MW. This provides us with the opportunity to compare quite similar sectors within a quasi-experiment. Workers in the roofing sector covered by the MW regulations comprise all blue-collar workers including minor employment. Apprentices, cleaning staff and white-collar workers are exempted from the regulations. Since 1997, the MW has been raised subsequently (compare Figure 2). The strongest increase thereby occurred in March 2003 for Eastern Germany, where the trade unions and employers agreed on a national MW of 9 Euros. Periods with no MW regulations are the result of tariff agreements that expired before the new regulations came into force. The interruptions were however so short, and the continuation of the MW expected, so that downward wage adjustment during this period are unlikely.

3.3 Business cycle trends and potential control sectors

The MW regulations were introduced in a period were the entire construction sector faced a severe and long-lasting downward trend in the aftermath of the boom period in the early 90s. The depicted revenues in Figure 3 show that the roofing sector as well as other comparable (uncovered) sub-sectors including plumbers, glaziers and painters experienced a similar slowdown.[3] Decreasing investments in housing and industrial buildings resulted in decreasing sales and revenues that led firms to increasingly lay off workers, especially in Eastern Germany. In fact,

[3]Note that, although available in the data, we dropped structural engineers since they experienced a somewhat diverging overall trend compared to the other sectors.

Figure 3: Development of revenues for roofers and selected control sectors



Notes: Revenues are taken from the German sales-tax statistics provided by the Federal Statistical Office.

the number of employed blue-collar workers subject to social security contributions decreased from 70,000 to 40,000 between 1994 and 2004 (see Appendix A.1). After 2004, the construction sectors almost fully recovered in Western Germany, while the recovery in Eastern Germany was rather marginal. The rising importance of energy-efficient upgrading thereby helped roofing, glazier and plumber firms to fill order books again. Moreover, roofers and plumbers further profited from increasing businesses with the installation of solar panels and solar energy driven heating systems.

There are two points worth mentioning here. First, options for roofers to find a better local employment in one of the closely related sub-sectors is very unlikely in Eastern Germany. This may also explain why we find only few job transitions between the sectors (see Section 6). Second, it is very unlikely that roofers took advantage of the more stable West German economy, due to the low degree of residential mobility of these workers.

Since the MW regulations were only implemented in parts of the construction sector (including the roofing sector), we are able to exploit the development of other uncovered sub-sectors as potential control groups to mimic the counterfactual development in the roofing sector. To see how comparable the other sub-sectors are with respect to their market structure, Table 1 shows some important market indicators for these sub-sectors. We contrast the figures of the selected industries to those of roofers for the year before the policy reform in order to test whether they might provide a potential control sector for a quasi-experiment. Overall, the comparison shows a very similar market size between roofers and plumbers in terms of firm counts and revenues. In fact, the number of companies per 1 million sector revenues, as a measure of competition, is identical. Also, value added, investments per employee as well as labour cost shares of roofing

Table 1: Various economic indicators for roofers and selected control sectors

	Roofers (1)	Plumbers (2)	Glaziers (3)	Painters (4)	Source (5)
Number of firms	10,960	13,860	3,307	8,392	A, 1996
Number of employees	87,175	94,028	16,067	51,997	A, 1996
Avg. number of employees per company	18.3	29.6	16.0	27.4	A, 1996
share of firms by revenues (in 1,000):					B, 1996
$<$ 100 DM	6.8	8.8	13.6	18.2	
100-500 DM	24.6	33.7	42.6	49,0	
500-1,000 DM	26.1	23.5	21.5	18,0	
1,000-2,000 DM	25.1	19.3	13.5	9.4	
$>$ 2,000 DM	17.4	14.6	8.5	5.4	
value added in € per employee	37,195	35,949	32,931	32,931	C, 2001
investments/employee (in €)	1,472	1,229	2,482	1,057	D, 2001/2002
share of labour costs (in %)	38.5	34.2	49.3	49.3	C, 2001
avg. gross daily wage/fulltime employee (in €)	66.2	68.6	66.3	67.9	A, 1996
number of companies/1 Mio. sector revenue	1.5	1.5	2.2	3	B, 1996
share of covered blue-collar workers: (in %)					A, 1996
unskilled	29.2	11.1	19.3	12.3	
skilled	66.5	83.1	73.6	82.9	
master craftmens	3.7	5	6.1	4.1	
part-time workers	0.3	0.5	0.7	0.4	

Notes: A - BA data projected to 100%; B - German sales-tax statistics of the German Federal Statistical Office (Umsatzsteuerstatistik); C - Cost Structure Survey of the German Federal Statistical (Kostenstrukturerhebung) for firms with 20-49 employees; figures for painters and glaziers are aggregated; D - Business and investment survey in the construction sector (Unternehmens- und Investitionserhebung im Baugewerbe)

companies is more closely related to plumbing firms compared to other sectors. We thus use plumbers as a suitable control group for a Difference-in-Differences analysis (see Section 6).

4 Administrative Linked Employer-Employee Data

For the analysis we are able to exploit two administrative data sets including a full sample of all roofers provided by the Central Pay Office (Landesausgleichskasse, LAK) as well as large subsamples of all roofers, plumbers, glaziers and painters subject to social security contributions available from the Federal Labour Agency (Bundesagentur für Arbeit, BA). Both data sources are discussed in detail below.

4.1 LAK Data

The LAK is a public service institution of the employer association ZVDH and the trade union IG Bau in Germany. The main objective is to help insure employees against several structural disadvantages of the sector. For instance, the agency compensates roofers for earnings losses caused by bad weather, ensures a thirteenth monthly income, administrates working-time accounts and old age benefits and promotes vocational education in the sector. For these purposes,

the office collects monthly information from firms on the number of actual working hours for each worker as well as their gross wages and the length of their current employment from the year 1995 onwards. Since the reporting is mandatory for firms, and may impose a penalty for non-compliance, the information is highly likely to comprise all blue-collar roofers. The information is complemented with further worker characteristics including the date of birth and sex of workers as well as an establishment identifier to calculate further firm-level characteristics. Since the data does not comprise information on education and training, we drop workers below 19 years of age that should eliminate most apprentices that are not covered by the MW regulations. Furthermore, we focus on men only, since female workers account for only a small fraction in this sector (less than 2%). Moreover, we drop observations where workers are reported to be sick, on vacation, serving in the military, and those with missing and unrealistically high (or low) wages and drop minor employment. Finally, we focus on monthly observations in June to make the data comparable to the BA data and to avoid distortions due to seasonal fluctuations during the months October to April where compensation payments by the LAK are more relevant. In total, we are able to exploit 1,055,137 June observations for 206,753 roofers across the period 1995-2010. Note that most descriptives in the following analysis are based on this very precise data set. However, the main disadvantage of the LAK data is that it is only available for the roofing sector, thus precluding the possibility of an inter-sectoral comparison. Furthermore, information on the education level and skills of workers is missing. For this reason, we exploit another data set discussed below.

4.2 BA Data

As a second data source we use Linked Employer-Employee Data from the Institute for Employment Research (IAB) that matches representative annual establishment survey data from the IAB Establishment Panel with personal data generated in labour administration and social security data processing. In particular, we use subsamples of roofers (75%), plumbers (30%), glaziers (75%) and painters (25%) subject to social security contributions by their employers. The data includes individual employment histories for these workers on a daily basis including several worker characteristics such as the age, sex, occupational status, gross daily wages and education of workers. The firm-level information comprises information on the workforce structure including the number of workers in certain educational groups. For the analysis, we use annual cross sections at the cut-off date June 30th. Similar to the LAK data we focus on male

workers above 19 years of age and drop minor employment. As an advantage of the data set, we are able to identify and drop apprentices and white-collar workers that are not covered by the MW regulations. In total, the data set comprises 788,665 yearly observations for 171,194 roofers as well as 1,522,014 observations for 340,095 workers from uncovered control sectors for the time period 1994-2008. The main disadvantage of the BA data set is the lack of hourly wages. We thus use daily wages for our inter-sectoral comparisons. In order to compare the LAK and BA data set we further impute the wages of roofers from the LAK to the BA data to get a probabilistic MW affectiveness measure. In short, we regress hourly wages in the LAK on a set of covariates that are included in both data sets. Based on the coefficients we then estimate hourly wages in the BA data set taking into account the imprecision of the estimates. Overall the imputation procedure performs quite well as shown in Appendix A.2. Note that we use the imputed wages for the descriptive analysis only.

5 Minimum Wage Bite and the Development of Wages

Table 2 shows several indicators of the MW bite in June preceding the new regulations within the next year for both workers with a binding and non-binding MW. A MW is thereby defined as binding if the salary of a worker exceeds the upcoming threshold. The worker is then said to be (directly) affected. Columns (1) and (2) show the fraction of affected workers in the LAK and BA data. In order to get a first impression of how the policy reform affected earnings, Column (3) displays the individual wage gap, which we contrast to actual wage growth of binding and non-binding workers in Columns (4)-(5). The individual wage gap tells us how much wages should have increased, on average, if firms had fully complied with the new regulations. For an international comparison, Column (6) further provides the Kaitz-index that is defined as the ratio between the MW level and the median wage in the sector. Note that the indicators may slightly underestimate the bite due to the fact that hourly wages may contain overtime compensation that is not subject to the MW.[4]

The indicators show large differences between Eastern and Western Germany. For Western Germany, the descriptives show a relatively low bite. Starting with 3.8% in 1997, the share of workers with a binding MW increased moderately to 5.2% in the course of the 2008 MW hike,

[4]Overtime hours account for 6% of the working hours in June. This may lead to an estimated hourly wage that is up to 1.6% too high depending on the applied overtime compensation scheme ranging from no additional compensation to a markup of 25%. Since we do not know which scheme is applied and since the resulting imprecision appears to be rather marginal, we left the data uncorrected.

Table 2: Indicators of the minimum wage bite measured in June prior to the next minimum wage regulations (LAK and BA data)

		Workers with a binding minimum wage?					
		Yes				No	
New MW regulation takes effect on	MW (in Euro)	Share (in %) LAK (1)	Share (in %) BA[a] (2)	Wage gap[b] (in %) LAK (3)	Δ Wage[c] (in %) LAK (4)	Δ Wage[c] (in %) LAK (5)	Kaitz Index LAK (6)
Western Germany							
01.10.97	8.2	3.8	1.4	16.9	3.6	2.3	65
01.09.01	8.9	1.5	2.5	9.6	7.0	1.5	67
01.03.03	9.0	1.5	2.6	10.0	5.6	2.5	67
01.04.04	9.3	2.1	3.1	9.3	5.9	1.5	68
01.05.05	9.6	2.7	4.3	8.6	4.7	0.7	70
01.01.06	10.0	4.1	5.9	7.8	5.0	1.2	73
01.01.07	10.0	4.4	6.3	8.2	7.0	3.3	73
01.01.08	10.2	5.2	7.1	6.9	5.6	2.3	73
01.01.09	10.4	4.6	7.1	6.5	8.1	3.1	73
Eastern Germany							
01.10.97	7.7	13.4	8.6	12.2	6.7	-0.1	82
01.09.01	8.4	14.0	16.8	4.1	4.7	0.7	89
01.03.03	9.0	33.9	28.6	4.3	4.2	0.2	95
01.04.04	9.3	43.8	34.1	3.9	4.2	0.4	98
01.05.05	9.6	46.7	41.4	4.3	4.0	0.2	99
01.01.06	10.0	55.3	49.1	4.1	4.1	0.2	100
01.01.07	10.0	45.0	47.3	1.6	1.9	1.0	100
01.01.08	10.2	53.2	48.9	2.7	3.3	1.4	101
01.01.09	10.4	49.8	51.2	2.4	3.3	0.7	100

[a] The share is based on imputed hourly wages (see Section 4.2). The values thus reflect the probability of an individual to earn a wage below the new MW level.
[b] The individual wage gap is calculated as follows $wgap_{it} = (MW_{i,t+1} - w_{it})/w_{it}$.
[c] Δ wage corresponds to the actual observed percentage nominal wage change $(w_{it+1} - w_{it})/w_{it}$ between the June preceding and the June following the new MW regulation.

before dropping again slightly in the year after. The results based on the BA data perform quite similarly, showing that the imputation procedure works quite well. According to the Kaitz-Index, the bite in West Germany lies in the range of what has been found for other countries. For instance, Dolton and Bondibene (2011) compare the MW bite across 22 OECD countries and find rates between 30% and 70%. Looking at the figures for wage growth among West German workers reveals only partial compliance with the MW regulations, although improving slightly at the end of the observation period. The latter might be explained by stronger controls after 2006 that have been reported by sector insiders (Aretz et al., 2012). Despite the lack of compliance, the figures for nominal wage growth range between 3.6% and 8.1% for affected workers, whereas the salaries of non-affected workers increased only moderately by 0.7-3.3%.

The findings for the Eastern part of the country look quite different. According to Column (1), already 13.4% of all roofers earned a wage below the 1997 wage floor. The share then increased rapidly to 34% in 2002, a few months before the national MW level was introduced. In June 2005, more than half of the workers had a wage below the 2006 MW level. In fact, the Kaitz-Index approached the value of 100, that is the median wage meanwhile equals the MW. Compared to the findings of Machin et al. (2003) for a strongly affected low-wage sector in the UK, the bite in the German roofing sector seems extraordinary hard. The mere size of affected workers in Eastern Germany also made misuse of the MW regulations harder which is reflected by the higher compliance observed. More strikingly, East German workers with salaries above the wage floor experienced almost no nominal wage growth. Even in the recovery period wages increased only moderately in nominal terms. The descriptive evidence thus suggests pronounced pay restraints in this part of the country and which happened during a severe downward trend in the sector (see Section 3.3). As a result of this wage moderation, workers experienced deteriorating real wages resulting in a strong wage compression at the upper tail of the real hourly wage distribution in Eastern Germany (see Figure 1).

To get some insights into how large (or small) the wage changes were and which type of workers profited (lost), Table 3 displays average yearly wage changes and other worker characteristics for selected wage quantiles. According to the figures, West German roofers in all quantiles experienced real daily wage losses between 0.3-0.5%. The picture for East Germany reveals a much more heterogenous pattern across quantiles. Whereas workers in the lowest quantile experienced real daily wage increases by 0.5%, corresponding wages for the highest paid workers decreased by 1.6% on average. Table 3 gives some indication that those workers with earnings losses in the upper tail mainly comprise skilled and more experienced workers in larger firms with higher educational degrees. The mapping of skills and wages is even more pronounced in the more unequal West German distribution. Overall, the findings hint at stagnating salaries for higher skilled labour in the sector. The decreasing pay rewards for skilled labour are thereby not only driven by new roofers entering the labour market with lower entry wages, but rather reflect pay restraints among higher skilled workers that have been working in the roofing sector and for the same firm ever since.[5] Also, except for the lowest reported quantile, there was not much adjustment in terms of working hours, despite the normal business cycle fluctuations (see Appendix

[5]For this, we restricted the data to all roofers that we observe across the entire 16-year time period (thus comprising a balanced panel) and who worked for the same firm. The descriptive findings were similar.

Table 3: Worker characteristics for certain quantiles of the real daily wage distribution (BA-data)

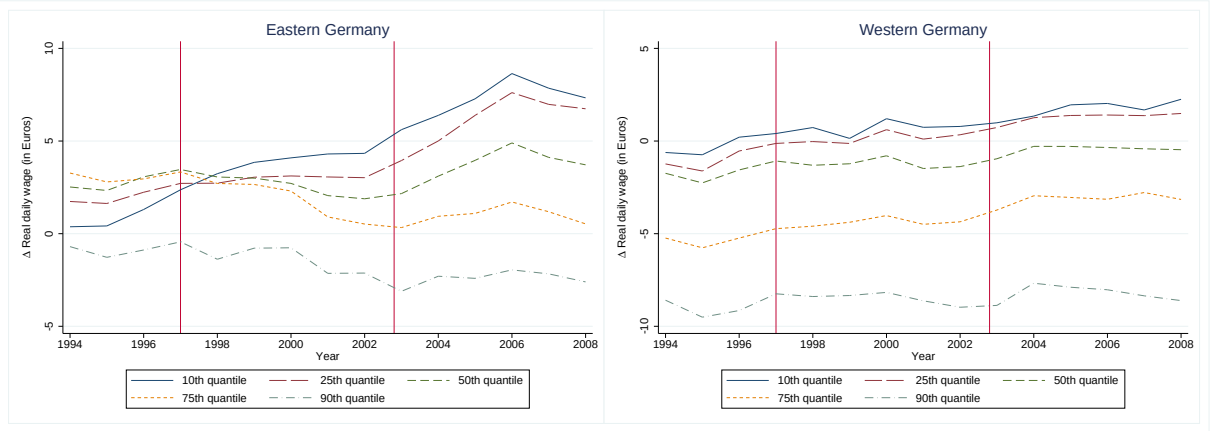
	Quantile				
	$\tau = 0.1$	$\tau = 0.25$	$\tau = 0.5$	$\tau = 0.75$	$\tau = 0.9$
Western Germany					
real daily wage (in Euro)	52.8	61.0	68.7	74.8	81.4
yearly growth of real daily wages (in %)	-0.5	-0.3	-0.4	-0.3	-0.5
nominal daily wage (in Euro)	58.5	67.6	76.1	82.9	90.2
yearly growth of nominal daily wages (in %)	1.0	1.3	1.2	1.2	1.0
share of unskilled workers (non-technicians)	59.0	47.0	28.6	18.1	17.5
share of skilled workers (technicians)	39.2	52.0	70.4	80.2	76.5
share of master craftmen	1.1	0.8	0.9	1.6	5.9
without vocational traning degree	43.4	35.2	20.6	13.6	13.6
with vocational traning degree	56.5	64.6	79.3	86.3	86.1
with university degree	0.1	0.2	0.1	0.1	0.3
tenure in sector (in days)	783	1,114	1,521	1,863	1,963
average workforce age	32.2	33.3	36.2	38.8	40.9
average firm size	11.5	11.8	12.1	12.9	16.0
number of workers	353.7	353.9	353.9	353.8	353.7
Eastern Germany					
real daily wage (in Euro)	42.4	46.2	50.4	56.3	63.4
yearly growth of real daily wages (in %)	0.5	-0.1	-0.8	-1.3	-1.6
nominal daily wage (in Euro)	47.1	51.2	55.8	62.2	70.0
yearly growth of nominal daily wages (in %)	2.0	1.5	0.8	0.2	-0.0
share of unskilled workers (non-technicians)	27.2	22.4	18.2	14.4	15.1
share of skilled workers (technicians)	71.3	76.7	81.0	83.8	80.5
share of master craftmen	0.7	0.6	0.6	1.7	4.1
without vocational traning degree	9.2	6.0	5.7	5.1	5.5
with vocational traning degree	90.8	93.9	94.2	94.7	94.3
with university degree	0.1	0.1	0.1	0.2	0.3
tenure in sector (in days)	853	1,042	1,169	1,499	1,711
average workforce age	33.7	34.1	35.3	37.5	38.2
average firm size	13.0	13.6	14.2	16.2	18.4
number of workers	172.1	172.1	172.3	172.3	172.0

Notes: All figures shown in the table reflect average yearly values. Real wages are inflation-adjusted to prices in 1994.

A.4). Of course, we can not completely rule out other compensation schemes.

There might be different forces driving the observed wage compression other than the MW. First, it may simply reflect an overall trend in the sector. Second, the composition of workers may have changed. Whereas the latter can only be investigated by means of a regression analysis, the first can be explored descriptively by an inter-sectoral comparison. To provide some evidence in this regard, we use the wage developments of plumbers as a counterfactual for roofers in the absence of the policy reform. Figure 4 shows the inter-sectoral real wage differential between roofers and plumbers over time by quantiles. The panels show that, except for the lowest earning group, wages developed quite similar between both sectors in the pre-reform period. In contrast, whereas wages of roofers in the upper quantiles decreased compared to plumbers in the post-

Figure 4: Development of roofers real daily wages relative to plumbers (BA data)



Notes: The vertical lines represent the introduction of the MW in October 1997 and the national MW in March 2003. A positive sign reflects a higher daily wage for roofers compared to plumbers. Wages are inflation-adjusted to prices in 1994.

reform period, low wage workers clearly improved in terms of daily labour income. The fact that the 10th quantile shows some anticipation behaviour will be one reason why we later conduct several placebo tests. For Western Germany, the inter-sectoral comparison reveals only marginal changes.

The decreasing pay rewards for high-skilled roofers compared to plumbers in Eastern Germany might be the result of a lower demand for these workers as suggested by (Aretz et al., 2013). The authors argue in favour of the scale effect driven by higher overall labour costs that dominate the substitution effect or some capital-labour substitutions (see Section 2). To test for the relevance of an increased cost burden due to the MW, Table 4 shows the size and change in firms' labour costs for binding and non-binding employees (as a share of total wage bill). We thereby distinguish between very small (less than 6), small (6-10), large (11-20) and very large firms (more than 20). The figures are only shown for firms with at least one MW worker. Not surprisingly, the total number of affected firms is much higher in Eastern compared to Western Germany (more than twice as high). For firms in both parts of the country, most affected firms are small firms (52% in West and 58% in East Germany), whereas the shares of larger firms with at least one MW worker are only marginal (6% and 4%). Moreover, within smaller firms, the share of affected workers is 50% and 71%. As a results, labour cost increases that firms had to bear for workers with a binding MW (as a share of total wage bill) amounts to 2.9% to 2.4% on average for small firms, while very large firms have to cope with corresponding cost increases of only 0.3% and 0.9%. Labour cost increases for workers with a non-binding MW were much

Table 4: Average changes in labour cost shares by firm size for firms with at least one MW worker (LAK-data)

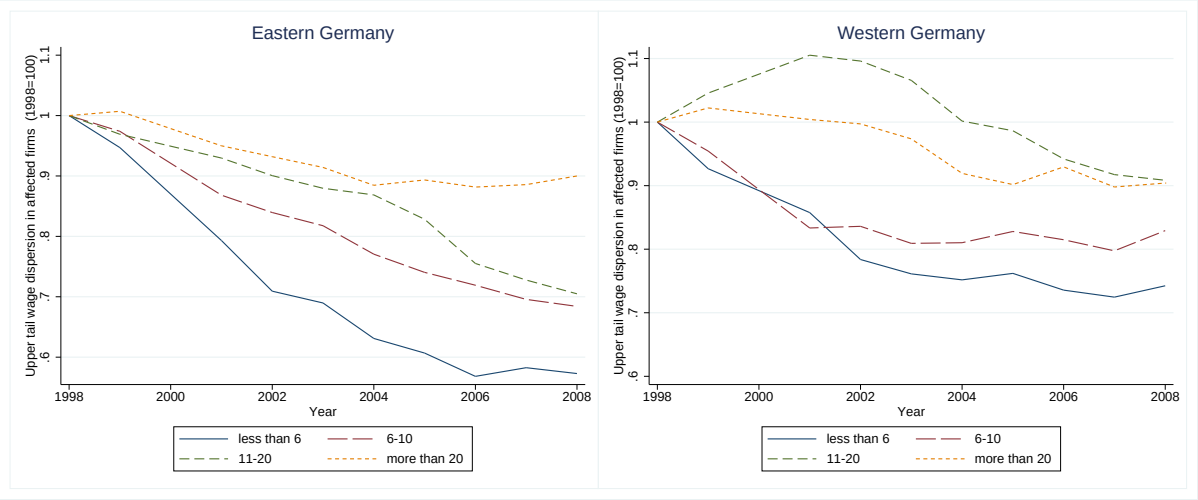
	number of employees			
	less than 6 (very small)	6-10 (small)	11-20 (large)	more than 20 (very large)
Western Germany				
number of employees	3.0	7.6	14.1	34.6
total wage bill (in Euros)	5,143	15,298	29,979	79,287
share of affected workers (in %)	49.6	19.4	12.4	7.6
labour cost share increase[a] (in %)				
for workers with binding MW	2.9	0.7	0.4	0.3
for workers with non-binding MW	1.2	1.5	1.8	1.0
accumulated labour cost share increase (binding MW)	26.0	6.2	3.8	3.0
number of firms with at least one affected worker	518.0	249.3	149.2	56.3
as a share of total firms (in %)	52.4	25.9	15.6	6.1
Eastern Germany				
number of employees	3.0	7.5	14.0	29.7
total wage bill (in Euros)	4,669	12,205	23,537	51,079
share of affected workers (in %)	68.5	50.0	43.4	37.4
labour cost share increase[a] (in %)				
for workers with binding MW	2.4	1.3	1.1	0.9
for workers with non-binding MW	0.4	0.5	0.4	0.3
accumulated labour cost share increase (binding MW)	22.0	12.0	9.8	8.4
number of firms with at least one affected worker	1,188.2	493.3	229.2	70.1
as a share of total firms (in %)	58.4	25.4	12.3	3.9

[a] Labour cost increase is calculated as follows: Δ *labour cost*$_{jt} = \sum_{i=1}^{N}(w_{ij,t+1}h_{ij,t+1} - w_{ijt}h_{ijt})$.
Notes: All values in the table are averages for the June observations before the next MW introduction including the years 1997, 2001-2008.

lower across firm size.

The labour cost burden due to MW workers is thus much higher for smaller compared to larger firms, although the overall burden seems quite low at a first glance. However, note that these are average values before each MW hike so that these costs accumulate over time. In fact, calculating the accumulated labour cost share increase for binding MW workers shows that the annual increases accumulate to a total of 22% and 26% for smaller firms. In contrast, labour cost share increases only accumulate to 3% and 8% for larger firms, although the 8% for Eastern Germany still seems quite high. For very small firms with less than 6 employees and a total wage bill of only around 5,000 Euros (for blue-collar workers), this increase might have required some cost-reducing adjustments. This is also confirmed by interviews where almost 50% (65%) of West (East) German roofing firms expressed that they would generally need to make necessary adjustments if labour costs increased by 10% (Aretz et al., 2011). Especially smaller firms face

Figure 5: Development of upper tail wage dispersion in firms with at least one MW worker (LAK data)



Notes: Panels are smoothed using a moving average. All time series are indexed to the year 1997.

limited options in this respect. First, they can not influence market prices much, compared to larger firms (i.e. they are price takers). Second, exploiting technological advances for capital-labour substitutions does not seem feasible either for such small firms. Therefore, pay restraints for skilled labour might have been the only option.

To test the later hypothesis more directly, Figure 5 shows the development of average upper decile wage dispersion within firms (measured by the standard deviation of hourly wages among workers with earnings above the firm median wage). The panels are shown by firm size and are restricted to firms with at least one MW worker. The figures are very similar between East and West Germany and show that wage differentiation in the upper tail within firms has decreased more strongly in smaller compared to larger firms. Although not shown here, this heterogeneous development across firms can not be observed for firms with no MW worker. To conclude, we have provided several descriptive statistics suggesting that smaller firms have been more conservative compared to larger firms in increasing wages for their highly paid employees. We have also shown that this observation coincides with an increasing labour cost burden these smaller firms are facing in the course of the MW policy. In the following analysis, we will test for this causally.

6 Quantile Treatment Effects on the Distribution of Earnings

6.1 Approach

The aim of the empirical analysis is to estimate the causal impact of the MW on different parts of the wage distribution in order to investigate whether the policy reform affected the overall distribution of wages in the German roofing sector. For the identification, we are able to exploit a quasi-experiment since, for institutional reasons, the MW was introduced only in parts of the construction sector including the roofing sector. This allows us to compare the wage distribution between roofers (treatment group) and a comparable sub-sector without a MW (control group). In particular, we use the wage distribution of plumbers (see Section 3) to construct a counterfactual distribution for roofers in the absence of the policy reform and compare their wages before and after the MW introduction. Abstracting from the estimation procedure (conditional vs. unconditional quantile regression, see discussion below), our quantile-specific Difference-in-Differences model can be written as follows:

$$q_t^\tau = \alpha^\tau + \beta^\tau D_i + \gamma^\tau Post_t + \delta^\tau (Post_t \times D_i) + \eta^\tau \mathbf{X}_{it} + \upsilon_t^\tau + \epsilon_{it}^\tau$$

where q_t^τ is the log daily wage of workers at the τth quantile. D_i refers to the treatment variable that takes the value one for treated roofers and zero for untreated plumbers. $Post_t$ takes the value one for the post-reform period (t_1: 1998-2008) and zero for the pre-reform period (t_0: 1994-1997). $\mathbf{X}_{it}$ is a set of individual and firm level covariates including age, tenure in sector, educational attainment (6 categories), occupational status (3 categories), a part-time dummy, qualification of the workforce (3 categories) and firm size (4 categories). This rich set of covariates controls for the selection into treatment based on observable characteristics. Moreover, υ_t^τ captures any time-specific effects. By comparing four wage distributions, namely that of roofers with plumbers both before and after the policy reform, the term δ^τ gives us the Quantile Treatment Effect (QTE) of the MW introduction (and subsequent increases) on the τth quantile of the earnings distribution (for a nice graphical illustration of Differences-in-Differences with quantile regression see also Havnes and Mogstad, 2014). The interpretation thereby depends on whether one compares conditional vs. unconditional quantiles, which is discussed in detail below.

The assumptions needed for identification are that differences in wages between roofers and plumbers would have stayed the same in the absence of the policy reform (common trends).

Furthermore, we need to assume that there are no indirect effects of the MW regulations in the roofing sector on the plumbing sector (no control group contamination). Concerning the first assumption, we have argued that the plumbing sector is a very comparable sector in terms of its market structure and experienced a very comparable trend in terms of important economic indicators (for details see Section 3). It is therefore very likely that the roofing sector would have experienced a similar wage development, had the MW regulations not been implemented in this sector, conditional on $\mathbf{X}$. Note that the inclusion of a large set of covariates as well as a set of time dummies should further ensure the assumption to hold, despite the general commonalities between the sectors. Moreover, comparing the outcome variable before the policy change shows quite a similar trend, although there are some hints for anticipation behaviour. To test for anticipation effects, we conduct several placebo tests and re-estimate the model with different specifications discussed in Section 6.3. The overall results however do not change much. To test for indirect effects on the control sector we further calculate transition rates of roofers into the plumbing sector. Since the share of job changes from the roofing to the plumbing sector was only 0.35% between 1994-2008, there does not seem to be much scope in terms of roofers leaving the sector and become a plumber and vice versa. Moreover, as the entire construction sector experienced a downward trend during the observation period, it is very unlikely that demand effects in the plumbing sector indirectly affected the roofing sector.

To get more insights into which period of analysis affected the wages of roofers most, we further run estimations where we interact the treatment variable with dummies for three sub-periods including 1998-2002, 2003-2005 and 2006-2008. The first period thereby reflects the period between the introduction of the MW in 1997 and the national level that was set in 2003. The years after 2003 are subdivided into two further periods to reveal further heterogeneities in recent years where the bite increased strongly. Finally, we interact the model with firm size to test whether smaller firms are driving the wage compression as suggested by the descriptives.

Quantile regression estimation. For the estimation we apply and contrast a conditional quantile regression approach proposed by Koenker and Bassett (1978) and Koenker (2005) with a unconditional quantile regression technique recently developed by Firpo et al. (2009). In case of conditional quantiles, the left-hand side of Equation 1 become $E[q^{\tau}|\mathbf{X}_{it}]$, that is we estimate the effect of the MW on the conditional distribution of wages, holding other factors constant. Note that conditional quantile regression estimates are thereby much harder to interpret as

they capture the impact at certain parts of the distribution within certain groups with similar observable characteristics. This precludes any implications on the impact of a policy change on the overall observed distribution including aggregate measures such as the wage variance or the Gini coefficient. The reason for this more restrictive interpretation is that conditional and unconditional quantiles cannot be equated as in mean regression analysis, since the Law of Iterated Expectations can not simply be applied to quantiles. Put differently, conditional quantiles do not average up to their population counterpart.

We therefore mainly focus on the method proposed by Firpo et al. (2009), which allow to estimate the effect of the MW on the unconditional (marginal) distribution of wages, holding other factors constant. For this, the authors provide a technique to transform conditional to unconditional quantiles before running the regressions. In short, the method consists of two steps. In a first step, the outcome variables Y is transformed (recentered) so that it aggregates back to the overall distribution of Y. The so called Recentered Influence Function (RIF) can be expressed as the weighted probability that the outcome variable Y lies above a certain quantile. Hence, the left-hand side of Equation 1 becomes $RIF[q^\tau]$. The weighting thereby occurs through a scaling factor equal to the inverse of the density of Y evaluated at q^τ, which provides the right transformation since the inverse of the cumulative distribution function transforms probabilities into unconditional quantiles. In a second step, the RIF is regressed on the explanatory variables using OLS or other specifications[6].

Based on our Difference-in-Differences model, we then receive Unconditional Quantile Treatment Effects (UQTE), which we contrast to our Conditional Quantile Treatment Effects (CQTE). There are few points worth mentioning regarding the different interpretation of the two approaches. Whereas CQTE capture changes in within-group inequality (or residual wage-inequality), UQTE include both a within- and between-group inequality effect. Put differently, in CQTE analyses, the relative position of an individual in the wage distribution is determined only by the unobserved component, while in UQTE the relative position is determined by both observed and unobserved factors. As Firpo et al. (2009) note, wages might increase due to the variable of interest for low wage quantiles where both the between and within-group effects go in the same direction, but can decrease wages for high wage quantiles where the between- and within group effects go in the opposite directions. To demonstrate the differences, the authors investigate the

[6]Firpo et al. (2009) also compare their results to other specifications including a Logit and nonparametric specification. Since the results do not seem to differ much between the RIF-OLS and the alternative specifications, we stick to the first.

impact of union coverage and conclude that the detected deviations between their conditional and unconditional quantile regressions may be driven by the fact that the union wage gap generally declines as a function of the (observable) skill level. In particular, we will compare both UQTE to CQTE to derive implications on MW induced changes in the returns to observable (unobservable) characteristics such as the education and experience of workers.

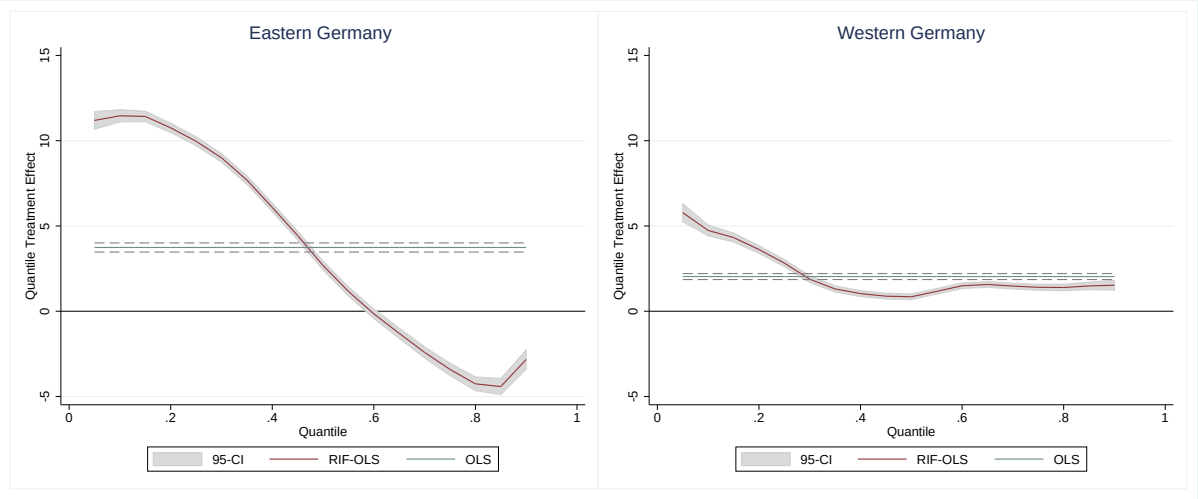
6.2 Results

Table 5 displays the coefficients for quantiles τ=0.1, 0.25, 0.5, 0.75, 0.9 (Columns 2-6) as well as two inequality measures including the wage variance and Gini coefficient (Columns 7-8). As a benchmark, we further add the coefficients of a simple OLS model in Column (1). The results are shown for the basic model as well as interacted with the three sub-periods and with firm size in two separate models. The UQTE of the basic specification are also shown graphically for 19 different quantiles (from the 5th to the 95th) in Figure 6 including its 95% confidence interval as well as basic OLS estimates (represented by the horizontal line). The figure already reveals a large degree of heterogeneity in the MW effect across quantiles as indicated by the deviations of the RIF-OLS coefficient plots from the OLS coefficient lines.

In particular, the coefficients in Table 5 for Western Germany across the entire period indicate that workers at the 0.1th quantile experienced MW induced real wage increases of 5%. The effects then decrease for the 0.25th quantile to 3% before fading out at about the median worker. For higher earning groups, the wage effects are only marginal. Despite the reduction in lower tail inequality, overall wage dispersion did not change much in this part of the country, although the Gini coefficient shows a significant but small decrease.

In contrast, the corresponding figures for Eastern Germany are much more pronounced in terms of size and heterogeneity. In particular, real wages of low-wage workers were bumped up by 12%, on average, as a results of the MW. The positive wage effects thereby extend to about the 0.6th quantile (compare Figure 6). Also noteworthy, the MW increased the location of the wage distribution (positive effect on the median). However, despite the location shift, East German roofers with high wages experienced real wage decreases of more than 3%. As a result of the wage-compression effect at both ends of the distribution, overall wage inequality among East German roofers decreased, as shown by the significant negative effects for both wage variance and Gini coefficient. This significant wage compression effect exactly mirrors the descriptive finding in Figure 1.

Figure 6: Unconditional Quantile Treatment Effects of the minimum wage



Notes: This figure shows OLS and QTE estimates including their 95% confidence intervals based on bootstrapping with 100 replications. The effects can be interpreted in percentage changes.

Looking at the QTE interacted with the sub-period dummies (corresponding quantile plots are shown in Appendix A.6) show that the effects gradually increased with the bite. The strongest impact is thereby estimated for the last sub-period where earnings of low-wage workers were pushed up by 22% in the case of Eastern Germany. In contrast, corresponding workers at quantiles 0.75 and 0.9 faced real wage losses of 5% and 3%. The effects seem particularly strong compared to other MW studies that have looked at MW wage spillovers. For instance, estimates for a low-wage sector in the UK by Manning (2003) amount to 11% in the neighbourhood of the MW, then fading out at about the median wage.

Our estimates further indicate that firm size is important. In particular, our findings suggest positive wage effects between 2% and 9% among West German firms with more than 10 employees, irrespective of their wage position. However, in smaller firms with 6-10 employees only low-wage workers experienced real wage growth. More strikingly, workers in firms with less than 6 employees experienced zero to negative real wage growth in Western Germany. In particular, whereas real wages of the lowest quantile remained unchanged, the upper quantile workers experienced wage decreases between 1.5% and 2%. Obviously, increasing labour costs for MW workers led smaller firms to restrain wages among better paid employees. This interesting phenomenon was particularly strong in Eastern Germany and affected employees in firms with up to 20 employees. Here, real wage increases for the lowest quantile range between 11% to 13%, whereas real wage losses among the highest quantiles amounted to 4.5% and 6.5%. Even in firms with more than 20 employees, real wages among better paid workers only increased by

Table 5: Unconditional Quantile Treatment Effects of the minimum wage

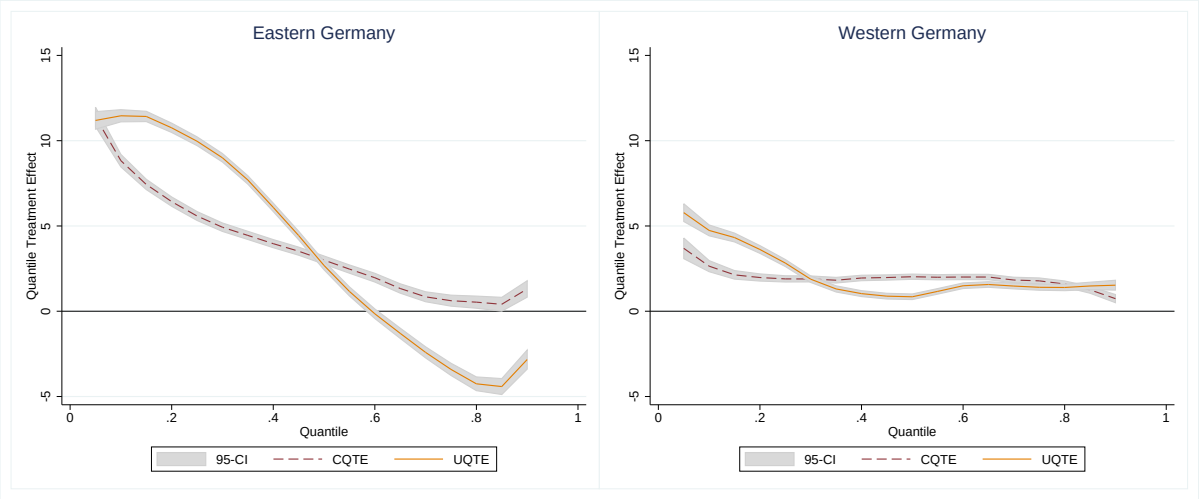
Dependent variable: log real daily wages								
	OLS	Quantile Regression Estimates					Inequality	
		$\tau = 0.1$	$\tau = 0.25$	$\tau = 0.5$	$\tau = 0.75$	$\tau = 0.9$	Variance	Gini
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Western Germany (N=1,055,380)								
Basic model								
1998-2008	2.04***	5.08***	2.83***	0.79***	1.36***	1.74***	-0.20	-0.14***
	(22.70)	(29.12)	(26.91)	(10.09)	(15.74)	(10.35)	(-1.81)	(-9.27)
Interacted with sub-periods								
1998-2002	1.49***	3.53***	2.20***	0.69***	0.96***	1.49***	0.13	-0.06***
	(14.46)	(17.98)	(18.53)	(7.79)	(9.76)	(7.76)	(0.99)	(-3.39)
2003-2005	2.68***	6.05***	3.57***	1.22***	1.95***	2.26***	-0.20	-0.14***
	(22.16)	(24.40)	(24.24)	(11.24)	(16.86)	(10.31)	(-1.30)	(-6.91)
2006-2008	2.53***	7.42***	3.41***	0.55***	1.57***	1.73***	-0.92***	-0.30***
	(19.80)	(27.22)	(21.77)	(4.94)	(13.80)	(7.88)	(-5.80)	(-14.67)
Interacted with firm size								
less then 6 employees	-2.19***	0.11	-0.60***	-2.19***	-1.45***	-2.02***	0.94***	0.09***
	(-19.13)	(0.46)	(-4.54)	(-23.32)	(-15.10)	(-11.23)	(7.04)	(5.30)
6-10 employees	1.70***	5.79***	3.19***	0.62***	0.19	0.16	-0.66***	-0.27***
	(16.43)	(28.41)	(25.55)	(6.63)	(1.90)	(0.88)	(-4.96)	(-15.35)
11-20 employees	3.66***	7.02***	4.24***	2.19***	2.23***	2.60***	-0.69***	-0.25***
	(34.72)	(34.54)	(33.41)	(22.61)	(20.99)	(13.20)	(-4.99)	(-14.09)
more than 20 employees	6.57***	8.83***	5.36***	3.50***	6.21***	8.14***	-0.61***	-0.13***
	(56.28)	(40.01)	(37.48)	(31.78)	(48.64)	(32.74)	(-3.79)	(-6.04)
Eastern Germany (N=451,245)								
Basic model								
1998-2008	3.74***	12.28***	9.44***	2.47***	-3.44***	-2.92***	-1.42***	-0.75***
	(27.34)	(62.93)	(75.72)	(20.49)	(-18.61)	(-9.89)	(-7.08)	(-35.66)
Interacted with sub-periods								
1998-2002	2.12***	8.38***	5.31***	1.47***	-2.33***	-2.79***	-0.67**	-0.46***
	(13.80)	(38.89)	(37.32)	(10.79)	(-11.19)	(-8.39)	(-2.95)	(-19.35)
2003-2005	4.81***	14.38***	13.33***	3.01***	-4.69***	-3.53***	-1.96***	-0.96***
	(25.92)	(48.76)	(71.29)	(16.29)	(-18.12)	(-9.23)	(-6.36)	(-29.71)
2006-2008	7.43***	21.75***	17.56***	4.88***	-5.37***	-2.60***	-3.09***	-1.41***
	(37.18)	(64.13)	(89.00)	(25.27)	(-21.07)	(-7.01)	(-9.59)	(-41.36)
Interacted with firm size								
less then 6 employees	0.61***	10.83***	7.96***	-0.37*	-7.43***	-6.49***	-1.29***	-0.79***
	(3.64)	(44.91)	(50.68)	(-2.43)	(-34.69)	(-20.22)	(-5.18)	(-29.99)
6-10 employees	2.62***	12.59***	9.22***	1.45***	-6.02***	-5.83***	-2.15***	-0.93***
	(17.01)	(58.34)	(62.56)	(9.64)	(-27.65)	(-17.91)	(-8.75)	(-36.00)
11-20 employees	3.60***	12.44***	9.41***	2.57***	-3.96***	-4.61***	-1.87***	-0.85***
	(22.69)	(58.23)	(63.42)	(16.66)	(-17.27)	(-13.45)	(-7.37)	(-31.81)
more than 20 employees	6.08***	11.44***	9.53***	4.79***	1.86***	2.43***	-0.41	-0.46***
	(34.20)	(51.73)	(62.21)	(29.58)	(7.25)	(5.96)	(-1.53)	(-16.11)

Notes: t-statistics in parenthesis. Significance levels: * 5%, ** 1%, *** 0.1%. Robust standard errors for OLS estimates. Standard errors of RIF regressions are bootstrapped with 50 replications. All models include a set of individual-level covariates including age, tenure, educational attainment (6 categories), occupational status (3 categories), part-time dummy as well as firm characteristics including qualification of workforce (3 categories) and company size (4 categories) and year dummies.

2% to 2.5% compared to 11.5% wage growth for the lowest earning group. This pattern exactly mirrors the descriptive observation that smaller firms show a large decline in their (upper-decile) wage dispersion.

To conclude, the quantile regression estimates suggest that policy makers seem to have met

Figure 7: Unconditional vs. Conditional Quantile Treatment Effects of the MW



Notes: This figure shows CQTE and UQTE estimates including their 95% confidence intervals based on bootstrapping with 100 replications. The effects can be interpreted in percentage changes.

their goals of improving the earnings of the working poor and reducing overall inequality in the sector. However, the estimates also reveal MW induced reductions in real wages for upper-decile workers in Eastern Germany. Note that these wage reductions are not only driven by new workers entering the labour market, but rather reflect real wage decreases of workers already working in the sector and within the same firm (for corresponding tests see next Section). This interesting stylized fact might seem puzzling at the first glance. However, as noted in Section 5, the MW in the German roofing sector bit particularly hard in the eastern part of the economy in the sense that a higher share of workers were affected overall and within firms. Since this has strongly increased the labour cost burden of smaller firms with a share of MW workers over 70%, it may have led to wage constraints among higher-wage workers. The restrictive wage policy of firms thereby only become possible due to an increasing number of human-capital workers queuing for jobs, which has increased the bargaining power of employers over still employed workers in the sector. Nevertheless, this is striking evidence since it may render potential labour shortages in the future if firms face increasing difficulties to adjust costs otherwise. In fact, according to sector insiders and an evaluation of vacancies and job searchers (compared to plumbers) shows that the shortage of highly skilled workers has become a major challenge in the roofing sector (Aretz et al., 2011).

Unconditional versus Conditional Quantile Treatment Effects. The RIF-Regressions in the previous section reveal a substantial MW induced wage compression effect at both tails

of the East German wage distribution. We now contrast these results to estimates from conditional quantile regressions in order to shed light on the forces driving the wage compression, in particular at the upper part.

Recall that CQTE measure the MW effects on the conditional wage distribution, that is changes in the wage distribution within groups of individuals with similar characteristics. Figure 7 plots both the CQTE and, for comparable reasons, UQTE. The detailed regression results for the CQTE are shown in Appendix A.7. Looking at the figure for Eastern Germany first, shows that conditional real wages increased for the lowest quantiles but remained unchanged for upper decile workers (compare dashed line). The finding indicates that within-group inequality has decreased at the lower rank, that is for workers with similar characteristics those at the lower part of the distribution (those with unfavourable unobserved characteristics) now earn more. It may however also be the result of a selection effect caused lay-offs of low-wage workers with poor unobserved characteristics as found by Aretz et al. (2013). In contrast, for high wage earners, within-group inequality has not changed, meaning that workers with similar characteristics still earn similar relative wages. For West Germany, we find a much smaller increase in within-group inequality at the lower tail.

Comparing UQTE (solid line) to CQTE in East Germany reveals interesting deviations. In particular, unconditional estimates are much higher for workers below the median and much lower for workers with earnings above the median. Put differently, whereas CQTE suggest that real wages did not change for upper quantile workers, UQTE suggest negative real wage changes at the upper tail as a result of the MW. The fact that UQTE are higher (lower) at lower (higher) quantiles indicate that MW effects decline as a function of (observable) skills (see also discussion in Section 6.1). The wage compression effect at the upper tail is thus driven solely by the between-group effect indicating that wage inequality decreased between (rather than within) groups with different observable characteristics at the upper tail. The results therefore hint at MW induced decreases in the average pay-rewards to observable skills among higher-wage workers including education and experience in the sector.

Overall, the comparison demonstrates that conditional quantile regression fails to account for the observed wage changes, whereas unconditional estimates exactly mirror the compression of wages both at the top and bottom of the real daily wage distribution. It also confirms the hypothesis that the MW has reduced the returns to observable skills, so that the career incentives have decreased for higher educated and experienced workers in the sector.

Table 6: Placebo tests and robustness checks for estimations in Table 5

Dependent variable: log real daily wages									
		OLS	Quantile Regression Estimates					Inequality	
Post-reform period	N		$\tau = 0.1$	$\tau = 0.25$	$\tau = 0.5$	$\tau = 0.75$	$\tau = 0.9$	Variance	Gini
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Western Germany									
Basic model (for comparison)									
1998-2008	1,055,380	2.04***	5.08***	2.83***	0.79***	1.36***	1.74***	-0.20	-0.14***
		(22.70)	(29.12)	(26.91)	(10.09)	(15.74)	(10.35)	(-1.81)	(-9.27)
Placebo tests									
I. 1996-1997	323,402	1.51***	3.11***	2.45***	1.46***	0.62***	0.89**	0.23	-0.10***
		(10.32)	(12.25)	(13.51)	(12.16)	(4.17)	(3.28)	(1.07)	(-4.19)
II. 1995-1996	245,290	0.58**	1.92***	0.98***	0.43**	-0.38*	-0.49	-0.60*	-0.14***
		(3.29)	(6.27)	(4.39)	(2.93)	(-2.10)	(-1.47)	(-2.29)	(-5.04)
III. 1995	166,419	0.21	1.21***	0.24	-0.18	-0.67**	-0.69	-0.92**	-0.14***
		(1.02)	(3.54)	(0.95)	(-1.06)	(-3.17)	(-1.78)	(-3.10)	(-4.14)
Robustness									
I. 1997-2008	1,055,380	2.18***	5.15***	3.07***	1.05***	1.44***	2.14***	0.01	-0.12***
		(22.30)	(27.38)	(26.76)	(12.25)	(15.14)	(11.44)	(0.06)	(-7.34)
II. without years	898,397	2.52***	6.03***	3.75***	1.33***	1.59***	2.26***	0.05	-0.15***
1996 and 1997		(21.93)	(26.94)	(27.71)	(13.05)	(14.19)	(10.10)	(0.38)	(-7.83)
III. only stayers	196,193	0.43**	0.46	0.19	1.05***	0.40*	-0.30	-0.31*	-0.06**
		(2.91)	(1.75)	(1.09)	(7.93)	(2.12)	(-0.81)	(-2.41)	(-2.83)
IV. only stayers	158,894	0.47**	0.84**	0.35	1.02***	0.13	-0.76	-0.41**	-0.09***
in same firm		(2.80)	(2.85)	(1.79)	(6.45)	(0.62)	(-1.80)	(-3.19)	(-3.84)
V. nominal daily wage	1,055,380	2.04***	4.05***	3.32***	4.67***	1.36***	-3.31***	-0.70***	-0.28***
		(22.70)	(21.02)	(28.75)	(59.36)	(16.77)	(-22.77)	(-6.12)	(-19.83)
Eastern Germany									
Basic model (for comparison)									
1998-2008	451,245	3.74***	12.28***	9.44***	2.47***	-3.44***	-2.92***	-1.42***	-0.75***
		(27.34)	(62.93)	(75.72)	(20.49)	(-18.61)	(-9.89)	(-7.08)	(-35.66)
Placebo tests									
I. 1996-1997	174,680	2.70***	4.96***	4.15***	3.07***	0.23	0.04	-0.56	-0.23***
		(12.08)	(15.25)	(17.75)	(13.85)	(0.77)	(0.09)	(-1.63)	(-6.50)
II. 1995-1996	131,340	0.81**	2.17***	1.80***	1.51***	-0.73	0.04	-0.08	-0.07
		(2.84)	(5.24)	(5.92)	(5.45)	(-1.90)	(0.09)	(-0.17)	(-1.65)
III. 1995	86,755	-0.07	0.69	0.70	0.52	-1.20**	-0.75	0.19	-0.01
		(-0.20)	(1.45)	(1.95)	(1.63)	(-2.72)	(-1.26)	(0.45)	(-0.20)
Robustness									
I. 1997-2008	451,245	4.07***	12.18***	9.37***	3.08***	-2.70***	-2.94***	-1.31***	-0.73***
		(26.89)	(58.42)	(70.64)	(23.88)	(-13.28)	(-8.86)	(-6.12)	(-32.02)
II. without years	363,320	4.64***	13.70***	10.57***	3.87***	-2.83***	-4.26***	-1.50***	-0.82***
1996 and 1997		(25.29)	(55.50)	(68.91)	(26.76)	(-11.49)	(-10.28)	(-6.20)	(-30.73)
III. only stayers	41,451	3.29***	11.76***	7.75***	0.85	-5.36***	-2.80**	-1.27***	-0.60***
		(7.78)	(26.33)	(21.57)	(1.86)	(-8.04)	(-2.74)	(-4.76)	(-11.33)
IV. only stayers	31,115	3.41***	11.23***	8.99***	1.84**	-6.67***	-1.71	-1.98***	-0.70***
in same firm		(6.36)	(23.23)	(21.39)	(3.18)	(-7.55)	(-1.22)	(-5.55)	(-10.33)
V. nominal daily wage	1,055,380	3.74***	5.27***	5.76***	5.38***	0.73***	0.17	-0.53**	-0.30***
		(27.34)	(23.67)	(40.28)	(41.26)	(4.29)	(0.65)	(-2.60)	(-14.64)

Notes: robust t-statistics in parenthesis. Significance levels: * 5%, ** 1%, *** 0.1%. Standard errors are bootstrapped with 50 replications. All models include a set of individual-level covariates including age, tenure, educational attainment (6 categories), occupational status (3 categories), part-time dummy as well as firm characteristics including qualification of workforce (3 categories) and company size (4 categories) and year dummies.

6.3 Robustness

To test whether our UQTE in Table 5 are contaminated by anticipation behaviour before the policy change, we conduct several placebo tests shown in Table 6. For this, we restrict the sample to the pre-reform years (1) 1994-1997, (2) 1994-1996 and (3) 1994-1995 and assume each last year to be the post-reform period. If there were no anticipation effects, we would observe QTE of zero at each quantile. The results suggest positive anticipation effects in 1997 (Placebo I) and to a lesser degree in 1996 (Placebo II), meaning that firms obviously started to adjust wages upwards prior to the MW during these years, thus downward biasing the estimates. We do not find any such effects for the year 1995 (Placebo III). To make sure the results are not driven by any of these anticipation effects, we re-estimate the basic model in two versions: In a first version, we declare the 1997 to the post-reform period (Robustness I) since there are only 3 months between the data point in June 30th and the MW introduction in October 1997 of the same year. In a second version, we drop all observations of the years 1996 and 1997 (Robustness II). The slightly higher coefficients of the latter models suggest that the basic model might be underestimating the wage effects. Overall, the estimates however do not change much suggesting that our estimates are quite robust

We have argued throughout the test, that the MW caused a compression at the top of the East German real wage distribution. This compression effect might thereby be the results of two different forces. First, it may reflect new workers entering the labour market with lower entry wages compared to existing workers in the firms they start working for. Second, the real wage reductions may be the result of wage restraints among the existing workforce that already was employed in the firm before the policy reform. To test this, we restrict the sample to workers who we observe in every year in the sample, that is we create a balanced sample (Robustness III). Whereas the effects decrease strongly in Western Germany, the effects stay almost unchanged for East German roofers, which implies that our estimates are not driven by workers entering the sample. We then further restrict the balanced sample to all workers that were employed in the same firm during the entire observation period (Robustness IV). Again the results are quite stable for Eastern German workers, thus suggesting that the effect is also not driven by workers that lost their job and returned to work with a lower salary in a different firm. Overall, we can conclude from these robustness checks that the wage-compression effect in Eastern Germany actually reflects wage restraints on long-standing employees in the roofing sector that worked

for the same firm ever since.

Although we conducted our analysis for real daily wages, as this is certainly the more relevant variable from a welfare perspective, we also check how our results change when using nominal daily wages as a dependent variable. In Eastern Germany, nominal wage increased for the lowest quantiles less than half as much compared to real wages. The effects ripple up to above the median wage as with real wages. For the top part of the nominal wage distribution we find zero and insignificant wage change. The results confirm that firms have been very conservative in their wage-setting, which, as prices increased, led to deteriorating real wages. The results for Western Germany using nominal wages are somewhat surprising. Whereas wage increases of lower-quantile wages were again somewhat lower in nominal terms, upper-quantile workers in Western Germany experienced negative nominal wage growth.

7 Conclusion

This study is motivated by recent descriptive findings for a German sub-construction sector that experienced a strong wage compression not only at the bottom but also at the top of the wage distribution in the aftermath of a MW introduction. In order to investigate whether the observed wage decreases for high-wage earners are driven by the policy reform, we estimate the MW effects on earnings for each quantile of the distribution. For the identification, we apply recently developed Unconditional Quantile Regressions suggested by Firpo et al. (2009) within a quasi-experiment. In particular, we are able to compare the wage distribution of the treated sector (roofers) with the distribution of an untreated control sector (plumbers) before and after the institutional change to derive Unconditional Quantile Treatment Effects. We further contrast the results to Conditional Quantile Treatment Effects in order to shed light on the wage compression effect at the upper tail of the distribution.

The results reveal large heterogeneities along the distribution, suggesting that the mean impact misses a lot. In particular, we find significant real daily wage increases of about 12% for lower-decile workers that ripple up to the 60-percent quantile in Eastern Germany, whereas the weaker wage effects in Western Germany (5% at the lower tail) pillar up to about the median worker. Here the policy seems to have met its goal of improving the earnings of the working poor and reducing overall wage inequality. However, the estimates also reveal some unexpected side effects of the reform. According to our estimates, the MW caused a reduction in real daily

wages of about 5% in Eastern Germany for the highest quantiles (stagnating nominal wages) that mostly comprise skilled and experienced workers. A comparison between unconditional with conditional quantile regression estimates further shows that the wage compression effect at the upper tail is thereby solely driven by a between-group effect, which suggests that the returns to observable skills have decreased among skilled workers as a result of the MW. Estimates by firm size suggest that the negative spillovers have mainly been taking place within smaller firms. The decline in pay rewards for skilled workers thereby not only reflects lower entry wages, but rather indicates wage restraints among experienced workers that have been working for the same firm ever since.

This interesting stylized fact for Eastern Germany is the result of several occurrences in the sector. First of all, the increasing bite of the MW strongly raised the labour cost burden, particularly among smaller firms with a share of MW workers over 70%. Our calculations show that the accumulated labour cost share for smaller firms increased strongly during the observation period. This increasing labour cost burden went along with a severe downward trend in the entire construction sector since 1995. Especially smaller firms with a limited influence on market prices (price-takes) and less possibilities for substituting labour by capital have limited the scope for wage increases among their skilled employees. However, wage restraints among highly paid workers then only became possible due to deteriorating employment chances also among upper-decile workers as suggested by the complementary study of Aretz et al. (2013) and which may have increased the bargaining power of firms over still employed workers. As a result, wage differentiation and thus incentives for human capital investments have been shrinking in the sector. The latter is also confirmed by comparing conditional with unconditional quantiles suggesting that the wage-compression effect at the top of the distribution is solely driven by a reduction in upper tail between-group inequality, that is deteriorating returns to observable skills in the sector. The findings might explain rising labour shortages that firms are facing recently as reported by separate interview with roofing firms. The less attractive working conditions for the more qualified workers may also be a reason for the MW induced rise in sole traders in the sector as suggested by Kraft et al. (2012). According to the authors, some of these qualified workers may have opted to start their own business to increase their earnings.

Although the investigations were conducted for the German roofing sector only, a MW might induce similar effects in other comparable sectors such as the main construction sector, the plumbing sector or the glazier industry. In particular, our study might explain the descriptive

evidence for the main construction sector which suggests that the MW regulations in that sector also led to a wage compression at the upper tail (Apel et al., 2012). Moreover, smaller firms in the plumbing and glazier industry, which face a similar market structure compared to the roofing sector, may react similarly to the national MW recently introduced by the German government and which is valid across all sectors. With 8.50€, the national MW has been set relatively high compared to international standards and might increase further.

Overall, the study demonstrates how institutions such as the MW that are mostly geared towards the lower rank may render unexpected side effects such as diminishing working conditions of workers higher up in the distribution that are mostly assumed to be unaffected by such policy reforms. Policy evaluators should thus take into account such heterogenous effects by looking at the entire distribution of earnings rather than simply looking at mean statistics. Furthermore, policy makers should be aware that a relatively high MW may more likely cause unfavourable effects in regions with lower price levels such as in East Germany as well as in smaller firms, especially in an economic downturn phase and may ultimately lead to decreasing returns to skills. However, further research is needed. First of all, the evaluation of employment spillovers that have been studied by Aretz et al. (2013) should be reconsidered by taking account of firm heterogeneities. It might also be interesting to follow the development in the sector in order to see how the distribution changes once the overall economy moves upward again, as the lastest figures in our data suggest. Finally, attempts to identify the cut-off point at which the MW induces unfavourable effects might be a fruitful line of further research.

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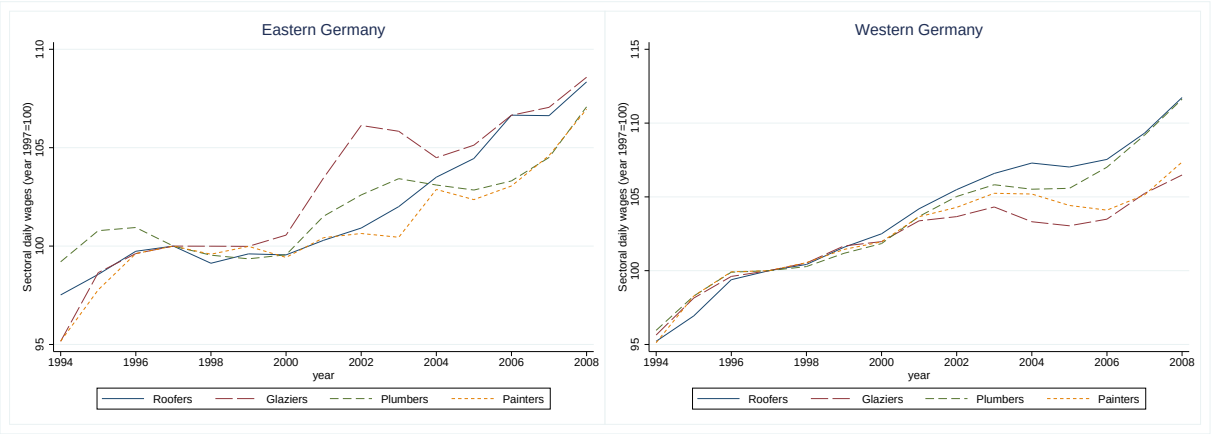
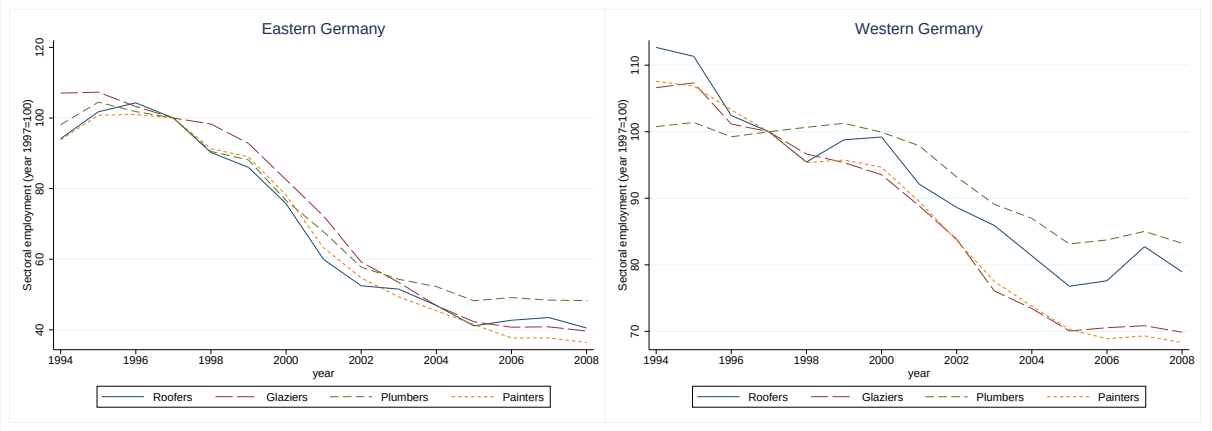
A Appendix

A.1 Development of gross daily wages and employment by sectors (BA data)

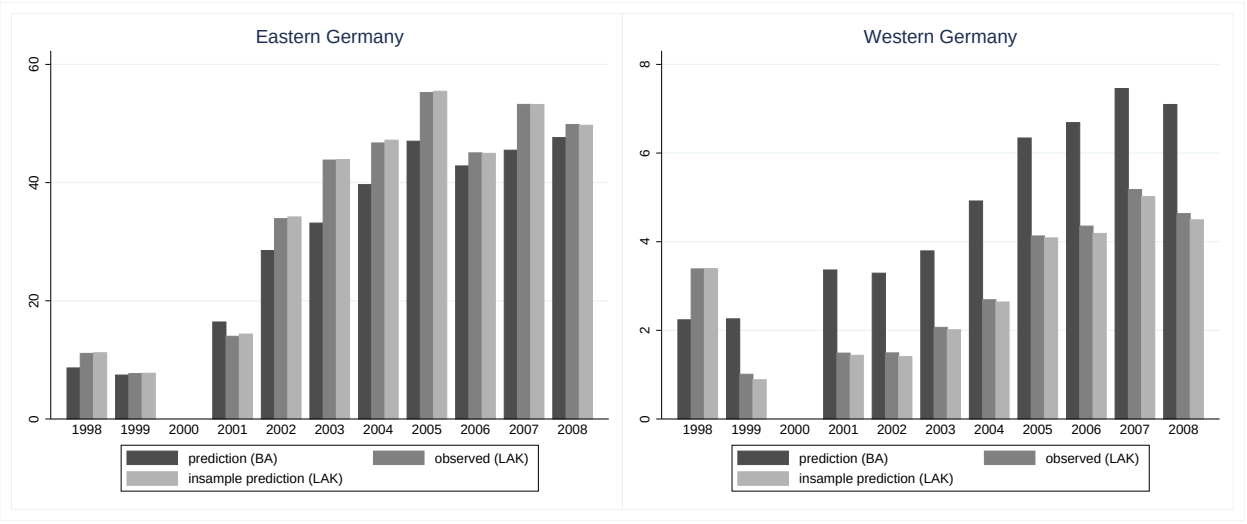
(a) Gross daily wages



(b) Employment



A.2 Share of affected workers based on observed and predicted hourly wages



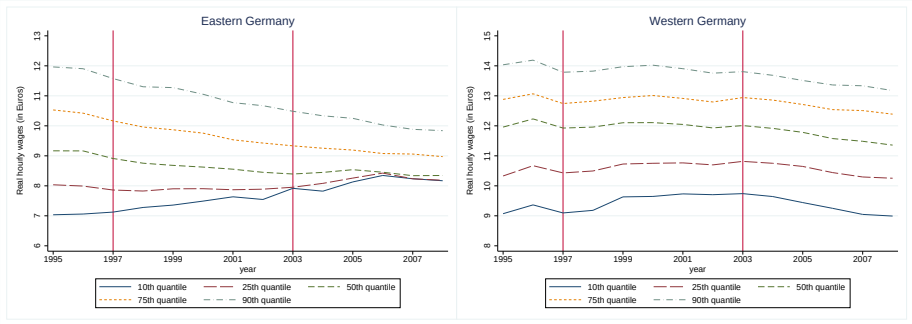
A.3 Detailed estimates for unconditional quantile regressions in Table 5 (Eastern Germany)

Dependent variable: log real daily wages								
	OLS	Quantile Regression Estimates					Inequality	
		$\tau = 0.1$	$\tau = 0.25$	$\tau = 0.5$	$\tau = 0.75$	$\tau = 0.9$	Variance	Gini
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Eastern Germany (N=451,245)								
Basic model:								
post-period interacted with treatment	3.74***	12.28***	9.44***	2.47***	-3.44***	-2.92***	-1.42***	-0.75***
	(27.34)	(62.93)	(75.72)	(20.49)	(-18.61)	(-9.89)	(-7.08)	(-35.66)
post-period dummy	-0.19***	-0.20***	-0.15***	-0.18***	-0.20***	-0.21***	-0.01**	-0.00
	(-86.48)	(-53.08)	(-70.46)	(-93.57)	(-77.73)	(-53.23)	(-2.73)	(-0.69)
treatment dummy	0.05***	0.05***	0.05***	0.06***	0.09***	0.03***	-0.01***	-0.00***
	(46.07)	(29.45)	(52.85)	(64.35)	(54.98)	(13.36)	(-5.73)	(-10.12)
age	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	-0.00*	-0.00***
	(70.17)	(52.39)	(62.11)	(66.25)	(61.26)	(43.41)	(-2.12)	(-5.58)
tenure in firm	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	-0.00***	-0.00***
	(116.00)	(83.16)	(96.76)	(111.82)	(84.01)	(41.39)	(-12.20)	(-29.38)
no high-school, with vocational training degree	0.03***	0.05***	0.02***	0.01***	-0.00	-0.01*	-0.03***	-0.01***
	(11.59)	(14.21)	(9.83)	(5.75)	(-0.02)	(-2.11)	(-9.75)	(-21.27)
high-school, without vocational training degree	-0.06**	-0.08***	0.00	0.02**	0.04**	0.06**	0.17***	0.02***
	(-2.80)	(-3.79)	(0.22)	(2.65)	(3.09)	(2.80)	(10.87)	(14.25)
high-school, with vocational training degree	0.05***	0.07***	0.05***	0.05***	0.04***	0.04***	-0.02*	-0.00***
	(9.17)	(10.97)	(11.04)	(12.95)	(6.50)	(3.71)	(-2.37)	(-5.96)
technical university degree	0.02	0.03**	0.03***	0.02**	0.02*	-0.01	-0.00	-0.00
	(1.80)	(2.87)	(4.24)	(3.14)	(2.22)	(-0.30)	(-0.44)	(-1.74)
university degree	0.05*	0.00	0.02	0.01	0.06***	0.08*	-0.02	-0.00
	(2.50)	(0.08)	(1.29)	(1.30)	(3.34)	(2.16)	(-1.01)	(-0.15)
skilled worker	0.08***	0.09***	0.07***	0.07***	0.09***	0.08***	-0.01***	-0.00***
	(69.86)	(43.99)	(57.93)	(63.96)	(62.92)	(45.68)	(-6.87)	(-12.36)
master craftsmen	0.33***	0.10***	0.13***	0.19***	0.39***	0.71***	0.14***	0.04***
	(114.90)	(35.96)	(75.91)	(117.74)	(134.87)	(106.67)	(42.43)	(112.71)
part-time dummy	-0.41***	-0.46***	-0.14***	-0.03***	0.03***	0.07***	0.58***	0.11***
	(-26.24)	(-32.30)	(-23.71)	(-7.98)	(4.59)	(7.63)	(65.81)	(114.16)
6-10 employees	0.03***	0.05***	0.03***	0.03***	0.02***	0.01***	-0.01***	-0.00***
	(35.68)	(31.16)	(34.10)	(29.77)	(18.51)	(8.24)	(-6.78)	(-17.56)
11-20 employees	0.05***	0.05***	0.04***	0.04***	0.04***	0.03***	-0.01***	-0.00***
	(47.18)	(30.91)	(41.91)	(41.92)	(32.41)	(19.21)	(-4.61)	(-11.61)
more than 20 employees	0.10***	0.08***	0.07***	0.08***	0.11***	0.14***	0.00**	0.00***
	(104.21)	(50.67)	(74.75)	(92.76)	(92.94)	(73.43)	(3.07)	(10.77)
number of low-skilled employees	-0.08***	-0.02***	-0.03***	-0.05***	-0.10***	-0.19***	-0.03***	-0.01***
	(-19.74)	(-3.90)	(-10.22)	(-15.91)	(-19.95)	(-22.29)	(-4.86)	(-15.54)
number of medium-skilled employees	-0.15***	-0.08***	-0.08***	-0.11***	-0.20***	-0.31***	-0.03***	-0.01***
	(-50.23)	(-20.82)	(-31.07)	(-45.27)	(-49.15)	(-44.13)	(-8.02)	(-25.31)
number of high-skilled employees	-0.01	-0.00	0.04***	0.04***	-0.05***	-0.13***	-0.03**	-0.01***
	(-1.41)	(-0.03)	(4.61)	(5.28)	(-4.91)	(-7.18)	(-2.94)	(-6.11)
constant	3.80***	3.44***	3.64***	3.82***	4.00***	4.27***	0.15***	0.05***
	(903.80)	(622.83)	(1084.92)	(1172.73)	(777.48)	(504.43)	(28.48)	(100.87)
N	451246	451246	451246	451246	451246	451246	451246	451246
R-squared	0.188	0.089	0.127	0.143	0.137	0.114	0.020	0.092
F	2618.4	954.8	2180.5	3224.1	2584.9	1142.5	292.3	1420.9

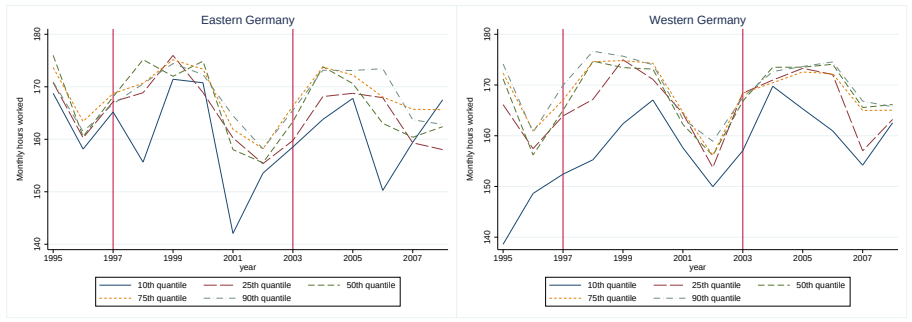
Notes: t-statistics in parenthesis. Significance levels: * 5%, ** 1%, *** 0.1%. Robust standard errors for OLS estimates. Standard errors of RIF regressions are bootstrapped with 50 replications. All models include a set of individual-level covariates including age, tenure, educational attainment (6 categories), occupational status (3 categories), part-time dummy as well as firm characteristics including qualification of workforce (3 categories) and company size (4 categories) and year dummies.

A.4 Development of real hourly wages, real monthly wages and hours worked (LAK data)

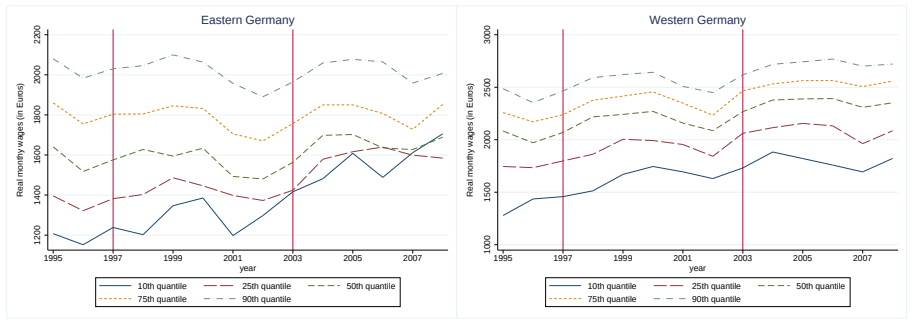
(a) Real hourly wages



(b) Monthly hours worked



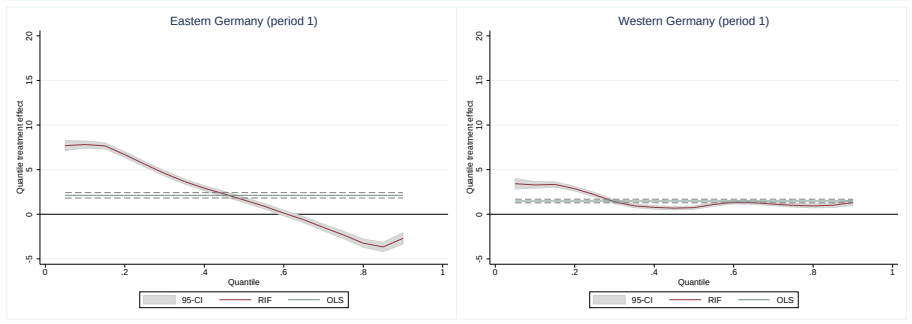
(c) Real monthly wages



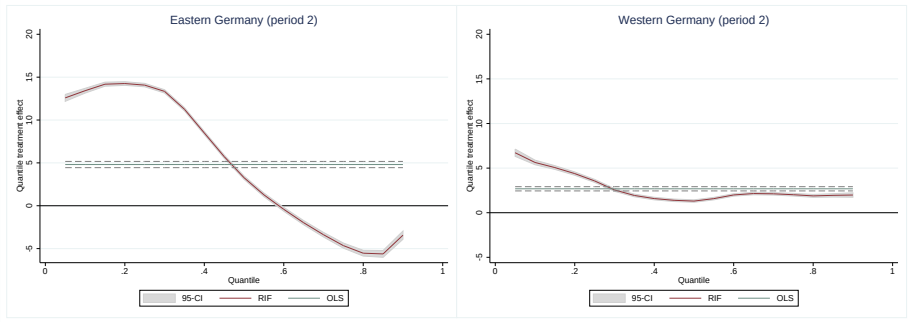
Notes: The vertical lines represent mark the introductions of the MW in October 1997 and the national MW in March 2003.

A.5 Unconditional Quantile regression estimates (interacted with period dummies)

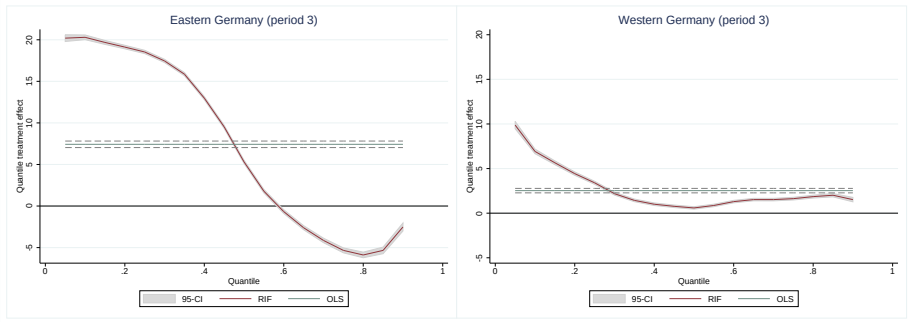
(a) 1998-2002



(a) 2003-2005



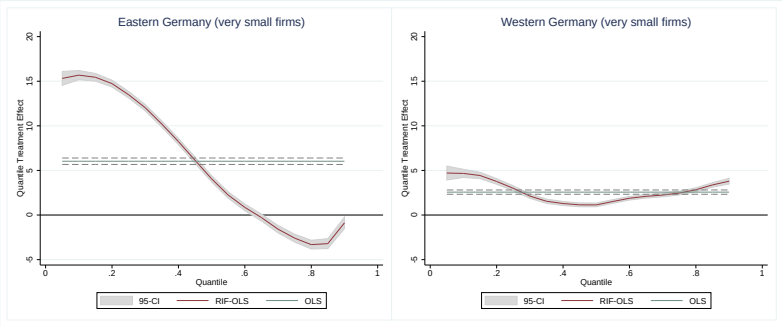
(a) 2006-2008



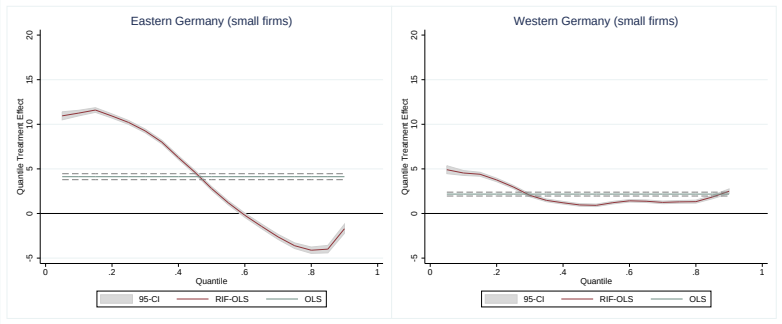
Notes: This figure shows OLS and QTE estimates including their 95% confidence intervals based on bootstrapping with 100 replications.

A.6 Unconditional Quantile regression estimates (interacted with firm size)

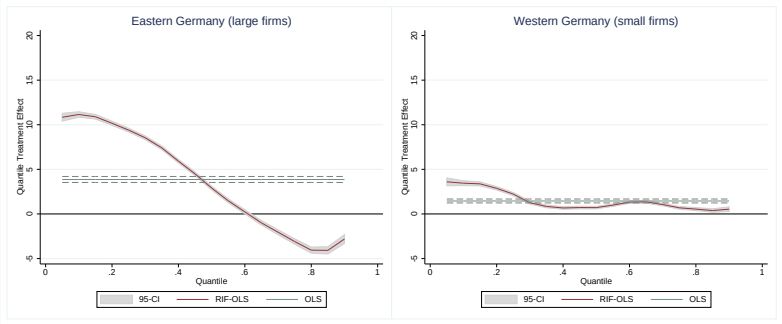
(a) very small firms



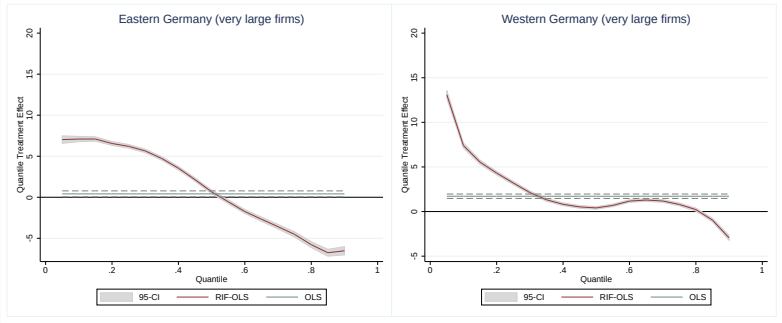
(a) small firms



(a) large firms



(a) very large firms



Notes: This figure shows OLS and QTE estimates including their 95% confidence intervals based on bootstrapping with 100 replications.

A.7 Conditional Quantile regression estimates

Dependent variable: log real daily wages						
	OLS	Quantile Regression Estimates				
		$\tau = 0.1$	$\tau = 0.25$	$\tau = 0.5$	$\tau = 0.75$	$\tau = 0.9$
	(1)	(2)	(3)	(4)	(5)	(6)
Western Germany (N=1,055,380)						
Basic model						
1998-2008	2.03***	2.64***	1.90***	2.02***	1.78***	0.74***
	(22.69)	(15.90)	(20.17)	(25.79)	(20.54)	(6.06)
Interacted with sub-periods						
1998-2002	1.49***	1.88***	1.42***	1.44***	1.26***	0.55***
	(14.46)	(10.03)	(13.22)	(16.15)	(12.79)	(3.92)
2003-2005	2.68***	3.06***	2.26***	2.68***	2.45***	1.46***
	(22.16)	(13.47)	(17.32)	(24.77)	(20.45)	(8.62)
2006-2008	2.53***	3.78***	2.60***	2.66***	2.20***	0.33
	(19.80)	(16.28)	(19.48)	(24.01)	(17.93)	(1.92)
Interacted with firm size						
less then 6 employees	-2.19***	-2.55***	-1.40***	-0.18	-0.06	-1.70***
	(-19.13)	(-12.72)	(-12.16)	(-1.88)	(-0.56)	(-11.49)
6-10 employees	1.70***	2.74***	1.78***	1.67***	1.35***	-0.23
	(16.43)	(13.63)	(15.47)	(17.64)	(13.12)	(-1.58)
11-20 employees	3.66***	5.03***	3.19***	2.73***	2.47***	1.35***
	(34.72)	(24.08)	(26.67)	(27.75)	(23.02)	(8.75)
more than 20 employees	6.56***	6.79***	4.75***	4.52***	5.08***	5.36***
	(56.28)	(28.30)	(34.58)	(40.04)	(41.14)	(30.24)
Eastern Germany (N=451,245)						
Basic model						
1998-2008	3.74***	8.83***	5.58***	3.00***	0.62***	1.31***
	(27.34)	(47.02)	(42.01)	(24.50)	(3.76)	(5.32)
Interacted with sub-periods						
1998-2002	2.12***	6.05***	2.94***	1.21***	-0.15	0.30
	(13.80)	(29.80)	(19.81)	(8.76)	(-0.84)	(1.07)
2003-2005	4.81***	11.20***	7.39***	3.75***	0.33	1.77***
	(25.92)	(40.47)	(36.54)	(19.96)	(1.33)	(4.66)
2006-2008	7.43***	15.20***	11.28***	6.79***	2.76***	3.44***
	(37.18)	(52.47)	(53.25)	(34.48)	(10.53)	(8.66)
Interacted with firm size						
less then 6 employees	0.61***	6.04***	3.89***	1.03***	-1.97***	-1.45***
	(3.64)	(26.40)	(23.48)	(6.67)	(-9.42)	(-4.66)
6-10 employees	2.62***	8.58***	5.11***	1.92***	-1.31***	-1.08***
	(17.00)	(38.15)	(31.34)	(12.61)	(-6.40)	(-3.53)
11-20 employees	3.60***	9.06***	5.58***	2.74***	-0.19	-0.01
	(22.69)	(39.05)	(33.21)	(17.46)	(-0.90)	(-0.02)
more than 20 employees	6.08***	10.09***	7.17***	5.01***	3.33***	4.25***
	(34.20)	(40.65)	(39.90)	(29.87)	(14.70)	(12.63)

Notes: t-statistics in parenthesis. Significance levels: * 5%, ** 1%, *** 0.1%. Robust standard errors for OLS estimates. Standard errors of RIF regressions are bootstrapped with 50 replications. All models include a set of individual-level covariates including age, tenure, educational attainment (6 categories), occupational status (3 categories), part-time dummy as well as firm characteristics including qualification of workforce (3 categories) and company size (4 categories) and year dummies.