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Revealing dynamics: The impact of minimum wage on inequality within Germany's regions

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Revealing Dynamics: The Impact of Minimum Wage on Inequality Within Germany's Regions

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Revealing Dynamics: The Impact of Minimum Wage on Inequality Within Germany's Regions

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July 4, 2025

This paper examines the impact of the statutory minimum wage introduction in Germany on within-region inequality. Utilizing SOEP data, we estimate the effects across population subgroups disaggregated by sex. Macro-level findings show that while the interquartile ratio did not change significantly overall, the interdecile and P25/P10 ratios declined by -9% and -5%, respectively. However, disaggregation by groups reveals opposite trends for men and women. For women, the effect on hourly wages is about -5% and statistically significant only in the first year after the reform. On the contrary, for men, it appears later, increases over time, and reaches -10% in 2019–2022. Individual-level analysis reveals that for men the effect is concentrated in the first quartile of wage distribution, with no significant reduction in working hours, contributing to a cumulative and statistically significant decline in inequality. For women, however, there are not only significant spillover effects—with the top quartile experiencing real hourly wage decline—but also a statistically significant reduction in contracted hours, especially for low-wage earners. Both of these factors contribute to the limited effects of policy on women, despite an initial rise in hourly wages at the lower end of the distribution.

JEL-code: J31, J68, R10, R23

Key words: minimum wage, inequality, regional differences, SOEP, difference-in-difference

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1 Introduction

In Germany, the statutory minimum wage was introduced in 2015 at an already high rate of 8.5 Euro per hour. Moreover, since that year, it has increased multiple times; in 2025, it reached 12.82 Euros (*BMAS - Mindestlohn* 2025).

Labour economists have studied the consequences of such policy for decades. Despite a vast body of literature (see, for instance, Ohlert, Dütsch, and Baumann (2024) for the systematic review of minimum wage studies in the context of Germany), there are still gaps to be closed. Many papers concentrate on the effects on (un-)employment (Garloff 2016; Bossler and Gerner 2019) as well as the distributional effects of minimum wage and between-region inequality. However, there is still a lack of evidence on the local effects of the reform as well as the differences in impact on heterogeneous population.

This paper looks at the dynamics of the within-region inequality – overall as well as separately for men and women – due to the introduction of minimum wage and length of exposure to it. Furthermore, it delves deeper in the heterogeneity analysis by testing possible mechanisms behind the observed dynamics.

To estimate the impact of the policy, we utilise German Socio-Economic Panel data (Goebel et al. 2019), which is a longitudinal survey collected on the individual level. It possesses a wide range of demographic characteristics and information about the weekly working hours and monthly income of employed persons. Utilizing the formula in Dütsch, Himmelreicher, and Ohlert (2019), we estimate the gross hourly wage of a respondent, thus directly comparing it to a statutory minimum wage. We conduct the analysis on two levels: macro-level and individual-level. The first setup allows us to evaluate the impact on the within-region inequality indicators directly, studying heterogeneity by sex as well as variation of the impact in time dimension. The second part of the analysis looks deeper into the mechanisms that lead to the observed macro-results. Our estimation method is a Difference-in-Difference (DiD) approach, utilising the intensity of a policy in a local labour market as a treatment indicator on the macro-level. On the individual level, however, the same variable is included in the regression as a control only, and the treatment is defined based on a respondent’s individual wage.

Our results demonstrate a statistically significant -9% reduction in the interdecile ratio. Moreover, the distribution of gross hourly wages appears to be not only truncated but also compressed on the left tail. This inequality reduction, however, does not translate to the one in terms of monthly individual wages or combined household income due to a decrease in working hours, especially for low-income employees. The dynamic aspect is profound: with more time passing after the introduction of the statutory minimum wage, these decreases in inequality proved to be stable and pronounced, particularly in the lower quartiles. Sex-specific effects demonstrate that men experienced a stable reduction both in hourly and monthly wages inequality, driven by an increase of wages in the lower

quartile of their wage distribution and no significant reduction in the working hours. In contrast, there were no robust statistically significant reduction in inequality for women, especially in the longer term: although hourly wages increased for the respondents in lower quartiles of wage distribution, the gains were offset by a reduction in contracted working hours; furthermore, pronounced spillover effects led to a decrease in real wages for the upper quartile of women. Thus, the observed inequality reduction for the whole sample is driven by a consistent effect on men; for women, however, the policy has a limited impact.

The structure of the paper is the following. Section 2 provides information on the minimum wage reform in Germany, the institutional and regional background of the country and reviews recent minimum wage literature. Section 3 describes the dataset used for the analysis. Next, we present the methods and results of the macro-level estimations in Section 4, followed by the same for the individual level in Section 5. The robustness of the results is discussed in Section 6. Finally, Section 7 concludes.

2 Literature Review

2.1 Institutional and Regional Background

2.1.1 Minimum Wage Introduction

The statutory brutto minimum wage was introduced in Germany on 1 January 2015 at 8.5 Euros per hour, covering the whole country. Since then, the Minimum Wage Committee (*germ.* Mindestlohnkommission) has re-evaluated it several times, reaching 12.41 Euro on 1 January 2024 and 12.82 Euro on 1 January 2025 (Destatis 2025).

The one of the bigger adjustments occurred in October 2022, resulting in the 12 Euro/h payment requirement (Justiz 2024b). Put differently, the minimum monthly wage for a full-time employee reached 2000 Euro. According to the estimation of the IAB, that increase has already affected up to 22% of workers (Börschlein et al. 2022). Moreover, already the introductory level of the minimum wage in Germany was high compared to the other EU countries: as per the Eurostat data, Germany ranked 3rd in the first half of the year 2015 in terms of minimum wages with PPP adjustment (Eurostat 2024).

Several groups of workers are exempt from the minimum wage legislation. Firstly, it is not binding for employees under 18 years of age without a finished training. Trainees, interns, volunteers and long-term unemployed are also excluded (*12 Euro Mindestlohn ab Oktober 2022* 2024) and can receive lower hourly wages. Furthermore, various transition periods have been introduced for the sectors. In particular, according to §24 MiLoG a.F. (Justiz 2024a), industries with binding collective wage agreements below the statutory

minimum wage could use an extended transition period till the year 2017 ¹.

Another essential part of the context is mini-job and midi-job institutions. A mini-job is a type of employment where no taxes or social security contributions are paid neither by an employee, nor by an employer. With the increase of the statutory minimum wage levels, the threshold for this type of employment has reached 520 Euro monthly, corresponding to employment of about 40 hours *per month* (*12 Euro Mindestlohn ab Oktober 2022* 2024). Workers can undertake several mini-jobs simultaneously. This arrangement is then legally treated as a midi-job with reduced social contributions, if combined monthly income is not higher than 1600 Euros. This additional threshold is introduced to prevent misuse of mini-job arrangements.

2.1.2 Regional Differences

Germany presents an interesting case study both from the minimum wage implementation strategy and regional features points of view. The high regional disparities are most pronounced when comparing Eastern and Western parts of the country. The differences were present already in 1970s, however, in Germany this geographical inequality was exacerbated by the division of the country into West and East Germany (MacKinnon, Béal, and Leibert 2024). Even more than 30 years later after the reunification, East Germany is still lagging in many aspects, especially with regard to unemployment and wages (Dirksmeier 2015; Schnabel 2016).

However, smaller-scale geographical units are essential as well. Bernard et al. (2023) expanded the concept of “geography of opportunity” to the theory of regional opportunity structures. According to the authors, there are four main types of opportunities: public and private services, civic engagement opportunities, natural and built environments, and economic conditions. In the latter set, the authors particularly highlight the importance of labour markets. Their developments and dynamics considerably contribute to the spatial inequalities on lower levels.

The regional unit of analysis in this paper is a local labour market (LLM) area rather than a NUTS-3 region. There are many ways to define the LLM, which follow the spirit of either administrative or functional approaches. The crucial characteristic of an administrative approach is that the LLMs must be nested within higher-level administrative units such as federal states. This structure allows automatically controlling for the federal-state level laws and thus expands the possible number of the applicable statistical methods. However, it poses difficulty with regard to estimating the effects near the borders of the LLM and federal states due to commuting, which results in regional interdependence, “fuzzy” LLM boarder and possibly biased results.

Thus, we are focusing on functional LLMs definition introduced by Kropp and Schwen-

¹These industries are hairdressing, meat production, agriculture and forestry (Dustmann et al. 2022)

gler (2016). The authors define the functional LLMs based on commuting patterns. In particular, they utilize a three-step approach. Firstly, they maximize commuting within a region. Secondly, they minimize cross-regional commuting. Finally, they test the assignment of a NUTS-3 region into the LLM for the longitudinal stability and adjust the local labour markets' borders. As a result of this approach, they came up with the 50 LLMs, which are stable over time and relatively homogeneous in population. As 90% of all commuting occurs within an LLM, it allows us to treat those as independent units of analysis. Studying the evolution of inequality within these regions allows for establishing the heterogeneous local effects of the minimum wage policy.

2.2 Minimum Wage Literature

Right after the statutory minimum wage policy implementation in Germany, a considerable body of literature was published, focusing on the short-term effects of the reform (e.g., Garloff 2016; Bossler and Broszeit 2017; Caliendo et al. 2018).

Caliendo, Wittbrodt, and Schröder (2019) provide a detailed review of early work on the minimum wage effects in Germany, covering both causal and descriptive studies. According to the authors, several major groups of outcomes are studied in the literature: wages and working hours, employment effects, and other effects such as unemployment, reservation wages or poverty risk. Moreover, they also state that the inequality outcomes were not studied profoundly.

With regard to the hourly wages, Caliendo, Wittbrodt, and Schröder (2019) report a consensus with estimated additional growth of 6-7% as well as left-cut distributions, spillover and compression effects. However, this did not translate into a monthly wage increase as reduced working hours were reported as the main channel for adjusting firms' employees-related costs.

Despite the negative prognosis of the Council of Experts (*germ.* Sachverständigenrat) (*Jahresgutachten 2014/15* 2015), the effects on overall employment are below 1% on average and are considered small. For instance, an early evaluation by Bossler and Gerner (2016) suggests a 0.2% decrease in overall employment. However, the marginal employment positions, i.e., mini- and midi-jobs, are affected disproportionately high. According to Caliendo, Wittbrodt, and Schröder (2019) the difference in effects can reach 2 p.p. compared to non-affected regions.

As for the last group of the outcomes, no significant effects were reported regarding the impact on unemployment or poverty reduction. However, reservation wages have increased up to 4% for German citizens.

Caliendo et al. (2023) estimate short- and medium-term effects, finding a 9% hourly wage increase in the first and 21% in the second case. However, it is compensated for by a reduction in working hours. On the contrary, Bossler and Schank (2023) documented

an impact on the *monthly* wages up to the 50th percentile and a convergence of the wage differentials across West and East Germany.

It is important to mention several other outcomes. Butschek (2022) finds an increase in the firms' selection based on expected workers' productivity at hiring. Ress and Spohr (2022) studied the change in union membership patterns, while Caliendo and Wittbrodt (2022) investigated the effects on the gender wage gap.

However, the evidence on the regional effects and the gender-related aspects of the minimum wage introduction in Germany is scarce. To the best of our knowledge, only a few papers concentrate on spatial differences. One of the early works is by Ahlfeldt, Roth, and Seidel (2018), who used the 2011-2016 data. They found early results of the spatial wage convergence in Germany, demonstrating that the wage distribution in the relatively low-wage, and thus, more affected, counties was converging faster than in the high-wage ones. Bonin et al. (2020) studied the effects on employment and unemployment in the regional labour markets. Regarding the between-region differences, no statistically significant effects on the regular employment types were established. However, marginal employment seems to be reduced. Dustmann et al. (2022), among other results, also demonstrated that the average establishment quality has increased on the regional level due to the introduction of minimum wage.

Despite the main postulated goal of the minimum wage introduction being inequality reduction, research on the impact of the policy of the inequality indicators is scarce compared to the number of studies undertaken on other aspects. Most of the literature concentrates on the USA or developing countries that have introduced minimum wage policies. Autor, Manning, and Smith (2016) have revisited the effects on inequality in the USA three decades after the minimum wage policy introduction. They have utilized variation in the minimum wages across states and have estimated it on the regional level, concentrating on the difference of the percentiles of the wage distribution compared to the median. Derenoncourt and Montialoux (2021) reviewed the effect of the minimum wage introduction on racial inequality in the USA and revealed that 20% of the reduction could be attributed to the policy without any disemployment effects for black workers.

Lin and Yun (2016) used the city-level data from China and found a 0.206 log points reduction of the inequality for the bottom half of the wage distribution. Their inequality measure is a linear difference between median wages and the 10th percentile. Engbom and Moser (2022) developed a theoretical model to study the impact of minimum wage introduction in Brazil in 1994 on the variance of wage distribution and tested it on empirical data. The results attribute about a third of the variance reduction to the minimum wage policies, highlighting the spillover effects. Campos-Vazquez and Esquivel (2023) concentrate on the impact of the minimum wage introduction in Mexico on poverty utilizing a natural variation in the minimum wage bite: the average increase of the minimum wages was 16 per cent, while next to the US border, it reached 100 per cent.

Despite such a significant difference, the impact on poverty was only up to a 3 p.p. reduction primarily due to the reduced inflow. However, the most vulnerable households were not affected by the policy.

To the best of our knowledge, only several papers explicitly discuss this issue in the context of Germany. Backhaus and Müller (2023) use the SOEP data for 2012-2016 and simulate two counterfactual scenarios with the assumptions of full-compliance, no employment effects or other changes. They measure inequality and poverty with the help of the Atkinson index and Foster-Greer-Thorbecke class indicator, concentrating on the changes in disposable household income. They have found that the minimum wage earners are scattered across the household income distribution; thus, compression of its lower part due to the introduction of minimum wage is not enough to reduce inequality.

On the contrary, Bossler and Schank (2023) found a significant reduction in wage inequality after the minimum wage introduction until 2017. The authors utilized the data from the Federal Employment Agency merged with the information on the social benefits. They have also estimated trends for conversion both within East and West Germany as well as between these parts of the country in terms of consumer price index deflated *monthly* wages of full-time workers, as there is no information on working hours in the data compared to the year 2013. The most pronounced effects are reported at the 5th and 20th percentiles of the distribution, going as high as the 50th percentile. However, there is a significant dip around the 10th percentile as it is located at the mini-job threshold.

Bachmann et al. (2022) found that the timing of the effect is different for men and women. Shortly after introducing the hourly minimum wage, women’s wages rose by approx. 6% and the ones for men increased later. However, the total increase is more significant for men than for women and reaches 14% in the later year. Caliendo and Wittbrodt (2022) showed that the introduction of the policy affected the reduction of the gender wage gap in Germany both at the 10th and the 25th percentiles.

This paper contributes to two strains of the minimum wage literature. Firstly, looking at the within-region differences in inequality development enriches the knowledge of the impact on the local labour markets, which is crucial for tailoring a policy effective not only on the general level. Secondly, it also enhances the understanding of the effects of reform on the different sub-groups of the population. The same intervention affects men and women differently, and it is essential to consider this discrepancy at the roll-out. Moreover, the policy setup with a constantly adjusted hourly minimum wage allows studying the question in light of the duration of the exposure to the policy.

Based on the current state of research, we formulate the main following hypotheses. Firstly, we expect the within-LLM within-subgroup inequality to be reduced due to the statutory minimum wage introduction. Secondly, we also expect that women will be affected mostly in the short run, while the effect for men is more pronounced in the long

run. To evaluate the hypotheses we first conduct the analysis on the LLM level, and then move to the individual level, focusing on the mechanisms.

3 Data

This paper utilizes the German Socio-Economic Panel (SOEP) collected by German Institute for Economic Research (DIW) (Goebel et al. 2019) and covering years up to 2022. This long data span allows us to estimate the effects of the minimum wage introduction on inequality in the long run. Although the number of observations is smaller than in the administrative data, the large quantity of demographic variables enables controlling for the considerable number of potential confounders. Another essential advantage of this survey data is that one can construct the *hourly* wages based on the contracted and actual working hours. This allows estimating effects both for the full-time and part-time workers. In order to evaluate the macro-level effects the data is aggregated to the functional local labour market level, which is defined in line with Kropp and Schwengler (2016) (see Section 2.1 for more details.)

Figure 1 demonstrates the evolution of the average interquartile ratio of men and women in the years before and after the minimum wage introduction. The figure plots average values of the within-LLM relations, disaggregated by sex.

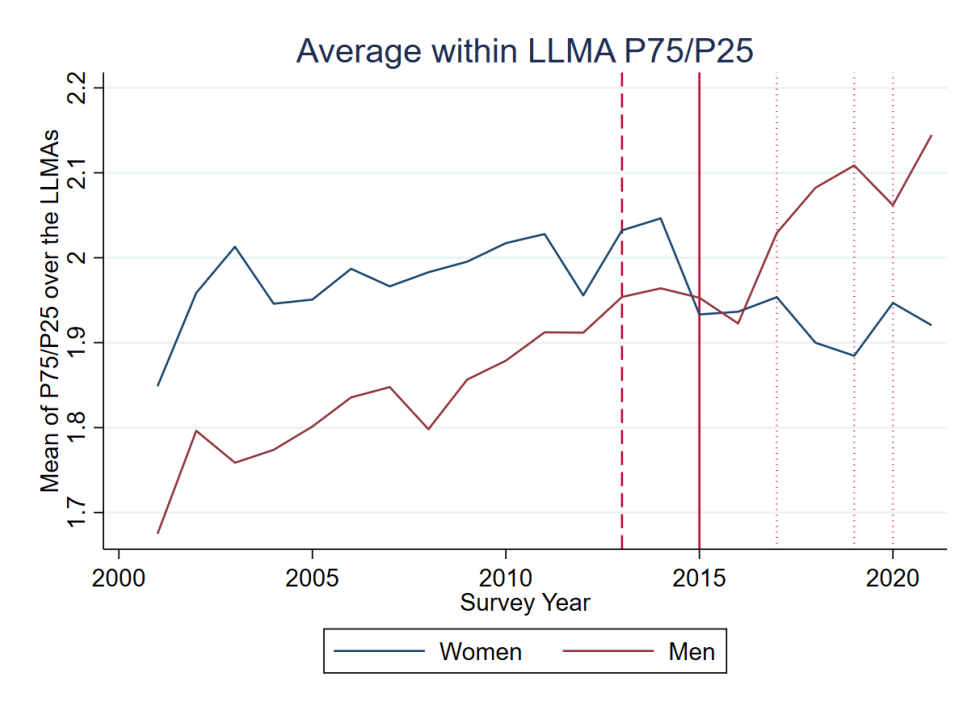


Figure 1: Within-region interquartile ratio evolution, disaggregated by sex

On this level, the within-group inequality was developing similarly before the statutory wage introduction, but then started to diverge. This descriptive statistic demonstrates

that on average the inequality between men has increased in the later years, while the one between women has slightly decreased. However, as Section 4 shows later, these tendencies are different between control and treated regions.

We report aggregated descriptive statistics on the LLM level in 2010-2022 in Table 1². The values were firstly aggregated on the LLM-year level. The control group is the LLMs with the low level of the minimum wage bite in 2013³. The treated group is composed of the (eventually) treated regions, thus aggregating the values before and after the statutory minimum wage introduction. A region was deemed treated if it was associated with the higher-than-average minimum wage bite in 2013.

Table 1: Regional level descriptive statistics, years 2010-2022

Variable	(1)		(2)		T-test
	N/[Clusters]	Mean/SE	N/[Clusters]	Mean/SE	Difference (1)-(2)
Mean hourly wage, contracted	336 [28]	17.777 (0.235)	264 [22]	15.621 (0.383)	2.156***
Mean hourly wage, actual	336 [28]	16.887 (0.236)	264 [22]	14.812 (0.353)	2.075***
Mean share of men	336 [28]	0.470 (0.004)	264 [22]	0.464 (0.005)	0.006
Mean # of years of education	336 [28]	12.034 (0.103)	264 [22]	12.120 (0.098)	-0.086
Mean age	336 [28]	41.621 (0.268)	264 [22]	41.724 (0.316)	-0.103
Mean HH size	308 [28]	3.290 (0.040)	242 [22]	3.153 (0.063)	0.136*
Mean # of working adults in a HH	308 [28]	1.449 (0.029)	242 [22]	1.375 (0.024)	0.074*
Mean share of migrants	336 [28]	0.338 (0.021)	264 [22]	0.256 (0.029)	0.082**

Note: The value displayed for t-tests are the differences in the means across the groups. Standard errors are clustered at variable amr. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Mean hourly wages - both contracted and actual - are high, above 8.5 Euro/hour for both types of regions. Nevertheless, in the control group, the average level of hourly wages is greater by 2.2 euro. In the case of full-time employees, it translates to an additional

²The statics separately for the years before and after treatment is presented in Appendix A.1 and demonstrates similar trends.

³Minimum wage bite defines, how much is a region affected compared to the other regions in the group based on the wages prior to the statutory minimum wage introduction. If the difference is relatively small, the region is said to have a low minimum wage bite.

350 Euro per month. Another important note is that for both groups, the actual hourly wage is lower than a contracted one, suggesting over-hours are present on average.

Interestingly, these differences cannot be explained by inequality regarding shares of men or average education levels or age. None of these characteristics is statistically significantly different between the two groups. However, the control group is characterized by a bigger household size and a higher number of working adults within it. Moreover, it is also coupled with a relatively higher share of migrants - 34% in the control group vs 26% in the treated areas.

On the individual level, the picture is similar, but numerical differences are more pronounced. It is evident in hourly wages: while for the control group, the individual hourly wages are not statistically different from the regional ones, for the treated group, though, the average wage over the years is 8.9 Euro/hour, resulting in about 10 euro difference per hour. This results in a monthly difference over the 1.5 thousand euro brutto. More details are available in Table 11 in Appendix A.1.

4 Regional Level Analysis

4.1 Methods

A regional variation in exposure to the minimum wage policy - the minimum wage bite - allows applying the Difference-in-Difference (DiD) approach on the regional level. Since we generate regional-level indicators using the individual-level data, adding a rich set of demographic control variables is possible. Moreover, this also enables us to perform a heterogeneous analysis by sex.

DiD approach features two main assumptions: the (conditional) parallel trend assumption and the no-anticipation assumption. To satisfy the latter, it is necessary to take into account that the introduction of the statutory minimum wage was announced in advance: not only has the law been debated for over a decade, but also the decision was made public in 2014. Thus, wages in 2014 and 2015 could have already been adjusted to the legislation. To ensure no-anticipation given the circumstances, we use 2013 as a treatment onset year. The (conditional) parallel trend assumption states that in the absence of treatment, the trends in control and treated regions would have been developing in the same manner. More formally, according to Wooldridge (2021): $E[y_t(0) - y_1(0)|d, \mathbf{x}] = E[y_t(0) - y_1(0)|\mathbf{x}], t = 2, \dots, T$, where y is an outcome of interest at time t , d represents the treatment indicator and \mathbf{x} is a set of control variables. The regional setup allows estimating the macro-indicators and precisely testing for both assumptions with the help of the Wild-type test and the Granger-causality test (Luedicke 2022). Moreover, it also provides a fully-balanced panel during the whole period.

We concentrate on the three main types of regressions: aggregated effect for the

period after minimum wage introduction (see Eq. 1); the three-part effect separated by the periods after introduction, which expands setup from Caliendo et al. (2023) (see Eq. 2); and a fully-dynamic setup (see Eq. 3).

We estimate the overall effect in the post-minimum wage period using the following regression below:

$$\ln(Y_{rgt}) = \beta_1(Bite_{rg}^{2013} \times \mathbb{1}\{t = 2015 - 2022\}) + \mu\mathbf{X}_{\mathbf{rgt}} + \gamma_t + \gamma_r + \epsilon_{rgt}, \quad (1)$$

where Y_{rgt} is an inequality measure for region r at time t for the subgroup g ; β_1 is the coefficient of interest; $Bite_{rg}^{2013}$ is a treatment indicator for a high minimum wage bite among a particular group in the region in the year 2013 defined as a normalized share of the employees in the region/subgroup, which have had gross hourly wage below 8.5 Euro in the year 2013. $\mathbf{X}_{\mathbf{rgt}}$ includes a set of the aggregated time-varying control variables for the demographic and labour market conditions to ensure the conditional parallel trends assumption⁴. The $\mathbb{1}\{t = 2015 - 2022\}$ is an indicator variable, which equals 1 for the all post-treatment periods. Finally, γ_t is time fixed effects; γ_r is regional fixed effects and ϵ_{rgt} is an error term.

The regional distribution of the minimum wage bite - current treatment indicator - is depicted in Figure 2, which plots it on the local labour market level both in continuous and binary variants. The highest bite is observed in the areas at East Germany and neighbouring labour markets. The second highest treatment intensity is concentrated in the northern regions, while in the south of the country the minimum wage bite is lower than average. Taking the cut-off at the average value, the regions in purple on the right-hand side of the Figure 2 represent the treated areas, while the ones in green are used as a control group. The geographic alignment of the areas is in line with the previous literature.

Moving to the the dynamic estimation, Equation 2 has the same structure and unobservable characteristics setup as the aggregated equation but features three separate treatment terms to disentangle the duration of exposure effects:

$$\ln(Y_{rgt}) = \beta^{2015}(Bite_{rg}^{2013} \times \mathbb{1}\{t = 2015\}) + \beta^{2016-2018}(Bite_{rg}^{2013} \times \mathbb{1}\{t = 2016 - 2018\}) + \beta^{2019-2021}(Bite_{rg}^{2013} \times \mathbb{1}\{t = 2019 - 2022\}) + \mu\mathbf{X}_{\mathbf{rgt}} + \gamma_t + \gamma_r + \epsilon_{rgt} \quad (2)$$

where effects for the first year of the statutory minimum wage (β^{2015}), medium-term

⁴The variables are average number of children below 16 years of age in a HH, average number of working adults in a HH, average years of education in a region, share of employed women in a region out of all women; share of migrants, share of the full-time employees; share of respondents between 15 and 24 years of age, log of population density; share of small and large firms in a region; share of industries by NACE encoding as well as 2 periods lagged average GDP per capita and unemployment rate.

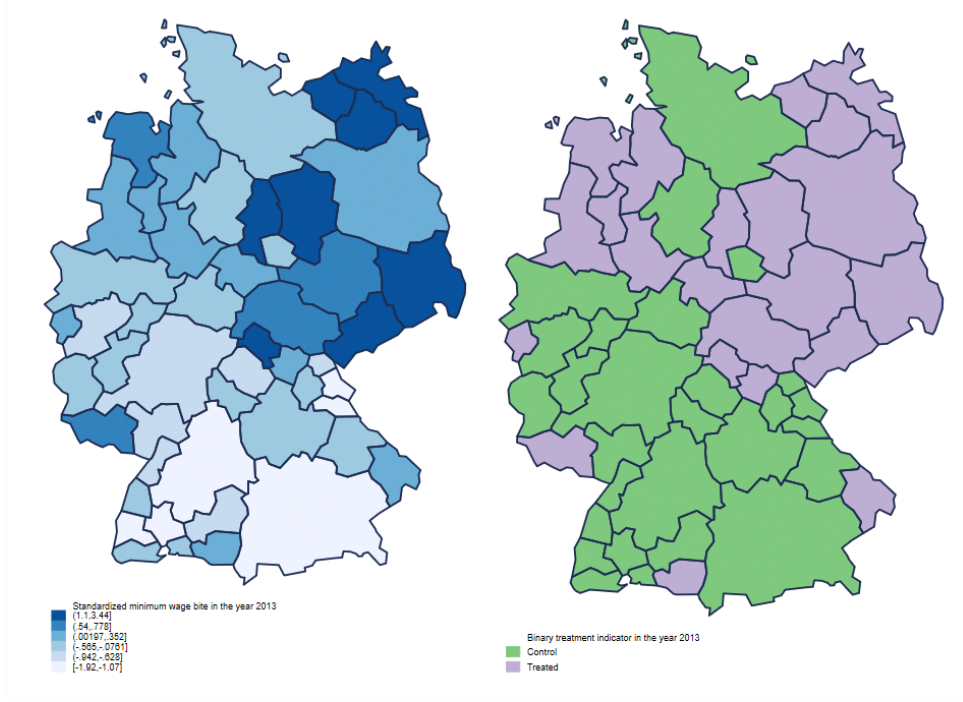


Figure 2: Minimum wage bite distribution in continuous (left) and binary (right) form

effects ($\beta^{2016-2018}$) and longer-term effects ($\beta^{2019-2022}$) are separated.

Finally, the fully dynamic setup (Eq. 3) evaluates the effects separately for each year:

$$\ln(Y_{rgt}) = \sum_{y=2015}^{2022} \beta^y (Bite_{rg}^{2013} \times \mathbb{1}\{t = y\}) + \mu \mathbf{X}_{rgt} + \gamma_t + \gamma_r + \epsilon_{rgt} \quad (3)$$

In the case of the regional-level estimation, we construct subsamples by aggregating a characteristic over a particular subgroup of respondents, thus keeping the same number of LLMs during the whole estimation period. However, we apply several general rules for the sample definition. The employed individuals between 18 and 64 years of age are included, for whom the information on working hours is present and the monthly wage was not imputed. The time period excludes the year 2014 to allow for its use as a base year.

We study different distributional aspects of within-LLM within-subgroup gross hourly and monthly wage distributions. In terms of hourly wages, we analyse the data in an aggregated manner as well as separately for men and women. The monthly income effects' evaluation covers not only these (sub)samples but also the household level distributions.

The set of indicators, which we utilize in this paper, was initially proposed by the IMF (2019) for measuring inequality between advanced economies, but can be easily adapted for regional comparisons within the said countries. Firstly, the *interquartile* ratio (P75/P25) of the distributions allows us to study the moderate effects on the within-region wage distribution of a (sub)group, and if its compression is present. Secondly, the *interdecile* ratio (P90/P10) provides a glimpse into more extreme outcome. On the other

hand, a ratio of the 25th percentile to the 10th percentile (P25/P10) tackles the impact at the lower parts of the wage distributions. Finally, standard deviation sheds light on the overall dispersion of wages in the region. For the monthly wages, we also estimate effects on Gini coefficient as the standard measure of inequality.

4.2 Results

4.2.1 Hourly Wages

We discuss results of the macro-level estimates in the section below. In particular, we first focus on the outcomes due to the impact of the statutory wage introduction on the hourly wage distributions. In the further subsection we review the effects on the monthly income of individuals and households.

Table 2 presents the most aggregated outcomes, i.e., for all subgroups and periods. The dependent variables are logarithms of the ratios based on the contracted gross hourly wage distribution.

Table 2: Aggregated effects of the minimum wage introduction on within-region inequality on LLM level on gross hourly wages

	P75/P25	P90/P10	P25/P10	SD
Bite2013 # Post-treatment years	-0.028 (0.020)	-0.096*** (0.032)	-0.053* (0.029)	-0.000 (0.025)
Observations	500	500	500	500
Parallel trends p-value	0.322	0.725	0.375	0.018
Granger causality p-value	0.327	0.735	0.374	0.017

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; Control variables are included as aggregated information on the LLM level: general hh composition, labour market conditions, average respondents' characteristics. The parallel trends test estimates an augmented model, allowing for varying slopes in the pre-treatment and post-treatment periods. The Wild test checks if the pre-trends coefficient is statistically significant. The Granger causality test augments the model with leads on treatment and performs a joint Wald test on the included coefficients.

Although there are no statistically significant effects on the interquartile ratio, there is a -9% reduction in the interdecile relation. This is particularly noteworthy as some previous research (e.g., Caliendo et al. 2023) reported a dip in the amplitude of the effect exactly at the 10th percentile due to a mini-job threshold, combined with no effects over the 50th percentile of the wage distribution. Moreover, P25/P10 has also decreased by -5%, highlighting the overall compression in the lower part of the within-region wage distributions. For all the results above, both parallel trends and no-anticipation assumptions hold.⁵ As for the standard deviation, there are no sizeable effects, but both assumptions

⁵Graphical evidence of the parallel trends assumption is presented in Figure 13 in Appendix A.2.

are questionable for the general level of the indicator.

Table 3 demonstrates the results for the same indicators but disaggregated by sex. Each of the indicators was constructed based on a separate sub-group distribution. These estimates suggest that the overall effect for women is unclear: the estimands for the outcomes, are negative (about -3%) and the assumptions are in place, but insignificant. The estimated coefficient of the impact on the SD is positive and insignificant, however, the DID assumptions are violated. For men, there is a clear reduction of -8% in terms of the interquartile ratio. The other effects are statistically insignificant.

Table 3: Effects of the minimum wage introduction on within-region inequality in terms of gross hourly wages on LLM level by sex

	P75/P25	P90/P10	P25/P10	SD
Panel A: LLMA effects, women				
Bite2013 (women) # Post-treatment years	-0.036 (0.023)	-0.030 (0.038)	-0.020 (0.034)	0.059 (0.036)
Observations	500	499	499	500
Parallel trends p-value	0.010	0.259	0.729	0.023
Granger causality p-value	0.010	0.256	0.733	0.023
Panel B: LLMA effects, men				
Bite2013 (men) # Post-treatment years	-0.075** (0.032)	-0.053 (0.067)	0.055 (0.045)	-0.049 (0.031)
Observations	500	499	499	500
Parallel trends p-value	0.795	0.132	0.054	0.097
Granger causality p-value	0.774	0.143	0.059	0.091

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; Control variables are included as aggregated information on the LLM level: general hh composition, labour market conditions, average respondents' characteristics. All variables are aggregated at the subgroup level. The parallel trends test estimates an augmented model, allowing for varying slopes in the pre-treatment and post-treatment periods. The Wild test checks if the pre-trends coefficient is statistically significant. The Granger causality test augments the model with leads on treatment and performs a joint Wald test on the included coefficients.

Table 12 in Appendix A.2 demonstrates the estimation results based on the setup in Equation 2, i.e., disaggregating the estimates by three periods (2015, 2016-2018 and 2019-2022). On the overall level (Panel A), the impact of the minimum wage introduction on inequality is delayed, and there are no statistically significant estimates for any of the inequality indicators in the year 2015. However, in the middle-run, both P90/P10 and P25/P10 relations show a reduction of -9% and -6%, respectively. In the long-run, however, only the reduction in interdecile relation is statistically significant and reaches -11%. This hints that the overall effect of the inequality reduction due to the minimum wage policy is concentrated in the later periods.

Separating by sex and time (Panels B and C) reveals that for men and women respective disaggregated estimates align with the aggregated ones. For women's within-group inequality, there is an initial interquartile ratio drop of 6%. However, this effect is only statistically significant in the short-run. For men, on the other hand, the impacts are very profound. The interquartile ratio shows a considerable delayed effect: starting from a -7% reduction in the first two periods, it increases by 3 p.p. in the last one.

Finally, the fully dynamic setup (Equation 3) sheds light on overall picture in terms of time-wise development. Figure 3 presents three outcomes for the overall population - effects on logarithms of coefficients gross hourly wages, in particular, the within-LLM ratios of P25/P10, P75/P25 and P90/P10. In 2015, all three indicators were negative but statistically insignificant.

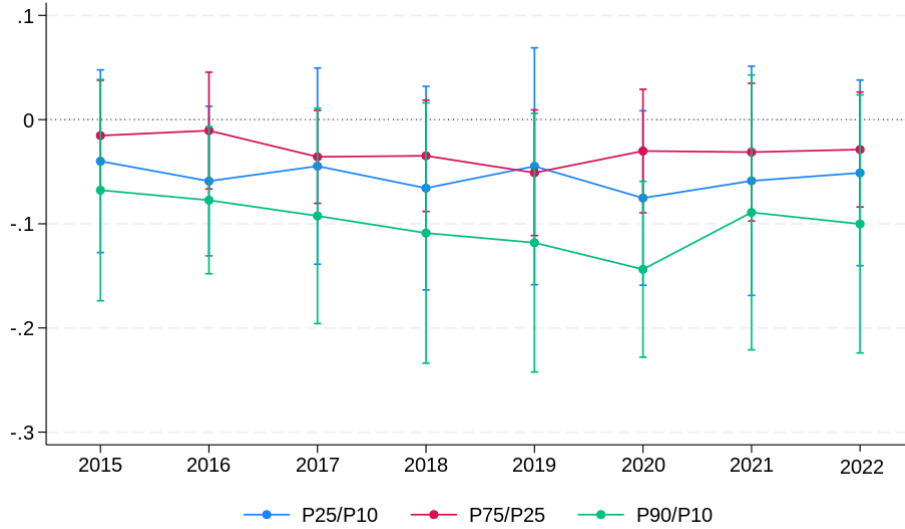


Figure 3: Dynamic effects of minimum wage introduction on LLM-level inequality indicators in terms of gross hourly wages, total sample

The impact on the interquartile ratio is stable during the whole period and reached approx. -5% but is only marginally significant. On the contrary, both P90/P10 and P25/P10 demonstrated an increased and accumulated effect over time. Already in 2016, the interdecile ratio reduced by -8%. Its most pronounced estimated effect in 2020 reached -0.15 log points. The P25/P10 - impact on the lower end of the hourly wage distribution - demonstrates a combination of patterns of interquartile and interdecile ratios, suggesting that the observed impact is driven by the changes in the lower end of wage distributions.

Figure 4 takes a closer look at the dynamics of the interquartile ratio of gross hourly wages, disaggregating it by sex as it produced mixed results on the full sample level⁶. Although both men and women start at the same -5% reduction in inequality within

⁶The P90/P10 are similar to the pictured results, while P25/P10 are not statistically significant for either group but women in the year 2016. The estimations are available by request.

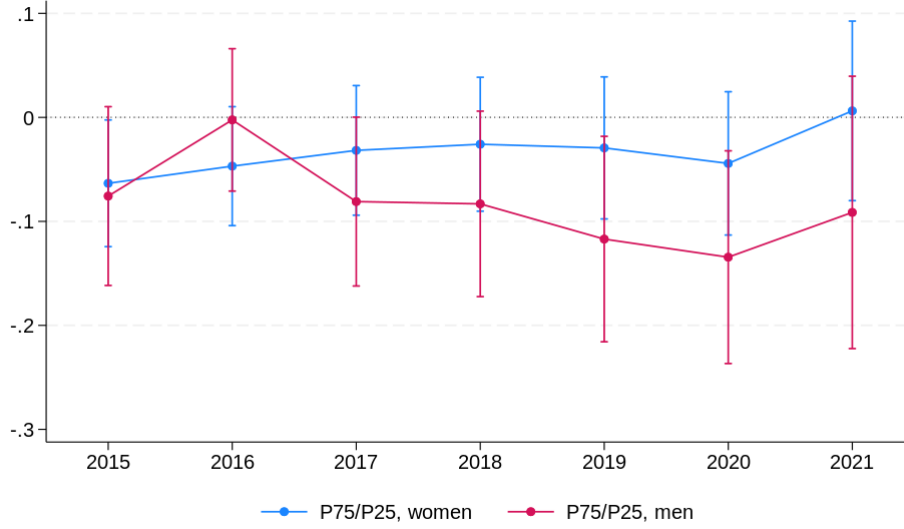


Figure 4: Dynamic effects of minimum wage introduction on interquartile ratio of gross hourly wages at LLM-level, disaggregated by sex

their subgroups, the trends evolve in the opposite directions. For women, the effect is non-persistent and present in the first two years after the reform but fades away with time. For men, on the other hand, the effect is delayed but accumulated in the later years, reaching -15% in 2020. This finding aligns with Bachmann et al. (2022), who reported similar timing and amplitude of effects on hourly wages of men and women.

Moreover, a regional aspect of the descriptive inequality evolution must be taken into account. Although on the level of the whole country inequality between men has been increasing, Figure 5 demonstrates presence of spatial patterns in the case of men.

The extend of the inequality within men's subgroup has stayed on the similar levels or even decreased in the treated LLMs, but a profound increase is observed over the years in the non-treated regions. Thus, the minimum wage introduction has counter-acted the trend of the increased inequality. However, on the country-level descriptive statistics it not pronounced due to the higher number of the control regions.

For women (Figure 16 in Appendix A.2), on the other hand, there are no pronounced geographical patterns associated with the impact of the minimum wage legislation. In the year 2013 the within-group inequality appeared to be more pronounced in the North-East of the country, while in the later years the changes are spread through Germany, regardless of the minimum wage bite in a region.

4.2.2 Monthly Income

In terms of monthly income, it is essential to study impact on the individuals as well as households as a whole: not only is the average size of a household in Germany over 3 persons (see Table 1), but also the respondents earning the minimum wage can be found

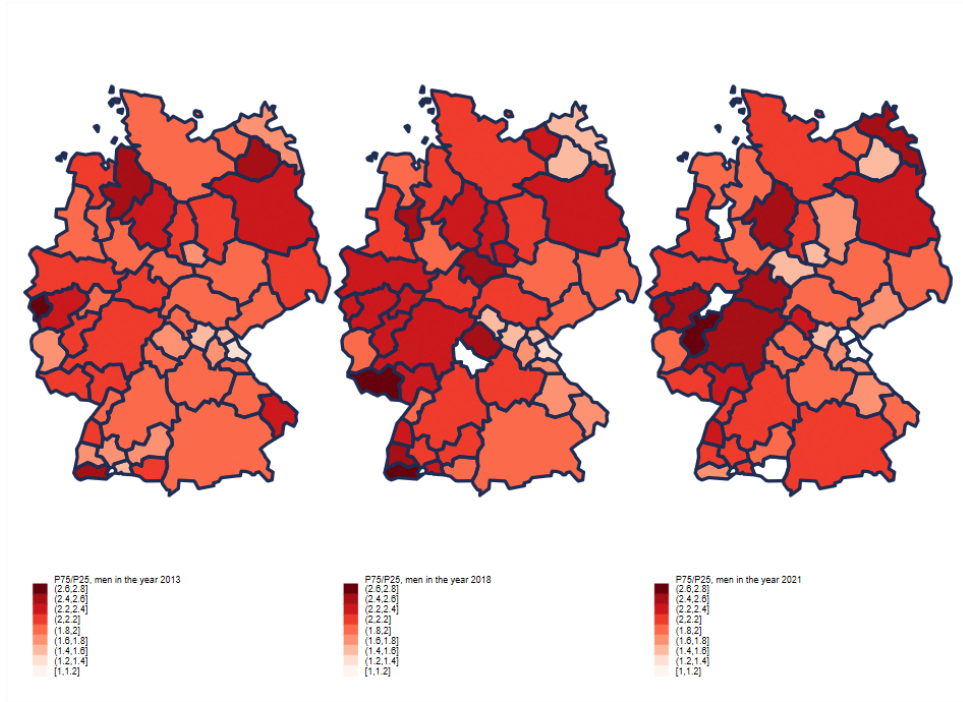


Figure 5: Regional inequality distribution of wages of men in the years 2013, 2018, and 2021

throughout the household income distribution (Backhaus and Müller 2023).

The set of indicators used to estimate monthly wages features the interquartile and interdecile ratios as well as the Gini coefficient and SD calculated on the respective wage distributions. These outcome variables provide important insights into changes in the shape of wage distributions as well as their dispersion.

Table 4 presents the results for the indicators based on the monthly income distributions. First four columns refer to the individual values, while the last four cover the impact on the households' inequality. Unfortunately, the reduction of inequality in terms of hourly wages does not translate into monthly outcomes: despite all the DiD assumptions holding on both subsamples, there are no statistically significant negative indicators.

For the households, although the estimated values are negative, their amplitude is relatively small and the standard errors are high, thus leading to the loss of significance. In terms of personal monthly wages, there is even a possible increase in the inequality in terms of monthly wages: the impact on the interdecile ratio is characterised by the positive, but insignificant estimate.

The disaggregation of the effects by sex sheds light on the findings. As Table 5 demonstrates, the impact on the hourly wages translates into reduction of monthly income inequality for men, but not for women.

This reduction is pronounced and statistically significant for the interquartile ratio in men's distribution of monthly income and equals -6%, with the DiD assumptions

Table 4: Aggregated effects of the minimum wage introduction on within-region inequality on LLMA level, monthly indicators

	Individual Monthly Wage				HH Monthly Wage			
	P75/P25	P90/P10	Gini	SD	P75/P25	P90/P10	Gini	SD
Bite2013 # Post-treatment years	-0.012 (0.029)	0.091 (0.059)	-0.001 (0.006)	-0.012 (0.031)	0.014 (0.040)	-0.036 (0.079)	-0.001 (0.007)	-0.007 (0.030)
Observations	500	500	500	500	500	500	500	500
Parallel trends p-value	0.998	0.861	0.933	0.980	0.633	0.474	0.701	0.837
Granger causality p-value	0.982	0.867	0.922	0.998	0.643	0.452	0.720	0.822

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; Control variables are included as aggregated information on the LLM level: general hh composition, labour market conditions, average respondents' characteristics. All variables are aggregated at the subgroup level. The parallel trends test estimates an augmented model, allowing for varying slopes in the pre-treatment and post-treatment periods. The Wild test checks if the pre-trends coefficient is statistically significant. The Granger causality test augments the model with leads on treatment and performs a joint Wald test on the included coefficients.

Table 5: Effects of the minimum wage introduction on within-region inequality on LLM level, disaggregated by sex

	Women				Men			
	P75/P25	P90/P10	Gini	SD	P75/P25	P90/P10	Gini	SD
Bite2013 # Post-treatment years	0.057 (0.049)	0.017 (0.073)	0.017** (0.007)	0.062 (0.039)	-0.061* (0.036)	-0.069 (0.102)	0.003 (0.008)	0.032 (0.038)
Observations	500	500	500	500	500	500	500	500
Parallel trends p-value	0.399	0.315	0.713	0.587	0.529	0.959	0.624	0.924
Granger causality p-value	0.401	0.321	0.715	0.599	0.521	0.947	0.610	0.886

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; Control variables are included as aggregated information on the LLM level: general hh composition, labour market conditions, average respondents' characteristics. All variables are aggregated at the subgroup level. The parallel trends test estimates an augmented model, allowing for varying slopes in the pre-treatment and post-treatment periods. The Wild test checks if the pre-trends coefficient is statistically significant. The Granger causality test augments the model with leads on treatment and performs a joint Wald test on the included coefficients.

being fulfilled. The other indicators are also not significant. As for women, there is no reliable evidence of any reduction in terms of monthly income inequalities: in fact, the estimated coefficients are positive, although not statistically significant for the interdecile and interquartile ratios as well as SD. On the other hand, the impact on Gini coefficient is statistically significant, and reaches 1.7%, suggesting an increase in dispersion of women's wages on the aggregated timeline.

The results for the three-period estimation (see Equation 2 for regression set up) are reported in Table 13 in Appendix A.2. Panel A demonstrates the results based on the total individual and household sample, while Panel B displays the estimates for men and women separately. Like in the aggregated case, there are almost no statistically

significant impact of the statutory minimum wage on within-region inequality in terms of monthly wages. The only exclusion is the -9% reduction in the interquartile range of men's monthly income in the year 2015.

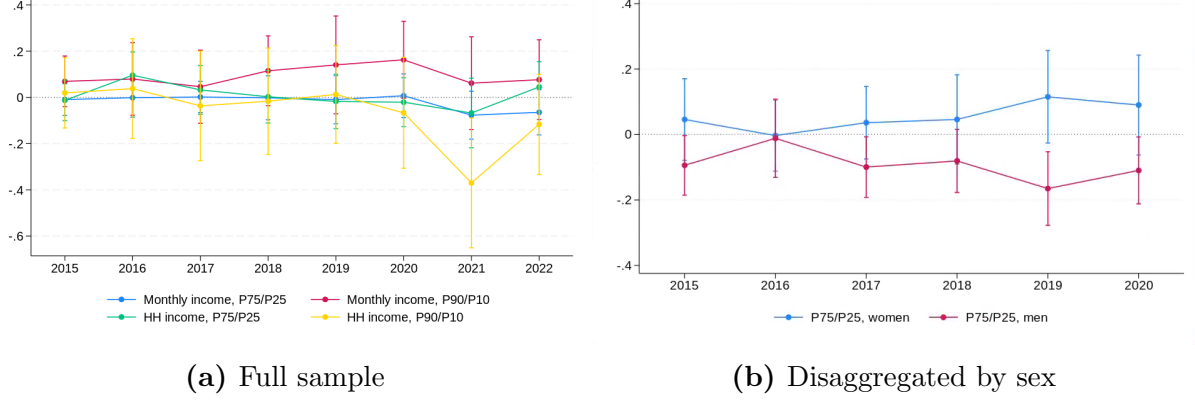


Figure 6: Impact of minimum wage introduction on within-region inequality in terms of monthly wages, selected indicators

Figure 6 illustrates the dynamic effect of the introduction of the minimum wage on selected indicators. In particular, Subfigure 6a focuses on the interquartile and interdecile ratios for the full sample of individuals as well as at the household level. Subfigure 6b zooms in on the interquartile ratio and disaggregates it by sex⁷. The first graph illustrates that the general lack of transition from hourly to monthly effects is *not* due to the mutual cancellation of dynamic coefficients. In fact, regardless of the duration of exposure to the policy, the estimates of the impact coefficients are statistically insignificant. However, disaggregating the interquartile ratio by gender (Subfigure 6b) shows that the effects for men and women cancel each other out in the full sample estimation. Moreover, compared to hourly wages (Figure 4), the patterns of the effects are similar. However, for men, the amplitude also remained for monthly earnings, while for women the coefficients became statistically insignificant.

In order to have a deeper understating of the mechanisms generating the estimated effects, in the next section we are switching to the individual level analysis. Firstly, it allows us to have a look at the “mechanical” changes in the distribution, i.e., if a reduction of the inequality stems from the increase of the wages in lower part of the distributions as it is expected with the introduction of the minimum wage policy, or if compression of the distributions is also present in higher percentiles. Secondly, individual level analysis is enabling us to check the possible mechanisms of transition of the impact on hourly wages to monthly income.

⁷Figure 17 in Appendix A.2 plots the values of the Gini coefficients.

5 Individual Level Analysis

5.1 Methods

The main goal of the individual-level analysis is not to define changes in inequality trends per se but rather to evaluate the main channels and mechanics of those. To execute the analysis the same SOEP dataset is used, allowing for controlling for both regional and individual effects. Although the methods used are the same as well - DiD with three types of treatment indicator setup - the key differences are treatment *definition* and heterogeneity of effects estimation.

Treatment can be defined either on the individual or regional level, however, both have advantages and disadvantages. The regional definition utilizing minimum wage bite, as in the Section 4, allows avoiding possible complications related to spillover effects. But it is a weak predictor for a particular person, as it rather shows the effect of the introduction of the minimum wage in the local labour market level. Moreover, it does not allow to directly account for a potentially varying intensity of exposure if an individual has changed her place of residence since 2013. Moreover, it also omits the fact that some individuals were affected, even when residing in a low-bite LLM.

On the other hand, it is also possible to define the treatment at the individual level by simply using the respondent's gross hourly wages in the year 2013 and comparing it to 8.5 Euro/h. However, introducing the statutory minimum wage also had a wide range of effects on the overall wage distribution (Gopalan et al. 2020; Fortin, Lemieux, and Lloyd 2021; Gregory and Zierahn 2022), i.e., the spillover effects are present and the SUTVA is violated (Laffers and Mellace 2020). Thus, defining treatment on the individual level only can lead to biased results.

Consequently, in order to ensure enough prediction power and simultaneously control for the overall exposure to the minimum wage, the treatment indicator is defined on the individual level and the regional wage bite is included as one of the control variables, thus acting as a proxy for potential spillover effects. Furthermore, we also conduct the analysis at two geographically different samples: firstly, we estimate the impact in terms of the whole country; secondly, we dive into the effects in the treated regions only.

To account for the possibly heterogeneous impact of the minimum wage for the different levels of earnings, we conduct estimations not only on the whole sample, but also by quartiles of the monthly income. We attribute a respondent to a particular quartile based on their monthly earnings in 2013, i.e., the last year, when the no-anticipation assumption holds. For each subgroup - total sample as well as men and women separately - we calculate the respective quartile values over LLM-year-(sex) distributions. Consequently, respondents with earnings between 0 and 25th percentile of their wage distributions (including the borders) are falling in the 1st quartile, (25,50] percentiles correspond to the

second quartile, etc.

Equation 4 below is based of Equation 1 and demonstrates how the regressions from the Section 4 are modified for the individual-level evaluation:

$$\begin{aligned} \ln(Y_{irt}) = & \beta_1(Treated^{2013} \times \mathbb{1}\{t = 2015 - 2022\}) + \beta_2 Bite_{rg}^{2013} + \\ & + \mu_1 \mathbf{X}_{irt} + \mu_2 \mathbf{Z}_{rt} + \gamma_t + \gamma_i + \gamma_r + \epsilon_{irt} \end{aligned} \quad (4)$$

Outcomes, treatment indicators as well as the set of control variables are now at the individual level instead of the regional subgroup aggregates. In order to capture LLM characteristics, the individual-level controls are augmented with the regional level variables. These variables are logarithm of population density, share of migrants as well as GDP per capita and unemployment rate (both lagged by 2 years) in a LLM area. Moreover, the subgroup-specific regional wage bite is added as a continuous numeric variable to the controls. The individual-level demographic variables include age and age squared, years of education, employment status (full-time, employment while studying, marginal employment and part-time employees used as a comparison), number of working adults in the household, number of children under 16 years of age in the HH and overall household size as well as German citizenship dummy, marital status, NACE code for the industry, and firm size.

As in the case of the regional-level analysis, the parallel trends assumption plays a crucial role in the estimation. Figure 7 presents a graphical depiction of it.

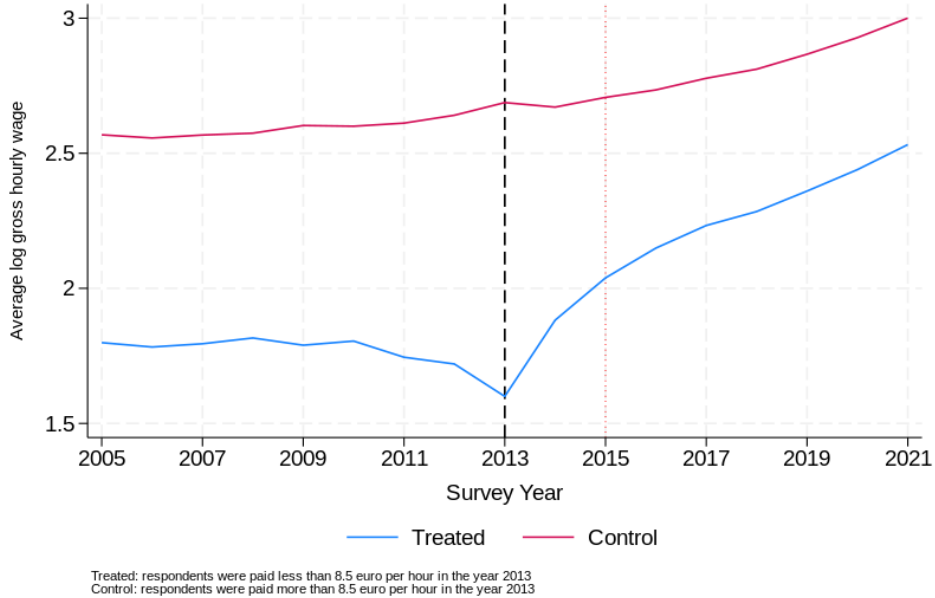


Figure 7: Parallel trends for the treatment on the individual level, overall

The figure demonstrates that the trends in the average logarithm of gross hourly wages were evolving similarly before 2013. However, after that, there is a pronounced

change for the treated group, with a trend becoming considerably steeper. The control group's trend continued to evolve similar to the pre-treatment periods. Consequently, the parallel trends assumption cannot be rejected even without controlling for additional factors.

5.2 Results

This subsection outlines the results of the individual-level estimation, featuring both aggregated samples as well as the sub-samples of men and women separately. Firstly, the overall impact as well as the one disaggregated by three periods (short-term, mid-term and long-term) is reported both for hourly wages as well as monthly income and contracted working hours. Then the estimation results by quartiles of monthly wage distributions are discussed. The last part of this sub-sections features the fully dynamic set up. It is to highlight that in all of the cases results from the treated only regions closely follow the whole country outcomes. Consequently, the exact numbers for the former are reported in Appendix [A.3](#).

5.2.1 Aggregated estimation

Table [6](#) presents the effects for both the overall sample and separated by sex. The most aggregated effect - whole sample and the whole period - totals to 0.23 logarithm points (lp) for contracted hourly wages and 0.20 lp for actual hourly wages⁸. At this level there appear to be no pronounced differences in the amplitude of impact by sex neither in terms of contracted hourly wages, nor with regard to the actual ones.

However, the estimation results disaggregated by the time passed since the minimum wage introduction demonstrate a different picture. As in the case of the regional level estimation, the effect is becoming larger for the longer-term impact: in 2015, it was around 0.19 lp overall and for women, while for men it reached 0.16 lp only. In 2016-2018, it has levelled off for all groups at 0.22 logarithmic points. In the later years - 2019-2022 - the amplitude has further increased, resulting in about 0.27 lp. In the case of actual hourly wages, the impact has a similar pattern but less pronounced amplitude.

Table [7](#) shifts the focus on monthly wages and contracted working hours. Monthly income appears to increase in every setup, thus highlighting the overall transmission of hourly wages increase to the monthly one on the individual level. Contracted hours, on the other hand, have negative coefficients. However, the decrease is only statistically significant for women and totals to -0.5 h in the aggregated set up and -0.74 h in the

⁸The contracted hourly wages is calculated based on the self-reported contracted weekly hours, while the actual hourly wages are calculated based on the self-reported actual working hours per week. Following Dütsch, Himmelreicher, and Ohlert (2019), we estimate monthly working hours by multiplying the reported hours at 4.33.

Table 6: Effects of minimum wage on the logarithm of monthly wages and a number of contracted working hours

	Overall		Men		Women	
	Contracted	Actual	Contracted	Actual	Contracted	Actual
<8.5 Euro/h in 2013 \times Years After	0.228*** (0.012)	0.201*** (0.012)	0.217*** (0.025)	0.202*** (0.025)	0.231*** (0.013)	0.201*** (0.013)
<8.5 Euro/h in 2013 \times 2015	0.190*** (0.013)	0.169*** (0.013)	0.161*** (0.027)	0.146*** (0.028)	0.203*** (0.015)	0.181*** (0.015)
<8.5 Euro/h in 2013 \times 2016-2018	0.223*** (0.012)	0.197*** (0.012)	0.221*** (0.026)	0.209*** (0.026)	0.224*** (0.014)	0.194*** (0.014)
<8.5 Euro/h in 2013 \times 2019-2022	0.270*** (0.014)	0.236*** (0.014)	0.280*** (0.030)	0.263*** (0.031)	0.265*** (0.016)	0.229*** (0.016)
Observations	72475	79205	33112	37117	39363	42088

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies. See Table 14 in Appendix A.3 for the results in treated LLMs only.

longer term. This corresponds with the less significant increase in monthly wages for women (0.18 lp in 2019-2022) than for men (0.24 lp in the same period.)

These overall findings are in line with the literature, which documents extensive additional growth in hourly wages compared to the non-treated set up. On the other hand, as Section 2 highlights, there is no definitive conclusion on transmission of the hourly wage impact to the monthly income one. It is often related to the employers reducing the contracted hours as a way to lower their costs due to legally binding minimum wage and can depend on the dataset used.

However, the analysis on the level of the whole sample does not reveal dynamics specific to the particular parts of the wage distribution or provides insights into within-group inequality developments. Table 8 delves deeper into these questions. The table is organized as follows: various dependent variables are reported in rows, while the subsamples are listed in columns. Three main groups - whole sample, men and women - are further disaggregated by the quartiles of their monthly wage distributions in 2013. The coefficients are the estimands from the aggregated exposure in the certain subgroup, thus representing the total effect over time.

A vast heterogeneity in impacts is observed between the groups. To start with, at the level of the total sample, the additional growth is documented in hourly wages (both contracted and actual) in the first two quartiles of the aggregated wage distribution, with lowest quartile having the highest increase of 0.25 lp in contracted hourly wages and 0.21 lp in the actual ones. In the second quartile the additional growth is about

Table 7: Effects of minimum wage on the logarithm of monthly wages and contracted wages

	Overall		Men		Women	
	Monthly Wage	Contracted Hours	Monthly Wage	Contracted Hours	Monthly Wage	Contracted Hours
<8.5 Euro/h in 2013 \times Years After	0.183*** (0.014)	-0.304 (0.194)	0.184*** (0.027)	-0.491 (0.343)	0.170*** (0.017)	-0.508** (0.238)
<8.5 Euro/h in 2013 \times 2015	0.152*** (0.015)	-0.303 (0.208)	0.144*** (0.028)	-0.477 (0.367)	0.151*** (0.018)	-0.397 (0.256)
<8.5 Euro/h in 2013 \times 2016-2018	0.180*** (0.015)	-0.264 (0.207)	0.180*** (0.028)	-0.526 (0.355)	0.169*** (0.018)	-0.416 (0.257)
<8.5 Euro/h in 2013 \times 2019-2022	0.216*** (0.018)	-0.366 (0.240)	0.242*** (0.034)	-0.443 (0.433)	0.188*** (0.021)	-0.736** (0.292)
Observations	80417	72643	37599	33165	42818	39478

Note: *** p<0.01, ** p<0.05, * p<0.10; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies. See Table 15 in Appendix A.3 for the results in treated LLMs only.

Table 8: Effects of minimum wage disaggregated quartiles of monthly wage distribution

	Overall				Men				Women			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Houly Wages (contracted)	0.246*** (0.022)	0.136*** (0.013)	-0.038 (0.068)	-0.268*** (0.014)	0.208*** (0.040)	0.048* (0.026)	-0.085 (0.182)	0.000 (.)	0.270*** (0.034)	0.120*** (0.019)	0.098*** (0.030)	-0.216*** (0.014)
Hourly Wages (actual)	0.207*** (0.023)	0.125*** (0.013)	-0.060 (0.069)	-0.319*** (0.018)	0.187*** (0.043)	0.058 (0.038)	-0.143 (0.189)	0.000 (.)	0.217*** (0.033)	0.092*** (0.019)	0.067** (0.034)	-0.252*** (0.018)
Monthly Wages	0.079*** (0.026)	0.090*** (0.011)	-0.043 (0.051)	-0.255*** (0.015)	0.107** (0.044)	0.040 (0.031)	-0.120 (0.129)	0.000 (.)	0.023 (0.034)	0.034** (0.014)	0.054** (0.022)	-0.216*** (0.013)
Contracted Hours	-1.509*** (0.350)	-1.128*** (0.287)	-0.769 (1.121)	0.229 (0.249)	-1.143* (0.589)	-0.629 (0.614)	-1.566 (1.924)	0.000 (.)	-2.452*** (0.461)	-2.194*** (0.413)	-0.785 (0.660)	-0.411 (0.286)
Actual Hours	-1.807*** (0.375)	-1.375*** (0.403)	0.570 (1.376)	2.762*** (0.552)	-1.094 (0.775)	-0.982 (1.080)	1.057 (2.405)	0.000 (.)	-2.615*** (0.464)	-1.948*** (0.466)	-0.308 (0.915)	1.256** (0.517)
Observations	12543	17767	21006	28142	4872	8011	10957	13379	6504	9263	11082	15390

Note: *** p<0.01, ** p<0.05, * p<0.10; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies. See Table 16 in Appendix A.3 for the results in treated LLMs only.

0.13 lp in both cases. As expected, the respondents who were in the third quartile of the aggregated wage distribution for the total sample in 2013 are not statistically significantly affected; the coefficients, however, are negative. Surprisingly, the spillover effects for the highest quartile are present: the (real) wages of respondents *dropped* due to the statutory minimum wage introduction. These findings corroborate the pattern presented in regional level analysis (Section 4). Firstly, on the level of the whole sample,

the change in interdecile ratio is statistically significant *both* due to additional increase in the wages at the lower decile and reduction at the upper one. Moreover, the respondents in the lowest parts of the wage distribution are affected the most, thus the compression at the lower part is observed.

Men and women, however, have a completely different pattern of effects across their wage distributions. For men, the spillover effects are minimal: in terms of the contracted hourly wages, the lowest quartiles demonstrate an additional increase in wages (0.21 lp), and already in the second quartile the impact is only marginally significant. The further quartiles of the wage distribution are unaffected. In terms of actual hourly wages, the only statistically significant increase of 0.19 lp is observed in the first quartile. This highlights that for men the statutory minimum wage policy has worked as intended and reduced inequality due to the additional wage growth at the lower end of wage distribution.

Women, however, are subject to considerable spillovers, as they are affected in *all* quartiles of their wage distribution. In the first quartile, the impact is positive and reaches 0.27 lp and 0.22 lp for the contracted and actual hourly wages respectively. In the latter quartiles, however, it reduces: in the second quartile, the additional increase is 0.12 lp (0.09 lp), and in the third quartile it further declines to 0.1 lp (0.07 lp). In the highest quartile however, instead of the additional growth, a considerable reduction in hourly wages is observed: in case of the contracted ones it reaches -0.22 lp; for the actual hourly wages it is higher in absolute terms and totals to -0.25 lp. Consequently, the observed reduction in the fourth quartile on the whole sample level is driven by the subsample of women rather than men. This is again consistent with the findings on the regional level, which document no reliable evidence for the decrease in inequality for women. It is to note that due to the nature of the DiD estimator, the observed changes can be interpreted as ones in *real* wages rather than nominal ones.

In terms of monthly wages the patterns are different as well. On the whole sample basis, the increase in hourly wages translates to growth of monthly income in the first two quartiles, but to a lesser extent and with the reverse amplitude: the aggregated additional growth equals to 8% for the first quartile and 9% for the second quartile of the monthly wage distribution. This lower “transmission” rate is due to the fact that even though the hourly wage increases, the contracted (and actual) monthly working hours decrease considerably. In fact, respondents in the first quartile face the *highest* decrease in their contracted working hours: -1.5 h on average vs -1.1 h in the second quartile. This is a common mechanism which is employed by the firms to reduce the costs associated with the hourly wages increase. The respondents in the third quartile of wage distribution, however, are not affected in terms of any studied outcomes. As for the upper quartile, the spillover effects are again negative leading to a -0.25 lp reduction in the monthly income. However, these respondents report a 2.7 h increase in their actual working hours. These individual-level findings are again in line with the LLM level ones,

which show no statistically significant decrease in interquartile or interdecile ratios of monthly wages.

The subsamples of men and women, again, have significant differences in their effects. For men, as in the case of hourly wages, there are no spillover effects, with monthly wages in the first quartile increasing by 10%. Contracted hours have decreased by -1.4 h, and the actual hours worked per week stayed the same. For women the picture is divergent. To start with, there is *no* additional monthly income growth in the first quartile of wage distribution: all the observed increase in the hourly wages was levelled off by the -2.5 h decrease in contracted hours. Moreover, the actual number of weekly hours worked has also reduced by -2.6 h. That is, the group of women that was targeted by the statutory minimum wage policy does not have any significant impact in terms of actual monthly income. As for the respondents in the second and third quartiles of the monthly income distribution, their monthly wages have increased by 3.4% and 5.4% respectively. However, only the second quartile of the wage distribution has faced a reduction in contracted (-2.2 h) and actual (-1.9 h) working hours. As for the top quartile of women, their reduction in contracted hourly wages directly translates to the decrease of their monthly income associated with the statutory minimum wage introduction (-0.22 lp) and *increase* in the actual working hours. In terms of the contracted hours there is no statistically significant change for this subgroup.

Table 9 provides a more dynamic set up for the evaluation of impact of the statutory minimum wage introduction. It is organised similarly to the Table 8, but the time dimension is disaggregated for the short-, mid- and long-term impact. The overall dynamics of the individual-level effects is consistent with the one on the regional level. In the case of the aggregated sample, the impact on the contracted and actual hourly wages is larger in the long-term than right after the reform and reaches 0.29 lp and 0.25 lp respectively in the first quartile. As for the second one, the pattern is similar but the amplitude is lower and totals to 0.17 lp and 0.16 lp respectively. As for the fourth quartile, the negative impact accumulates as well, and it is more pronounced for the hourly wages based on the actual weekly hours.

However, not all of the increases in hourly wages transfer to the monthly increase as well. For respondents in the first quartile, despite the highest increase in hourly wages in the long-term, there is no statistically significant effect on monthly wages in the same period. In fact, it was reducing through the time. This is coupled with a considerable decrease in contracted hours, which was -1.3 h in 2015 and reached -2.6 h in 2019-2022, thus outweighing the gain through hourly wages. For respondents in the second quartile, however, the monthly income displayed a growth of 8-10% steadily through the observed period, despite their working hours being reduced as well. However, this reduction was less significant than in the case of the first quartile and reached only -1.5 h in the long term. Respondents in the third quartile of wage distribution are not affected statistically

Table 9: Effects of minimum wage on the logarithm of monthly wages and contracted wages disaggregated by exposure length and quartiles of monthly wage distribution

	Overall				Men				Women			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Hourly Wages (contracted) \times 2015	0.242*** (0.025)	0.112*** (0.014)	-0.066 (0.066)	-0.252*** (0.037)	0.172*** (0.044)	0.045 (0.028)	-0.115 (0.188)	0.077*** (0.025)	0.274*** (0.038)	0.084*** (0.020)	0.089*** (0.032)	-0.227*** (0.027)
Hourly Wages (contracted) \times 2016-2018	0.231*** (0.024)	0.140*** (0.013)	-0.048 (0.066)	-0.265*** (0.022)	0.219*** (0.044)	0.051* (0.026)	-0.102 (0.185)	0.040 (0.034)	0.259*** (0.037)	0.129*** (0.021)	0.100*** (0.030)	-0.212*** (0.016)
Hourly Wages (contracted) \times 2019-2022	0.293*** (0.032)	0.166*** (0.016)	-0.023 (0.067)	-0.268*** (0.015)	0.266*** (0.061)	0.044 (0.028)	-0.077 (0.185)	0.000 (.)	0.293*** (0.046)	0.166*** (0.026)	0.120*** (0.033)	-0.220*** (0.016)
Hourly Wages (actual) \times 2015	0.199*** (0.026)	0.097*** (0.014)	-0.092 (0.070)	-0.273*** (0.039)	0.162*** (0.046)	0.034 (0.040)	-0.152 (0.193)	0.122 (0.077)	0.217*** (0.037)	0.052** (0.021)	0.057 (0.035)	-0.250*** (0.031)
Hourly Wages (actual) \times 2016-2018	0.199*** (0.025)	0.133*** (0.013)	-0.075 (0.069)	-0.319*** (0.027)	0.201*** (0.047)	0.058 (0.039)	-0.150 (0.191)	0.033 (0.036)	0.211*** (0.036)	0.108*** (0.020)	0.066* (0.034)	-0.255*** (0.021)
Hourly Wages (actual) \times 2019-2022	0.245*** (0.032)	0.157*** (0.017)	-0.038 (0.070)	-0.319*** (0.018)	0.206*** (0.063)	0.099** (0.045)	-0.141 (0.189)	0.000 (.)	0.235*** (0.045)	0.128*** (0.025)	0.103*** (0.037)	-0.248*** (0.020)
Monthly Wages \times 2015	0.105*** (0.026)	0.079*** (0.012)	-0.084* (0.050)	-0.234*** (0.030)	0.114** (0.045)	0.029 (0.032)	-0.137 (0.133)	0.006 (0.059)	0.035 (0.035)	0.012 (0.015)	0.065*** (0.023)	-0.229*** (0.026)
Monthly Wages \times 2016-2018	0.070** (0.029)	0.093*** (0.011)	-0.053 (0.050)	-0.242*** (0.024)	0.109** (0.047)	0.045 (0.031)	-0.133 (0.131)	0.037 (0.038)	0.029 (0.038)	0.045*** (0.016)	0.046** (0.023)	-0.217*** (0.015)
Monthly Wages \times 2019-2022	0.047 (0.034)	0.104*** (0.014)	-0.021 (0.050)	-0.255*** (0.015)	0.086 (0.062)	0.043 (0.033)	-0.114 (0.131)	0.000 (.)	-0.022 (0.045)	0.045** (0.020)	0.053** (0.025)	-0.216*** (0.016)
Contracted Hours \times 2015	-1.229*** (0.388)	-0.855*** (0.319)	-1.210 (1.157)	0.197 (0.618)	-0.979 (0.646)	-0.858 (0.642)	-0.798 (2.082)	0.289 (1.159)	-2.517*** (0.508)	-1.847*** (0.414)	-0.328 (0.714)	-0.819 (0.632)
Contracted Hours \times 2016-2018	-1.325*** (0.389)	-1.169*** (0.297)	-0.767 (1.135)	0.532 (0.441)	-1.119* (0.652)	-0.510 (0.616)	-1.347 (1.979)	0.329 (0.859)	-2.261*** (0.508)	-2.227*** (0.444)	-0.968 (0.665)	-0.464 (0.327)
Contracted Hours \times 2019-2022	-2.612*** (0.469)	-1.506*** (0.383)	-0.647 (1.141)	0.226 (0.249)	-1.677* (0.893)	-0.660 (0.778)	-1.692 (1.963)	0.000 (.)	-2.868*** (0.603)	-2.824*** (0.551)	-1.457* (0.782)	-0.373 (0.334)
Actual Hours \times 2015	-1.417*** (0.431)	-0.826* (0.421)	0.030 (1.469)	1.329 (1.478)	-0.823 (0.885)	-0.517 (1.230)	0.554 (2.684)	-6.189** (2.599)	-2.712*** (0.526)	-1.509*** (0.497)	0.218 (0.916)	0.654 (0.956)
Actual Hours \times 2016-2018	-1.747*** (0.411)	-1.555*** (0.415)	0.863 (1.382)	3.418*** (0.839)	-1.147 (0.819)	-0.754 (1.110)	0.785 (2.471)	-0.221 (1.152)	-2.397*** (0.510)	-2.118*** (0.501)	-0.373 (0.906)	1.495*** (0.567)
Actual Hours \times 2019-2022	-2.788*** (0.494)	-1.863*** (0.521)	0.482 (1.428)	2.758*** (0.552)	-1.686* (1.020)	-2.490* (1.276)	1.155 (2.389)	0.000 (.)	-3.026*** (0.637)	-2.348*** (0.620)	-1.566 (1.087)	1.005* (0.559)
Observations	12543	17767	21006	28142	4872	8011	10957	13379	6504	9263	11082	15390

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies. See Table 17 in Appendix A.3 for the results in treated LLMs only.

significantly at any variables at any point in time. As for the top quartile, the reduction in their monthly income was also increasing in amplitude with the time; their contracted hours do not appear to be changing, but the actual ones were increasing significantly (by about 3 h) in the longer-term.

The tendencies in the sub-samples of men and women resemble the ones found at the regional-level analysis. Moreover, the estimated impact by quartiles of wage distributions is similar to the set up in the totally aggregated manner. It is to highlight that the reduction in contracted working hours is present in the first quartile of both men and women, although for women the impact is higher: for example, in 2019-2022 the estimated decline in the contracted hours for men was -1.7 h, while for women the same coefficient reached -2.8 h. Furthermore, in case of women, reduction in contracted hours reached

further up in the wage distribution with the time, totalling to -1.5 h in the third quartile. This again highlights that firms utilize this channel more intensively with time to reduce the costs associated with the minimum wage introduction; and women are subject to more pronounced cuts, despite the fact that already at the roll-out of the policy their average weekly working hours were lower than men's.

5.2.2 Dynamic Results

In this subsection we concentrate on a dynamic aspect of the estimated results, thus zooming in the changes of the impact of minimum wage introduction over time. In particular, we focus on monthly wages, as previous estimation revealed the most pronounced dynamic aspect in this dependent variable. However, the outcomes for hourly wages is available in Appendix A.3.

Figure 8 concentrates on the effects of monthly wage on the whole sample (Panel A) and disaggregated by sex (Panel B). It demonstrates that in the case of the individual treatment setup and controlling for the regional bite, the effects for the whole sample appeared already in 2015 and increased in the further years. A more steep increase is observed in the later years. In the year 2015, the effect reached about 0.15 lp, while in the year 2022, it totalled to 0.25 lp.

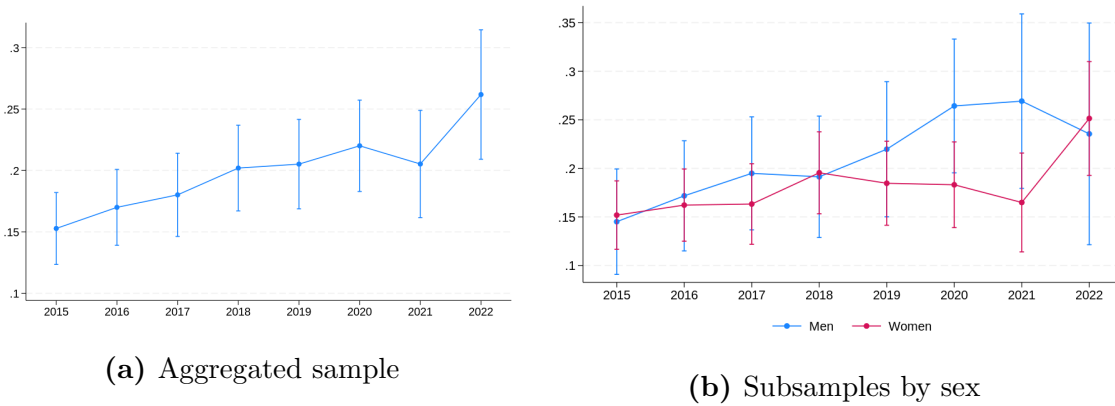


Figure 8: Dynamic effects of minimum wages on logarithm of monthly wages

As for the subsamples of men and women, the impact on the individual level mirrors the regional level one: while women have been affected early on and the amplitude is similar through the whole period (ca. 0.18 lp), the onset of effect for men happened with a delay, but totalling to a greater amplitude over years.

Moving on to the effects on monthly wages of the respondents at a certain quartile of wage distribution, Figure 9 presents the dynamic estimates for the whole sample. Respondents in the first and second quartiles of wage distribution are impacted positively during the whole period, but amplitude of the effects vary. In 2015, i.e., in the short term, the respondents in the first quartile are demonstrating the biggest increase of ca.

10% in their monthly wage; as for those in the second quartile, their monthly income has also grown, but only for about 8%. However, with the prolonged exposure, the impact on the monthly wages of the respondents in the first quartile of wage distribution lowers and becomes statistically insignificant from the year 2019 onward. This, as discussed in the previous section, goes hand in hand with decreased contracted working hours counteracting any additional income acquired through increase in hourly wages. Figure 22 in Appendix A.3 also highlights this fact: it clearly demonstrates that during the whole period the increase in hourly wages for the respondents in the first quartile of wage distribution was statistically significantly higher than for those in the second. However, this does not translate to monthly wages growth. In contrast, the impact on the respondents in the second quartile of the wage distribution is steadily increasing with time, reaching ca. 16% at 2022.

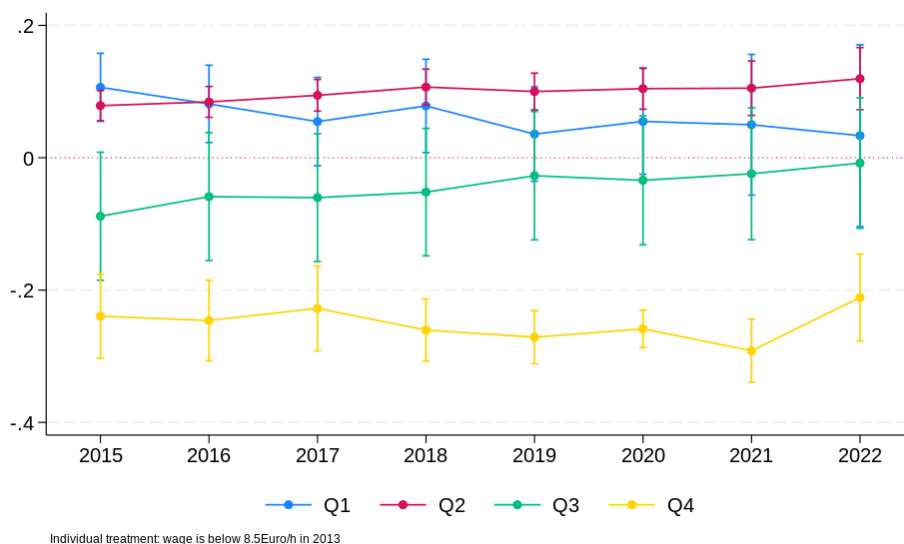


Figure 9: Dynamic effects of minimum wages on logarithm of monthly wages, disaggregated by quartile

For the respondents in the higher half of the wage distribution - third and fourth quartiles - the spillover effects are present in a form of *negative* impact on monthly wages. In the year 2015, both quartiles were affected negatively, leading to a -8% reduction of monthly wages for the respondents in the third quartile of wage distribution; and a nosedive of -0.23 lp for those in the top quartile. For the former, however, the negative impact levelled off already in 2016, and was not statistically significant from that time onward. As for the latter, the reduction in monthly wages persisted through the whole period and was relatively stable.

Disaggregating the results even further by sex (Figure 10) allows us to grasp the sub-group specific dynamic. Subfigure 10a displays the estimation results for men, while subfigure 10b focuses on women.

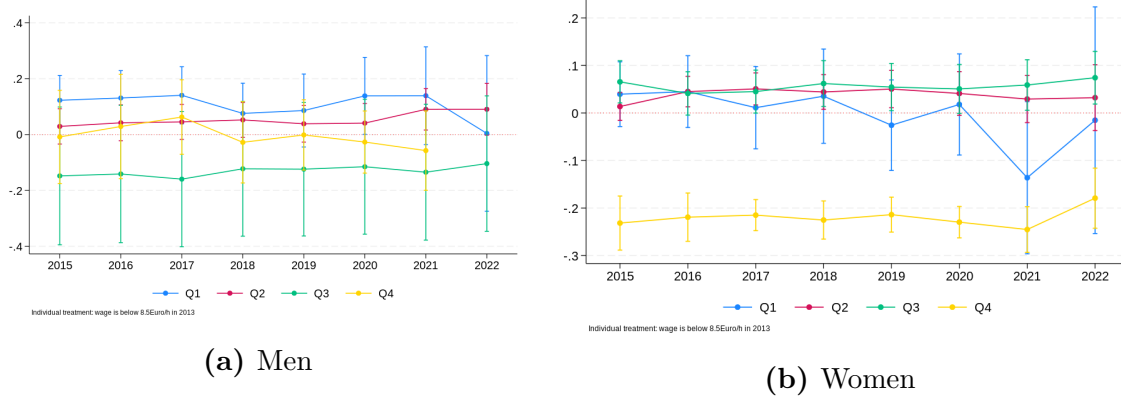


Figure 10: Dynamic effects of minimum wages on logarithm of monthly wages, disaggregated by quartile and sex

As for men, the Figure does not demonstrate any pronounced spillover effects in terms of monthly wages⁹: statistically significant impact is present only for the respondents in the first quartile of the wage distribution, and is stable over time. For women, however, the spillover effects are significant. In the year 2015 the impact was statistically significant *only* for the top half of the wage distribution. Although for the first and second quartile the estimated coefficients in terms of monthly wages are positive, they are not statistically different from zero, due to an immediate and pronounced reduction in working hours. In fact, for the first quartile of the wage distribution not only the impact on monthly income never becomes statistically significant, but also the estimated coefficients become *negative* in the longer term. Women in the middle of their wage distribution - the ones in the second and third quartiles - are the only sub-groups of women, whose monthly income has increased as a result of the statutory minimum wage introduction, but only in the longer term and for about 5%. The women in the top quartile, on contrary, faced a drastic reduction in their monthly income, which reaches -0.25 lp.

To sum up, in terms of both the aggregated and dynamic results, we make several pronounced observations. Firstly, the reduction in inequality observed on the regional level for the hourly wages is indeed due to the significant increase in wages of those at the lower end of the wage distribution in case of total sample and a subsample of men. However, for the monthly wages, the picture is unclear due to the different utilisation of contracted hours by the firms: although the hourly wage increase was the highest for those in the lowest quartile, the reduction of contracted hours is the most pronounced for the same group. This leads to the offset of costs for a firm associated with a necessity to comply with the legislation. Secondly, the impact for men and women is extremely heterogeneous. While for men the decrease of the of the inequality is associated with the steady positive impact on the first quartile of their wage distribution *only*, women face significant spillover effects. In particular, for a relative increase in the pay for the other

⁹Figure 23a in Appendix A.3 demonstrates no spillover effects for men in terms of hourly wage either.

groups, highly qualified high-earning women are the ones, who appear to bear the cost: they are the only subgroup, which not only does not have an increase in wage, but also the ones facing robust *decrease* in their payments. Moreover, the cost reduction channel via the reduced contracted working hours is also mostly applied on women, but in the lowest quartile, thus leading to no significant impact in terms of monthly wages for the initially targeted group.

6 Robustness Checks

The section concentrates on estimating the robustness of the results discussed above. Firstly, we provide alternative tests for the conditional parallel trends assumption, then move on to varying the definitions of minimum wage bite.

Conditional parallel trends. Although the tables in the sections above provide the results of the test for the parallel trend assumptions, we additionally test it by re-estimating the regional-level regressions in the panel event-study set up. This approach corresponds to the DiD estimations, but allows for a direct inclusion of lags and leads in the equation. For this model, the time variable is recoded with regard to the event, i.e., introduction of the minimum wage (2013). The LLMs with a minimum wage bite in the year below average are considered to be a control group. For these observation the time variable is set to missing.

Consequently, we estimate the following model:

$$\ln(Y_{rt}^g) = \alpha + \sum_{i=0, y \neq 1}^9 \beta^i (\mathbb{1}\{t = i\}) + \sum_{j=1}^5 \beta^j (\mathbb{1}\{t = -j\}) + \mu \mathbf{X}_{rt}^g + \gamma_t + \gamma_r + \epsilon_{rt}, \quad (5)$$

where the indicator variable $\mathbb{1}\{t = i\}$ represents the included leads, and $\mathbb{1}\{t = -j\}$ stands for lags. As in the previous setup, $\ln(Y_{rt}^g)$ is a logarithm of an outcome of interest and \mathbf{X}_{rt}^g is a set of control variables on the regional level. γ_t and γ_r are time and regional fixed effects; ϵ_{rt} is an error term. The baseline year is 2015.

Figure 11 provides an example of the event-study estimates, using impact on the interquartile relation as an example¹⁰. In the periods before the reform the indicators are not statistically different from zero in any of the years, confirming that the conditional parallel trends assumption cannot be rejected. This aligns with the test value reported in the previous sections. A similar outcome is found for the other indicators and/or subsamples, and it all of the cases it aligns with the test results.

Minimum wage bite definition. In the literature, the minimum wage bite is not defined in a unique manner, resulting in various alternative definitions that can be tested

¹⁰Full results are available by request.

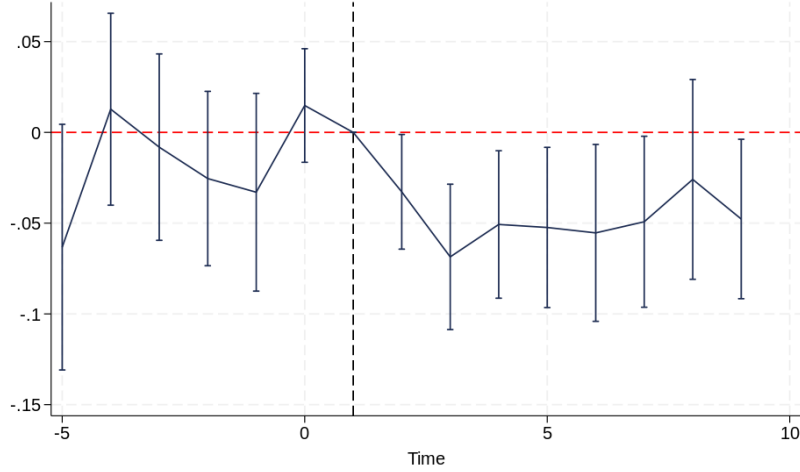


Figure 11: Event study estimation of the impact of minimum wage introduction on interquartile ratio of gross hourly wages on LLM level, total sample

without employing additional data. For instance, Bonin et al. (2020) use the average difference between the hourly wage rate and the statutory minimum wage for all hourly wages below the new wage floor (zero for wages above 8.50 Euro) at the regional level. And Bundesamt (2023) concentrates on the Kaitz Index, thus covering only the full-time employees. Garloff (2019) use as the minimum wage shares of the individuals, who are employed full-time and earn less than 1400-1450-1500 Euro per month in 2013. We have tested our original estimations utilizing the definitions of the minimum wage bite above, and the results are stable and comparable with the ones reported in the paper.

Figure 12 demonstrates the impact of the introduction of the minimum wage on the interquartile ratio of subsample of the full-time workers.

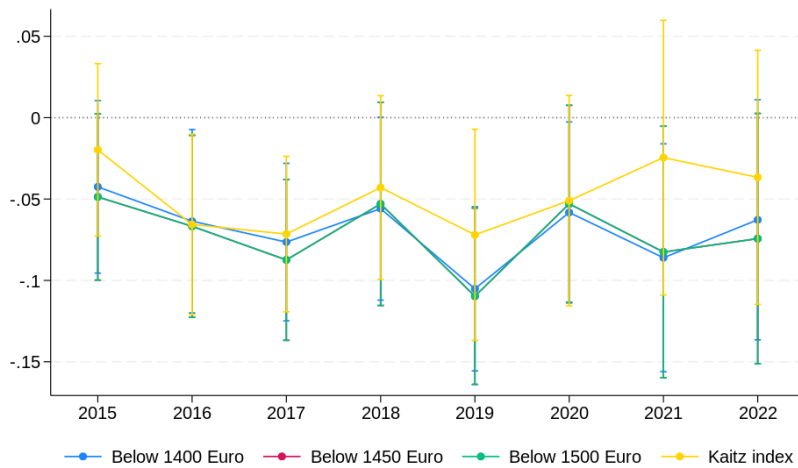


Figure 12: Dynamic effects of minimum wages on interquartile ratio of hourly wages on LLM level utilizing the full sample, various minimum wage bite definitions

Firstly, the dynamic estimated results appear to closely follow each other regardless of

the minimum wage bite definition. Secondly, the pattern of the effects is similar to the one observed on a full-sample estimation. The amplitude of the estimated coefficients is higher for the full-time workers only, however, the estimands are not statistically significantly different from the full sample, thus confirming our previous results.

7 Discussion and Conclusion

This paper studies the effects of the introduction of minimum wage on inequality within German regions on two levels. The regional-level analysis is used in order to evaluate a direct impact on selected macro-indicators. The individual analysis allows for disentangling both between-groups and within-groups differences.

Since the statutory minimum wage was introduced in the whole country in 2015, the regional variation in its effects plays a crucial role as an identifying assumption. Concentrating on 50 functional local labour markets, which can be treated as independent observations, a regional minimum wage bite was defined in continuous and dichotomous manners. The latter served as a binary treatment variable for the regional-level analysis. The former, in turn, was added to the individual-level estimations to control for the spillover effects. The main treatment variable on the individual level, however, was a dummy showing if a respondent’s wage in the year 2013 was below 8.5 Euro/hour (i.e., the initial level of the statutory minimum wage).

Using SOEP data and their aggregates enabled us to conduct a heterogeneity analysis on the LLM and individual levels, controlling for a rich set of covariates. Three types of effects have been evaluated using DiD approach: aggregated effect, three-period effects following Caliendo et al. (2023) with separate indicators for 2015, 2016-2018 and 2019-2022 periods; and a fully dynamic setup.

Firstly, the total sample has allowed us to evaluate the effects on within-region inequality, focusing on the geographical aspect of this statutory legislation’s impact. The findings highlight that the effect on a macro-level inequality in terms of contracted gross hourly wages is pronounced at the extremes of the distribution: for the whole sample, there is no statistical significance for the interquartile ratio coefficient, but a -9% and -5% reduction for P90/P10 and P25/P10 indicators is present. This finding is supported by the individual-level analysis, which highlights the strongest positive effect of the minimum wage introduction for the lowest quantile of the distribution. However, this positive impact on inequality does not appear to transfer to the monthly wages of individuals or the total household income, as none of the inequality indicators reduced statistically significantly. Individual-level analysis revealed that this is due to a considerable reduction in contracted working hours, which offsets the growth of the hourly wages. Moreover, this reduction is most pronounced in the lowest quartile and reaches -1.5 h per week.

The dynamic analysis of the within-region inequality showed that in the later periods,

a -5% reduction in the interquartile ratio of gross hourly wage distribution is observed and stable, thus the general insignificance of this indicator stemmed from the immediate effect. The interdecile and P25/P10 ratios, in turn, are statistically significant and gaining higher amplitude over time. The trends of their estimated effects follow each other, thus indirectly highlighting that the reduction in the interdecile ratio is due to a compression in the lower end of the wage distribution. The individual-level analysis supports this finding by demonstrating a more pronounced impact on gross hourly wages in the first quartile of the wage distribution, which is accumulating over time. However, the effect on the monthly wages of these respondents fades away with time due to an increased usage of contracted hours reduction in longer term.

Secondly, there is also a noticeable heterogeneity of effects by respondents' sex. The interquartile ratio has reduced for men, both in terms of hourly and monthly wages, by -7% and -6%, respectively. The individual-level analysis demonstrates that the legislation has affected only respondents in the first quartile of their wage distribution, and for them no statistically significant reduction in working hours was present. Moreover, from a dynamic point of view, although the impact on men's inequality appeared after 2016, it was not only statistically significant during the whole period but also accumulating during the observed time. This finding seems to contradict descriptive statistics on the country level, which showed increase in inequality among men in the later years. However, geographical disaggregation of men's inequality indicators demonstrates that even though value of those increased in non-treated regions, there was a profound reduction in the treated LLMs. However, population-wise the control areas are bigger, which leads to the observed effect on the country level. Consequently, we infer that the minimum wage policy effectively targeted male workers, reducing wage inequality by increasing the mean income within the lower quartile of the wage distribution for this group.

For women, on the other hand, it is impossible to draw such a clear conclusion about policy implications. Regional-level analysis has demonstrated no statistically significant reduction in inequality due to minimum wage introduction for this subgroup of respondents. The only exclusion is the short-term -5% reduction in the interquartile ratio of gross hourly wages in 2015, which became statistically insignificant a year later. In the case of the monthly wages, the inequality reduction was never statistically significant. This is, however, in line with the country-level trends, which register a decline in inequality between women in general, regardless of the exposure to the minimum wage policy.

The individual-level analysis reveals considerable dissimilarities in how the policy affects women compared to men. There are two main differences. Firstly, women are susceptible to considerable spillover effects of the minimum wage policy. While there is an additional growth of women's gross hourly wages in the years following the policy's introduction for the first three quartiles of the wage distribution, women at the top

quartile faced cuts in their real hourly payments. Secondly, the reduced working hours – both contracted and actual – on the total sample level appear to be driven by the impact on women in the lowest quartiles of the wage distribution. As a result, even though women in the first quartile demonstrated the most considerable increase in their hourly wages out of all subgroups, their rise in monthly salaries is statistically insignificant in all of the estimation setups. This is a result of the simultaneous decrease in their working hours, which is, according to the literature, a common way for firms to channel the built-up costs. Moreover, this mechanism seems to become more popular with time, as the contracted hours drop becomes more significant for all groups in the later years.

There are several limitations to this study. Firstly, respondents self-report both contracted and actual working hours. This can lead to a potential measurement error due to recall bias and the need to convert monthly hours, which are usually stated in a contract, to weekly ones. Robustness checks, which are performed on the subsample of full-time employees result in similar estimates, which, on the one hand, reduces the concern. On the other hand, it omits a considerable part of the population, especially a disproportionately high share of women, who are employed only part time. This can result in the underestimation of the impact for this subgroup. Secondly, only the impact on the employed individuals is researched, which is associated with a possible self-selection bias. Consequently, there is an implicit assumption that this bias is not different between the treated and control groups.

This study is closing only a small part of the gap in the literature regarding the heterogeneous effects of the minimum wage policy, and further research is required. The possible directions are providing more information on the exact mechanisms of the inequality reduction and firms' adaptations, e.g., if the firms force employees to transition the different employment type as an adaptation mechanism. Another promising field is evaluating whether the policy has reached the other goals - poverty and poverty risk reduction - among the heterogeneous groups of respondents. Moreover, a more detailed profiling of the places with the highest effects can be helpful for further policy development to figure out under which conditions the statutory minimum wage policy had the best impact on the regional, household and individual levels.

References

- 12 Euro Mindestlohn ab Oktober 2022 (Jan. 2024). [Online; accessed 22. Jan. 2024]. URL: <https://www.bundesregierung.de/breg-de/aktuelles/12-euro-mindestlohn-2006858#:~:text=In%20Deutschland%20gibt%20es%20seit,oder%20teilweise%20Praktikantinnen%20und%20Praktikanten..>
- Ahlfeldt, Gabriel M, Duncan Roth, and Tobias Seidel (2018). “The regional effects of Germany’s national minimum wage”. In: *Economics Letters* 172, pp. 127–130.
- Autor, David H, Alan Manning, and Christopher L Smith (2016). “The contribution of the minimum wage to US wage inequality over three decades: a reassessment”. In: *American Economic Journal: Applied Economics* 8.1, pp. 58–99.
- Bachmann, Ronald et al. (2022). *Auswirkungen des gesetzlichen Mindestlohns auf Löhne und Arbeitszeiten*. Tech. rep. RWI Projektberichte.
- Backhaus, Teresa and Kai-Uwe Müller (2023). “Can a federal minimum wage alleviate poverty and income inequality? Ex-post and simulation evidence from Germany”. In: *Journal of European Social Policy* 33.2, pp. 216–232.
- Bernard, Josef et al. (2023). “Regional opportunity structures: A research agenda to link spatial and social inequalities in rural areas”. In: *Progress in Human Geography* 47.1, pp. 103–123.
- BMAS - Mindestlohn (June 2025). [Online; accessed 12. Jun. 2025]. URL: <https://www.bmas.de/DE/Arbeit/Arbeitsrecht/Mindestlohn/mindestlohn.html>.
- Bonin, Holger et al. (2020). “The German statutory minimum wage and its effects on regional employment and unemployment”. In: *Jahrbücher für Nationalökonomie und Statistik* 240.2-3, pp. 295–319.
- Börschlein, Erik-Benjamin et al. (2022). *Mindestloohnerhöhung im Oktober 2022: 12 Euro Mindestlohn betreffen mehr als jeden fünften Job*. Tech. rep. IAB-Kurzbericht.
- Bossler, Mario and Sandra Broszeit (2017). “Do minimum wages increase job satisfaction? Micro-data evidence from the new German minimum wage”. In: *Labour* 31.4, pp. 480–493.
- Bossler, Mario and H. Gerner (2019). “Employment Effects of the New German Minimum Wage: Evidence from Establishment-Level Microdata”. In: *ILR Review* 73, pp. 1070–1094. DOI: [10.1177/0019793919889635](https://doi.org/10.1177/0019793919889635).
- Bossler, Mario and Hans-Dieter Gerner (2016). “Employment effects of the new German minimum wage: Evidence from establishment-level micro data”. In: *IAB -Discussion Paper*. ISSN: 2195-2663.
- Bossler, Mario and Thorsten Schank (2023). “Wage inequality in Germany after the minimum wage introduction”. In: *Journal of Labor Economics* 41.3, pp. 000–000.
- Bundesamt, Statistisches (Sept. 2023). *Relative Höhe des Mindestlohns nach Arbeitsmarktreionen*. [Online; accessed 1. Sep. 2023]. URL: <https://www.destatis.de/DE/Themen/Arbeit/Verdienste/Mindestloehne/Mindestloehne.html>.
- Butschek, Sebastian (2022). “Raising the bar: minimum wages and employers’ hiring standards”. In: *American Economic Journal: Economic Policy* 14.2, pp. 91–124.
- Caliendo, Marco and Linda Wittbrodt (2022). “Did the minimum wage reduce the gender wage gap in Germany?” In: *Labour Economics* 78, p. 102228.
- Caliendo, Marco, Linda Wittbrodt, and Carsten Schröder (2019). “The causal effects of the minimum wage introduction in Germany—an overview”. In: *German Economic Review* 20.3, pp. 257–292.

- Caliendo, Marco et al. (2018). “The short-run employment effects of the German minimum wage reform”. In: *Labour Economics* 53, pp. 46–62.
- (2023). “The short-and medium-term distributional effects of the German minimum wage reform”. In: *Empirical Economics* 64.3, pp. 1149–1175.
- Campos-Vazquez, Raymundo M and Gerardo Esquivel (2023). “The Effect of the Minimum Wage on Poverty: Evidence from a Quasi-Experiment in Mexico”. In: *The Journal of Development Studies* 59.3, pp. 360–380.
- Derenoncourt, Ellora and Claire Montialoux (2021). “Minimum wages and racial inequality”. In: *The Quarterly Journal of Economics* 136.1, pp. 169–228.
- Destatis (Jan. 2025). *Gesetzlicher Mindestlohn in Deutschland*. [Online; accessed 22. Jan. 2024]. URL: <https://www.destatis.de/DE/Themen/Arbeit/Verdienste/Mindestloehne/Tabellen/gesetzlicher-mindestlohn.html>.
- Dirksmeier, Peter (2015). “The intricate geographies of gender ideologies in Germany”. In: *Geoforum* 64, pp. 12–24.
- Dustmann, Christian et al. (2022). “Reallocation effects of the minimum wage”. In: *The Quarterly Journal of Economics* 137.1, pp. 267–328.
- Dütsch, Matthias, Ralf Himmelreicher, and Clemens Ohlert (2019). “Calculating gross hourly wages—the (structure of) earnings survey and the German socio-economic panel in comparison”. In: *Jahrbücher für Nationalökonomie und Statistik* 239.2, pp. 243–276.
- Engbom, Niklas and Christian Moser (2022). “Earnings inequality and the minimum wage: Evidence from Brazil”. In: *American Economic Review* 112.12, pp. 3803–3847.
- Eurostat (Jan. 2024). *Statistics | Eurostat*. [Online; accessed 21. Jan. 2024]. URL: https://ec.europa.eu/eurostat/databrowser/view/EARN_MW_CUR__custom_65998/bookmark/table?lang=en&bookmarkId=b445623e-611a-4943-8465-026d191c54e9.
- Fortin, N., T. Lemieux, and N. Lloyd (2021). “Labor Market Institutions and the Distribution of Wages: The Role of Spillover Effects”. In: *Journal of Labor Economics* 39, S369–S412. DOI: [10.1086/712923](https://doi.org/10.1086/712923).
- Garloff, Alfred (2016). *Side effects of the new German minimum wage on (un-) employment: First evidence from regional data*. Tech. rep. IAB-discussion paper.
- (2019). “Did the German minimum wage reform influence (un) employment growth in 2015? Evidence from regional data”. In: *German Economic Review* 20.3, pp. 356–381.
- Goebel, Jan et al. (2019). “The German socio-economic panel (SOEP)”. In: *Jahrbücher für Nationalökonomie und Statistik* 239.2, pp. 345–360.
- Gopalan, R. et al. (2020). “State Minimum Wages, Employment, and Wage Spillovers: Evidence from Administrative Payroll Data”. In: *Journal of Labor Economics* 39, pp. 673–707. DOI: [10.1086/711355](https://doi.org/10.1086/711355).
- Gregory, Terry and Ulrich Zierahn (2022). “When the minimum wage really bites hard: The negative spillover effect on high-skilled workers”. In: *Journal of Public Economics* 206, p. 104582.
- IMF (2019). *World Economic Outlook, October 2019: global manufacturing downturn, rising trade barriers*. International Monetary Fund.
- Jahresgutachten 2014/15* (June 2015). [Online; accessed 30. Jun. 2025]. URL: <https://www.sachverstaendigenrat-wirtschaft.de/publikationen/jahresgutachten/fruehere-jahresgutachten/jahresgutachten-201415.html>.
- Justiz, Bundesamt für (Jan. 2024a). *Fassung § 24 MiLoG a.F. bis 01.01.2018 (geändert durch Artikel 15 G. v. 11.08.2014 BGBl. I S. 1348)*. [Online; accessed 22. Jan. 2024]. URL: <https://www.buzer.de/gesetz/11256/al65564-0.htm>.

- Justiz, Bundesamt für (Jan. 2024b). *MiLoG - Gesetz zur Regelung eines allgemeinen Mindestlohns*. [Online; accessed 22. Jan. 2024]. URL: <https://www.gesetze-im-internet.de/milog/BJNR134810014.html>.
- Kropp, Per and Barbara Schwengler (2016). “Three-step method for delineating functional labour market regions”. In: *Regional Studies* 50.3, pp. 429–445.
- Laffers, Lukas and Giovanni Mellace (2020). “Identification of the average treatment effect when SUTVA is violated”. In: *Discussion Papers on Business and Economics, University of Southern Denmark* 3.
- Lin, Carl and Myeong-Su Yun (2016). “The effects of the minimum wage on earnings inequality: Evidence from China”. In: *Income Inequality Around the World*. Emerald Group Publishing Limited, pp. 179–212.
- Luedicke, Joerg (2022). *Difference-in-differences estimation using Stata*.
- MacKinnon, Danny, Vincent Béal, and Tim Leibert (2024). “Rethinking ‘left-behind’ places in a context of rising spatial inequalities and political discontent”. In: *Regional Studies*, pp. 1–6.
- Ohlert, Clemens, Matthias Dütsch, and Arne Baumann (2024). “The Minimum Wage in Germany: Institutional Setting and a Systematic Review of Key Findings”. In: *Jahrbücher für Nationalökonomie und Statistik* 245, pp. 113 –151. DOI: [10.1515/jbnst-2023-0038](https://doi.org/10.1515/jbnst-2023-0038).
- Ress, Simon and Florian Spohr (2022). “Was it worth it? The impact of the German minimum wage on union membership of employees”. In: *Economic and Industrial Democracy* 43.4, pp. 1699–1723.
- Schnabel, Claus (2016). “United, yet apart? A note on persistent labour market differences between western and eastern Germany”. In: *Jahrbücher für Nationalökonomie und Statistik* 236.2, pp. 157–179.
- Wooldridge, Jeffrey M (2021). “Two-way fixed effects, the two-way mundlak regression, and difference-in-differences estimators”. In: *Available at SSRN 3906345*.

A Appendix

A.1 Additional Descriptive Statistics

Table 10: Regional level descriptive statistics, years 2010-2013 (above) and 2015-2022 (below)

Variable	(1) Control		(2) Eventually Treated		T-test Difference (1)-(2)
	N/[Clusters]	Mean/SE	N/[Clusters]	Mean/SE	
Mean hourly wage, contracted	112 [28]	16.577 (0.259)	88 [22]	14.127 (0.405)	2.450***
Mean hourly wage, actual	112 [28]	15.318 (0.225)	88 [22]	13.047 (0.399)	2.271***
Mean share of men	112 [28]	0.453 (0.004)	88 [22]	0.447 (0.005)	0.006
Mean # of years of education	112 [28]	12.288 (0.093)	88 [22]	12.305 (0.091)	-0.017
Mean age	112 [28]	41.632 (0.200)	88 [22]	41.430 (0.295)	0.202
Mean HH size	112 [28]	3.292 (0.033)	88 [22]	3.170 (0.062)	0.122*
Mean # of working adults in a HH	112 [28]	1.526 (0.030)	88 [22]	1.414 (0.027)	0.112***
Mean share of migrants	112 [28]	0.224 (0.016)	88 [22]	0.156 (0.025)	0.067**

Variable	(1) Control		(2) Eventually Treated		T-test Difference (1)-(2)
	N/[Clusters]	Mean/SE	N/[Clusters]	Mean/SE	
Mean hourly wage, contracted	196 [28]	18.586 (0.244)	154 [22]	16.620 (0.401)	1.966***
Mean hourly wage, actual	196 [28]	17.923 (0.265)	154 [22]	15.997 (0.358)	1.926***
Mean share of men	196 [28]	0.482 (0.005)	154 [22]	0.477 (0.005)	0.005
Mean # of years of education	196 [28]	11.865 (0.121)	154 [22]	11.993 (0.107)	-0.128
Mean age	196 [28]	41.605 (0.355)	154 [22]	41.891 (0.375)	-0.286
Mean HH size	168 [28]	3.294 (0.051)	132 [22]	3.142 (0.065)	0.153*
Mean # of working adults in a HH	168 [28]	1.381 (0.037)	132 [22]	1.334 (0.027)	0.047
Mean share of migrants	196 [28]	0.407 (0.028)	154 [22]	0.317 (0.033)	0.090**

Notes: The value displayed for t-tests are the differences in the means across the groups. Standard errors are clustered at variable amr. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table 11: Individual level descriptive statistics, years 2010-2022

Variable	(1) Control		(2) Eventually treated		T-test Difference
	N/[Clusters]	Mean/SE	N/[Clusters]	Mean/SE	(1)-(2)
Gross hourly wages based on <i>contracted</i> working hours	107347 [18082]	19.125 (0.076)	15641 [3057]	8.953 (0.071)	10.172***
Gross hourly wages based on <i>actual</i> working hours	106600 [18044]	17.658 (0.073)	15524 [3054]	8.508 (0.075)	9.149***
Share of men	107347 [18082]	0.486 (0.004)	15641 [3057]	0.327 (0.010)	0.159***
Age	107347 [18082]	44.361 (0.080)	15641 [3057]	38.414 (0.254)	5.948***
Years of education	104839 [17537]	12.889 (0.024)	14681 [2839]	11.375 (0.043)	1.515***
Full-time employed	105025 [17417]	0.873 (0.003)	14384 [2634]	0.792 (0.009)	0.081***
Marginally employed	107347 [18082]	0.050 (0.001)	15641 [3057]	0.161 (0.006)	-0.111***
Share of German citizens	107347 [18082]	0.882 (0.002)	15641 [3057]	0.844 (0.006)	0.038***
Share of migrants	107347 [18082]	0.218 (0.003)	15641 [3057]	0.309 (0.009)	-0.091***
Firm size: (0,20) employees	105103 [17756]	0.201 (0.003)	15154 [3010]	0.380 (0.008)	-0.180***
Firm size: [20,200) employees	105103 [17756]	0.268 (0.003)	15154 [3010]	0.298 (0.007)	-0.030***
Firm size: [200,2000) employees	105103 [17756]	0.231 (0.003)	15154 [3010]	0.163 (0.006)	0.068***
Firm size: ≥ 2000 employees	105103 [17756]	0.300 (0.003)	15154 [3010]	0.159 (0.006)	0.142***

Notes: The value displayed for t-tests are the differences in the means across the groups. Standard errors are clustered at variable pid. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

A.2 Additional Estimation Results: Regional Level

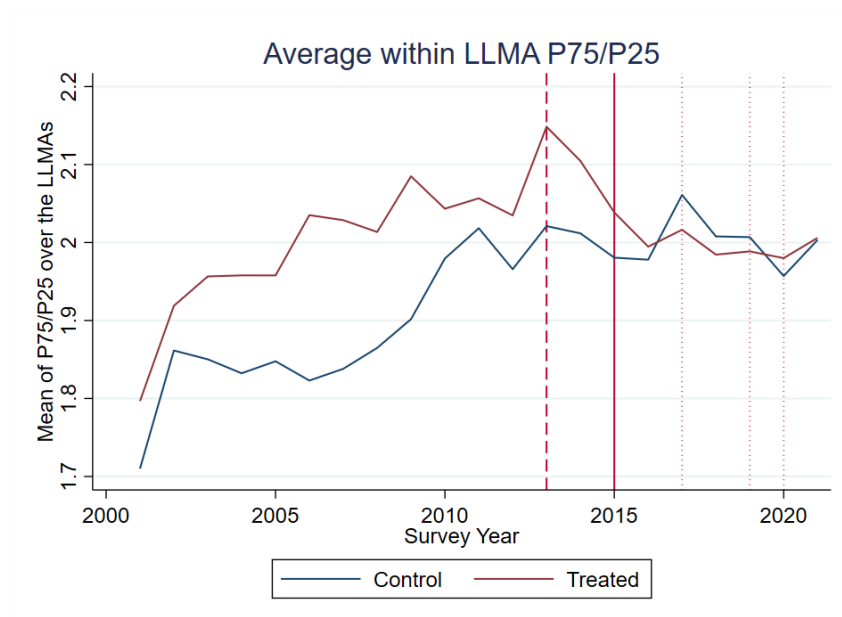


Figure 13: Developments of P75/P25 of hourly gross wages for treatment and control groups, regional level

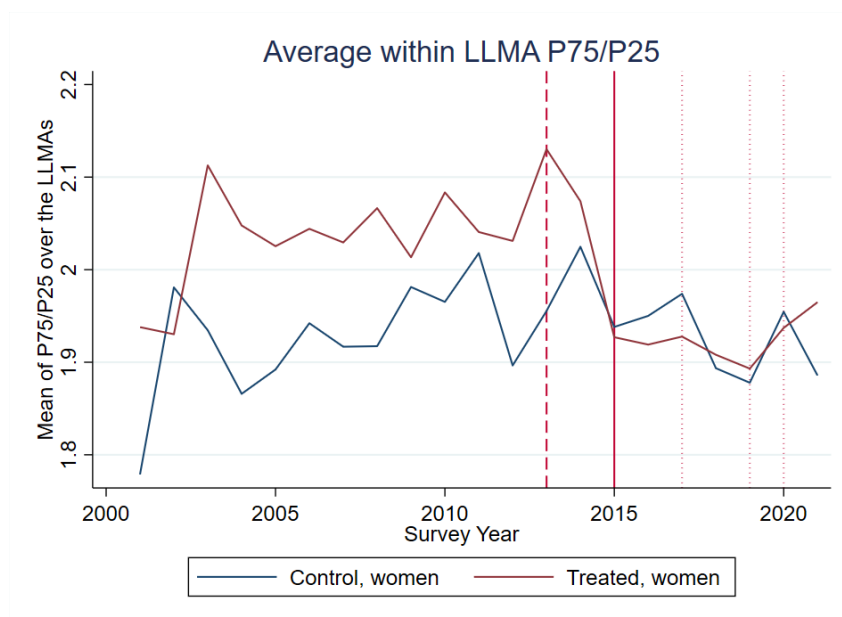


Figure 14: Developments of P75/P25 of hourly gross wages for treatment and control groups of women, regional level

Table 12: Three-period effects of the minimum wage introduction on within-region inequality on LLMA level, hourly wages

	P75/P25	P90/P10	P25/P10	SD
Panel A: LLMA effects, overall				
Bite2013 # Year 2015	-0.016 (0.026)	-0.068 (0.053)	-0.040 (0.043)	-0.009 (0.029)
Bite2013 # Years 2016-2018	-0.027 (0.022)	-0.093** (0.037)	-0.057* (0.033)	-0.000 (0.024)
Bite2013 # Years 2019-2022	-0.035 (0.022)	-0.114*** (0.040)	-0.057 (0.038)	0.004 (0.031)
Panel B: LLMA effects, women				
Bite2013 # Year 2015	-0.064** (0.030)	-0.021 (0.052)	0.005 (0.045)	0.052 (0.038)
Bite2013 # Years 2016-2018	-0.035 (0.023)	-0.032 (0.050)	-0.039 (0.045)	0.080** (0.034)
Bite2013 # Years 2019-2022	-0.026 (0.030)	-0.031 (0.053)	-0.013 (0.046)	0.041 (0.050)
Panel C: LLMA effects, men				
Bite2013 # Year 2015	-0.077* (0.042)	-0.045 (0.097)	0.085 (0.072)	-0.034 (0.040)
Bite2013 # Years 2016-2018	-0.056* (0.032)	-0.027 (0.067)	0.056 (0.050)	-0.056* (0.030)
Bite2013 # Years 2019-2022	-0.102** (0.040)	-0.094 (0.077)	0.036 (0.051)	-0.048 (0.037)
Observations	500	499	499	500

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; Control variables are included as aggregated information on the LLM level: general hh composition, labour market conditions, average respondents' characteristics. All variables are aggregated at the subgroup level. The parallel trends test estimates an augmented model, allowing for varying slopes in the pre-treatment and post-treatment periods. The Wild test checks if the pre-trends coefficient is statistically significant. The Granger causality test augments the model with leads on treatment and performs a joint Wald test on the included coefficients.

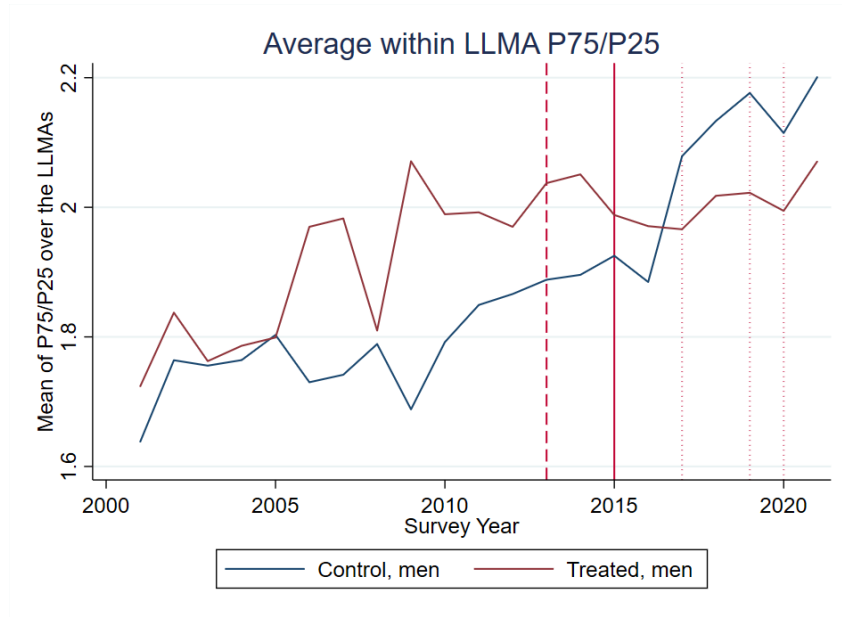


Figure 15: Developments of P75/P25 of hourly gross wages for treatment and control groups of men, regional level

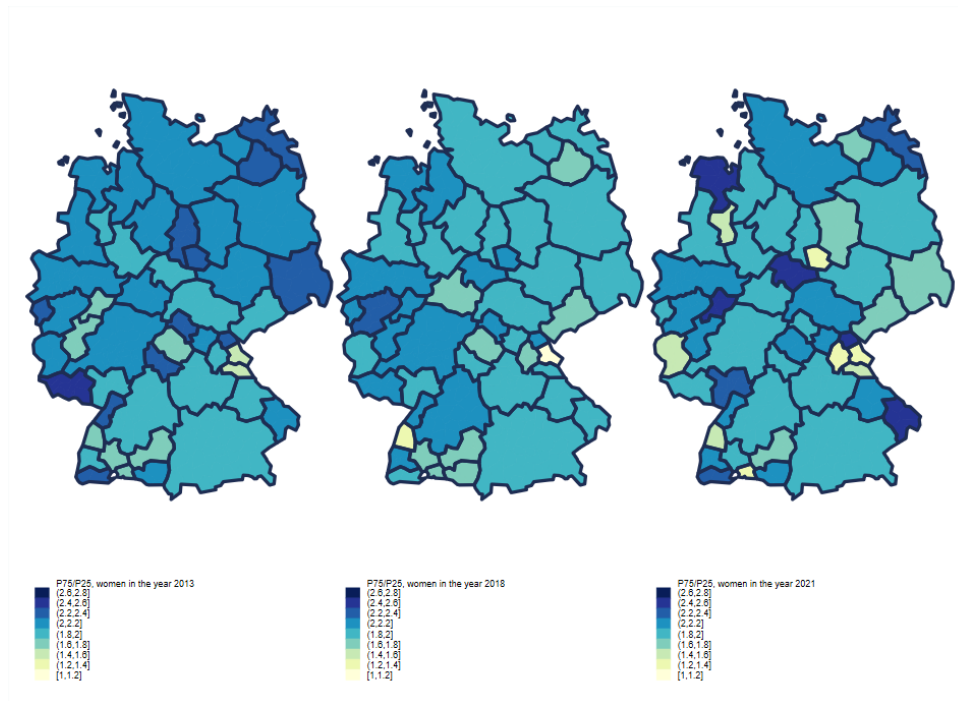


Figure 16: Regional inequality distribution of wages of women in the years 2013, 2018, and 2021

Table 13: Effects of the minimum wage introduction on within-region inequality on LLM level, monthly income

	Individual Monthly Wage				HH Monthly wage			
	P75/P25	P90/P10	Gini	SD	P75/P25	P90/P10	Gini	SD
Panel A: LLM-level effects, overall								
Bite2013 # Year 2015	-0.008 (0.034)	0.070 (0.054)	-0.000 (0.005)	-0.029 (0.025)	-0.012 (0.043)	0.025 (0.076)	0.003 (0.007)	-0.028 (0.027)
Bite2013 # Years 2016-2018	0.001 (0.032)	0.082 (0.064)	-0.001 (0.006)	-0.021 (0.031)	0.046 (0.044)	0.003 (0.093)	0.001 (0.008)	-0.005 (0.032)
Bite2013 # Years 2019-2022	-0.031 (0.041)	0.114 (0.076)	-0.002 (0.009)	0.008 (0.043)	-0.012 (0.048)	-0.117 (0.088)	-0.005 (0.009)	0.001 (0.039)
Panel B: LLM-level effects, disaggregated by sex								
	Monthly Wage of Women				Monthly Wage of Men			
	P75/P25	P90/P10	Gini	SD	P75/P25	P90/P10	Gini	SD
Bite2013 # Year 2015	0.070 (0.073)	0.015 (0.112)	0.009 (0.008)	0.035 (0.037)	-0.098** (0.045)	-0.158 (0.106)	-0.005 (0.008)	-0.004 (0.034)
Bite2013 # Years 2016-2018	0.034 (0.049)	0.068 (0.089)	0.022** (0.009)	0.103** (0.041)	-0.032 (0.041)	-0.027 (0.105)	0.005 (0.010)	0.024 (0.041)
Bite2013 # Years 2019-2022	0.073 (0.060)	-0.031 (0.074)	0.015 (0.010)	0.034 (0.062)	-0.079 (0.048)	-0.072 (0.130)	0.007 (0.011)	0.067 (0.050)

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; Control variables are included as aggregated information on the LLM level: general hh composition, labour market conditions, average respondents' characteristics. All variables are aggregated at the subgroup level. The parallel trends test estimates an augmented model, allowing for varying slopes in the pre-treatment and post-treatment periods. The Wild test checks if the pre-trends coefficient is statistically significant. The Granger causality test augments the model with leads on treatment and performs a joint Wald test on the included coefficients.

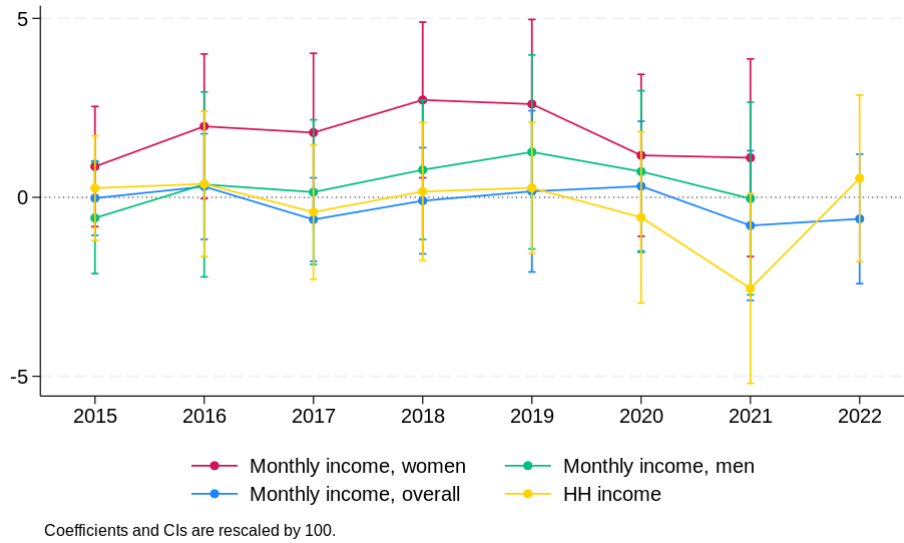


Figure 17: Effect on the estimated Gini coefficients

A.3 Additional Estimation Results: Individual Level

Table 14: Effects of minimum wage on the logarithm of monthly wages and a number of contracted working hours, treated regions only

	Overall		Men		Women	
	Contracted	Actual	Contracted	Actual	Contracted	Actual
<8.5 Euro/h in 2013 \times Years After	0.216*** (0.016)	0.183*** (0.016)	0.217*** (0.039)	0.163*** (0.038)	0.215*** (0.017)	0.193*** (0.018)
<8.5 Euro/h in 2013 \times 2015	0.169*** (0.019)	0.141*** (0.019)	0.131*** (0.047)	0.086* (0.045)	0.189*** (0.020)	0.169*** (0.021)
<8.5 Euro/h in 2013 \times 2016-2018	0.217*** (0.017)	0.188*** (0.017)	0.233*** (0.040)	0.180*** (0.039)	0.210*** (0.019)	0.193*** (0.019)
<8.5 Euro/h in 2013 \times 2019-2021	0.256*** (0.019)	0.212*** (0.019)	0.285*** (0.042)	0.226*** (0.043)	0.243*** (0.021)	0.213*** (0.022)
Observations	23458	25459	10553	11734	12905	13725

Note: *** p<0.01, ** p<0.05, * p<0.10; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies.

Table 15: Effects of minimum wage on the logarithm of monthly wages and contracted wages, treated regions only

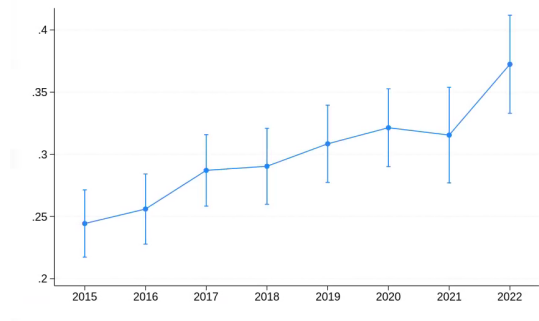
	Overall		Men		Women	
	Monthly Wage	Contracted Hours	Monthly Wage	Contracted Hours	Monthly Wage	Contracted Hours
< 8.5 Euro/h in 2013 \times Years After	0.183*** (0.018)	0.073 (0.263)	0.182*** (0.037)	0.100 (0.486)	0.174*** (0.021)	-0.164 (0.318)
< 8.5 Euro/h in 2013 \times 2015	0.138*** (0.021)	0.010 (0.294)	0.122*** (0.041)	0.089 (0.541)	0.146*** (0.025)	-0.128 (0.361)
< 8.5 Euro/h in 2013 \times 2016-2018	0.186*** (0.020)	0.101 (0.276)	0.185*** (0.040)	0.071 (0.499)	0.176*** (0.023)	-0.152 (0.337)
< 8.5 Euro/h in 2013 \times 2019-2022	0.218*** (0.023)	0.085 (0.327)	0.249*** (0.046)	0.169 (0.573)	0.194*** (0.027)	-0.211 (0.402)
Observations	25907	23532	11917	10577	13990	12955

Note: *** p<0.01, ** p<0.05, * p<0.10; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies.

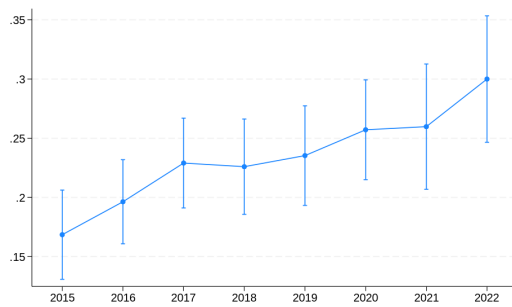
Table 16: Effects of minimum wage on the logarithm of monthly wages and contracted wages disaggregated by quartiles of wage distribution, treated regions only

	Overall				Men				Women			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Houly Wages (contracted)	0.183*** (0.042)	0.145*** (0.018)	-0.039** (0.016)	-0.300*** (0.023)	0.121 (0.085)	0.053 (0.035)	0.000 (.)	0.000 (.)	0.206*** (0.066)	0.100*** (0.028)	0.147*** (0.031)	-0.210*** (0.021)
Hourly Wages (actual)	0.176*** (0.042)	0.118*** (0.017)	0.000 (0.020)	-0.346*** (0.028)	0.149* (0.090)	0.033 (0.029)	0.000 (.)	0.000 (.)	0.218*** (0.060)	0.079*** (0.028)	0.111*** (0.039)	-0.253*** (0.028)
Monthly Wages	0.033 (0.045)	0.099*** (0.014)	-0.023** (0.011)	-0.283*** (0.024)	0.082 (0.080)	0.037 (0.036)	0.000 (.)	0.000 (.)	-0.064 (0.062)	0.046** (0.018)	0.083*** (0.022)	-0.209*** (0.022)
Contracted Hours	-0.801 (0.606)	-1.159*** (0.385)	0.275 (0.405)	0.488 (0.409)	-0.232 (1.056)	-1.279* (0.769)	0.000 (.)	0.000 (.)	-1.986** (0.870)	-1.697*** (0.588)	-1.440** (0.641)	-0.667 (0.436)
Actual Hours	-1.848*** (0.632)	-0.679 (0.550)	-1.355** (0.653)	2.822*** (0.797)	-0.880 (1.486)	0.029 (1.258)	0.000 (.)	0.000 (.)	-3.315*** (0.874)	-1.568** (0.655)	-0.946 (1.436)	1.366* (0.717)
Observations	3965	5757	6679	9149	1586	2369	3508	4302	2141	2960	3740	4944

Note: *** p<0.01, ** p<0.05, * p<0.10; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies.

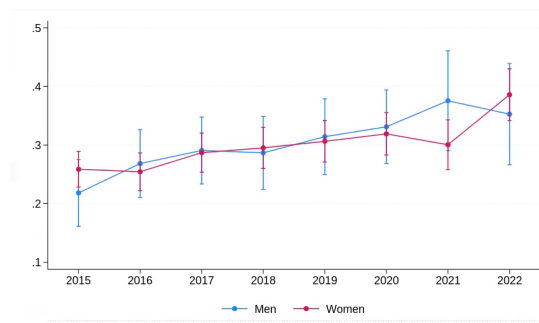


(a) All regions

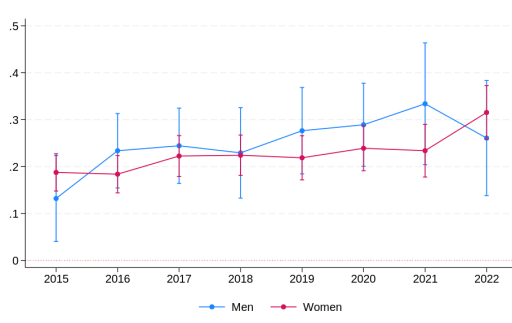


(b) Treated regions only

Figure 18: Dynamic effects of minimum wages on logarithm of contracted hourly wages, overall



(a) All regions



(b) Treated regions only

Figure 19: Dynamic effects of minimum wages on logarithm of contracted hourly wages, disaggregated by sex

Table 17: Effects of minimum wage on the logarithm of monthly wages and contracted wages disaggregated by exposure length and quartiles of monthly wage distribution, treated regions only

	Overall				Men				Women			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Hourly Wages (contracted) \times 2015	0.157*** (0.047)	0.113*** (0.020)	-0.059*** (0.022)	-0.205*** (0.042)	0.001 (0.095)	0.051 (0.039)	0.039 (0.036)	0.108*** (0.032)	0.187*** (0.071)	0.093*** (0.028)	0.131*** (0.036)	-0.285*** (0.034)
Hourly Wages (contracted) \times 2016-2018	0.191*** (0.046)	0.152*** (0.019)	-0.047*** (0.017)	-0.271*** (0.034)	0.191** (0.092)	0.056 (0.034)	0.015 (0.022)	0.067 (0.043)	0.216*** (0.071)	0.107*** (0.030)	0.146*** (0.031)	-0.216*** (0.026)
Hourly Wages (contracted) \times 2019-2022	0.217*** (0.056)	0.187*** (0.024)	-0.018 (0.020)	-0.301*** (0.023)	0.178 (0.119)	0.045 (0.042)	0.000 (.)	0.000 (.)	0.215** (0.085)	0.098*** (0.036)	0.189*** (0.038)	-0.206*** (0.026)
Hourly Wages (actual) \times 2015	0.147*** (0.046)	0.092*** (0.018)	-0.027 (0.028)	-0.186*** (0.059)	0.033 (0.094)	0.011 (0.035)	0.041 (0.040)	0.199** (0.091)	0.186*** (0.066)	0.067** (0.029)	0.101** (0.040)	-0.301*** (0.039)
Hourly Wages (actual) \times 2016-2018	0.197*** (0.045)	0.129*** (0.017)	-0.016 (0.021)	-0.295*** (0.042)	0.226** (0.097)	0.040 (0.029)	0.015 (0.032)	0.098** (0.041)	0.244*** (0.065)	0.094*** (0.030)	0.103*** (0.038)	-0.271*** (0.032)
Hourly Wages (actual) \times 2019-2022	0.181*** (0.054)	0.139*** (0.025)	0.034 (0.024)	-0.347*** (0.028)	0.214* (0.127)	0.062* (0.036)	0.000 (.)	0.000 (.)	0.210*** (0.078)	0.059 (0.038)	0.167*** (0.045)	-0.236*** (0.032)
Monthly Wages \times 2015	0.081* (0.045)	0.084*** (0.015)	-0.059*** (0.017)	-0.187*** (0.039)	0.054 (0.084)	0.020 (0.039)	0.015 (0.029)	0.078 (0.077)	-0.021 (0.064)	0.043** (0.020)	0.086*** (0.024)	-0.232*** (0.056)
Monthly Wages \times 2016-2018	0.030 (0.051)	0.101*** (0.014)	-0.024** (0.012)	-0.230*** (0.039)	0.097 (0.088)	0.046 (0.036)	-0.004 (0.021)	0.094* (0.051)	-0.059 (0.072)	0.057*** (0.020)	0.077*** (0.024)	-0.216*** (0.025)
Monthly Wages \times 2019-2022	-0.053 (0.062)	0.126*** (0.020)	-0.000 (0.014)	-0.284*** (0.024)	0.116 (0.115)	0.046 (0.039)	0.000 (.)	0.000 (.)	-0.172** (0.085)	0.022 (0.025)	0.100*** (0.027)	-0.202*** (0.025)
Contracted Hours \times 2015	0.070 (0.713)	-0.639 (0.420)	-0.363 (0.550)	-0.251 (1.106)	0.887 (1.224)	-1.630** (0.780)	-0.626 (0.828)	0.078 (1.433)	-1.660 (1.031)	-1.595*** (0.600)	-0.953 (0.709)	0.696 (1.345)
Contracted Hours \times 2016-2018	-0.883 (0.645)	-1.387*** (0.402)	0.534 (0.424)	0.659 (0.754)	-0.849 (1.145)	-1.002 (0.799)	-0.605 (0.541)	0.493 (1.183)	-1.859** (0.918)	-1.703*** (0.619)	-1.549** (0.659)	-0.877* (0.497)
Contracted Hours \times 2019-2022	-2.547*** (0.758)	-1.527** (0.608)	0.371 (0.440)	0.490 (0.408)	-1.002 (1.439)	-1.596 (1.006)	0.000 (.)	0.000 (.)	-3.170*** (1.138)	-1.912** (0.794)	-2.227** (0.982)	-0.445 (0.487)
Actual Hours \times 2015	-0.960 (0.725)	-0.156 (0.567)	-1.941** (0.940)	0.064 (2.352)	0.306 (1.734)	0.093 (1.356)	-0.797 (1.324)	-5.709 (3.687)	-2.770*** (1.002)	-1.335* (0.717)	-0.666 (1.379)	1.982 (1.621)
Actual Hours \times 2016-2018	-1.886*** (0.678)	-1.099* (0.568)	-0.566 (0.682)	3.212** (1.278)	-1.517 (1.505)	0.246 (1.261)	-0.314 (1.239)	-0.260 (1.623)	-3.301*** (0.935)	-1.838*** (0.706)	-0.798 (1.401)	1.954** (0.808)
Actual Hours \times 2019-2022	-3.524*** (0.823)	-0.488 (0.802)	-1.853** (0.773)	2.833*** (0.796)	-2.178 (1.922)	-1.006 (1.489)	0.000 (.)	0.000 (.)	-4.533*** (1.151)	-1.315 (0.898)	-2.173 (1.749)	0.811 (0.791)
Observations	3965	5757	6679	9149	1586	2369	3508	4302	2141	2960	3740	4944

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; All regressions include control variables. The variables include demographic controls on a personal/hh level (age, sex, years of education, number of children below 16 years of age in a HH, number of working adults in HH, marital status, migration background dummy, German citizenship dummy) as well as regional level controls (share of very small, small, large and very large firms, GDP per capita lagged by 2 periods) and LLMA dummies.

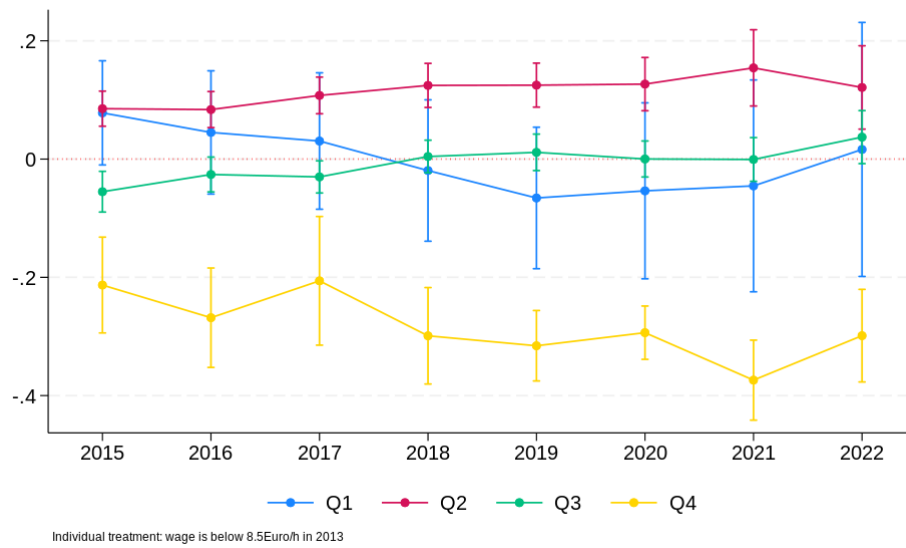


Figure 20: Dynamic effects of minimum wages on logarithm of monthly wages in treated regions, disaggregated by quartile

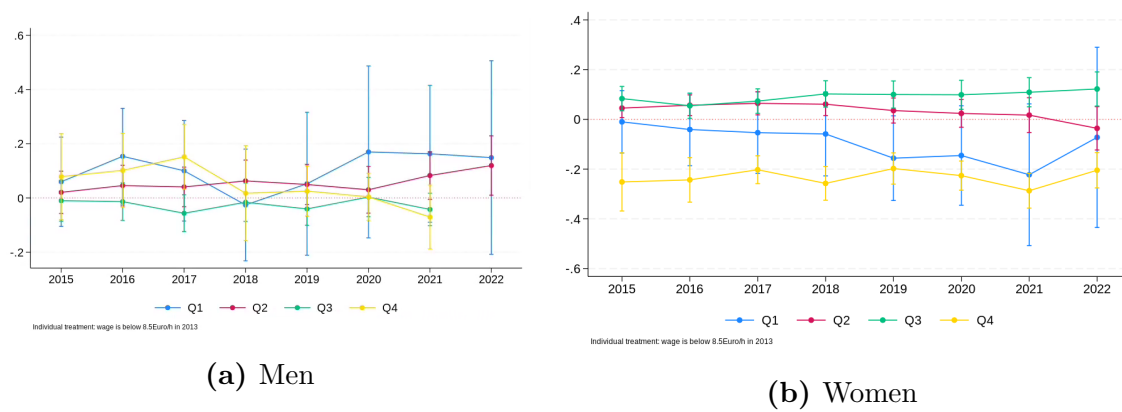


Figure 21: Dynamic effects of minimum wages on logarithm of monthly wages in treated regions, disaggregated by quartile and sex

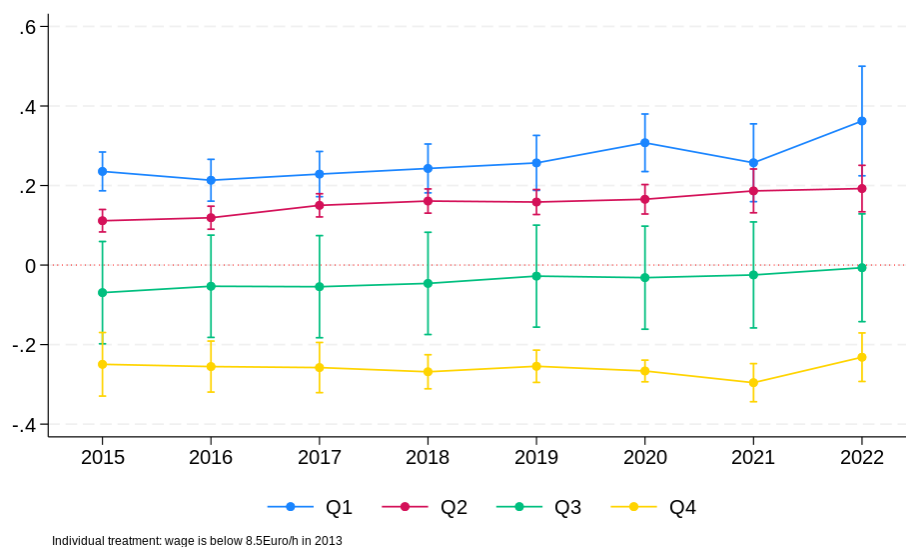


Figure 22: Dynamic effects of minimum wages on logarithm of contracted hourly wages, disaggregated by quartile

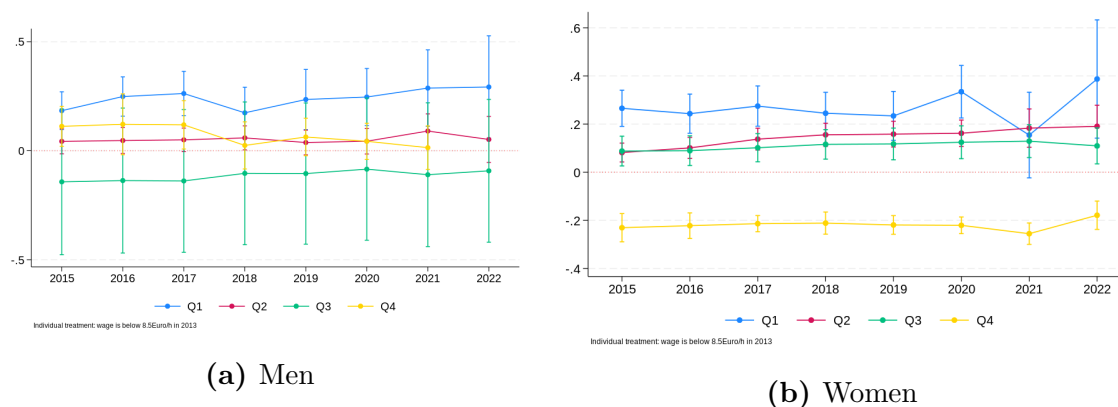


Figure 23: Dynamic effects of minimum wages on logarithm of contracted hourly wages, disaggregated by quartile and sex

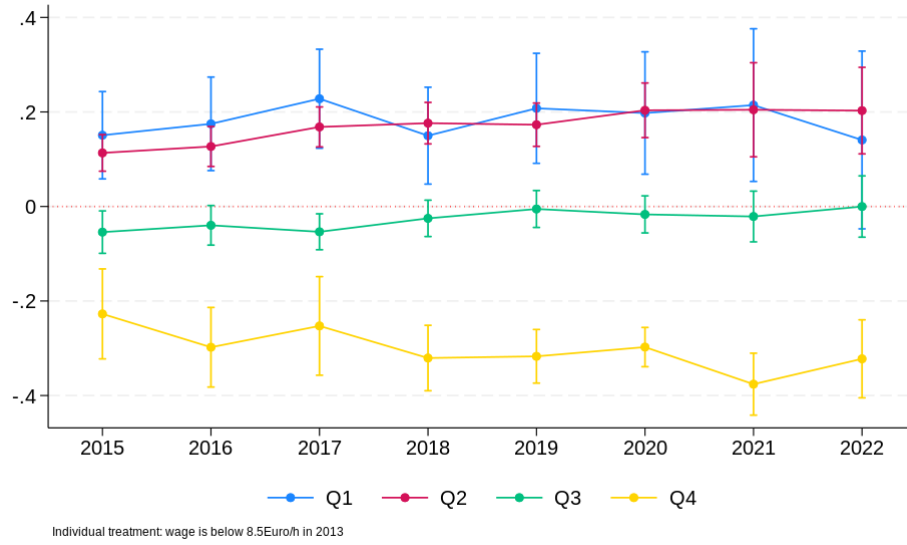
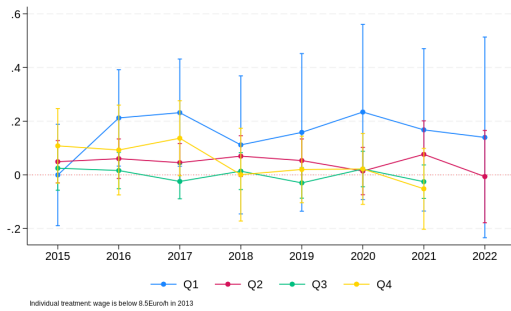
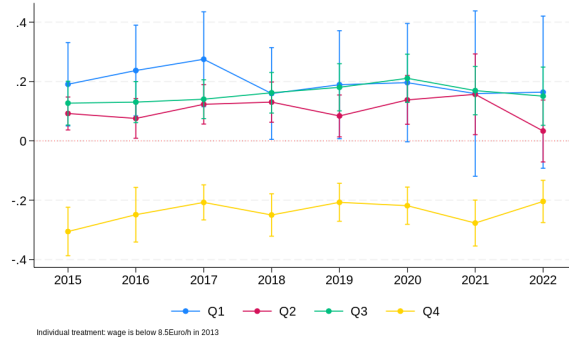


Figure 24: Dynamic effects of minimum wages on logarithm of contracted hourly wages in treated regions, disaggregated by quartile



(a) Men



(b) Women

Figure 25: Dynamic effects of minimum wages on logarithm of contracted hourly wages in treated regions, disaggregated by quartile and sex