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ABSTRACT

This paper studies the relationship between inequalities in working hours and overall earnings inequality in Germany between 2006 and 2014, and the role of declining collective bargaining coverage. Using data from the German Structure of Earnings Survey (GSES), a variance decomposition of earnings inequality reveals that hours inequality and the covariance between wages and hours become more important over time in determining earnings inequality. Based on unconditional quantile regressions, we show that the presence of collective agreements tends to increase working hours at the bottom of the distribution, and lowers them at the top end of the distribution, while controlling for individual and firm-specific characteristics. These findings imply that union presence is not only able to compress wage inequality, but might reduce earnings inequality through a compression of working hours.

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This paper studies the relationship between inequalities in working hours and overall earnings inequality in Germany between 2006 and 2014, and the role of declining collective bargaining coverage. Using data from the German Structure of Earnings Survey (GSES), a variance decomposition of earnings inequality reveals that hours inequality and the covariance between wages and hours become more important over time in determining earnings inequality. Based on unconditional quantile regressions, we show that the presence of collective agreements tends to increase working hours at the bottom of the distribution, and lowers them at the top end of the distribution, while controlling for individual and firm-specific characteristics. These findings imply that union presence is not only able to compress wage inequality, but might reduce earnings inequality through a compression of working hours.

Keywords: Inequality, working hours, collective bargaining, decomposition, unconditional quantile regression, RIF regressions, Structure of Earnings Survey

JEL Classification: J22, J31, J52, C31, D31

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1 Introduction

A growing body of literature examines the development of earnings inequality, both across and within countries. This research has mostly focused on wage inequality, while only few studies have considered the dispersion in working hours. However, individuals' earnings are by definition the product of hourly wages and the number of hours worked. The distribution of working hours thus also has an impact on earnings inequality. Inequality in hours might rise as a result of increases in part-time employment or overtime hours. Hours dispersion varies substantially across countries (Blau & Kahn, 2011) and has also developed differently over time. For Germany, Checchi et al. (2016) find that hours inequality has increased during the last decades, and is responsible for one third of earnings inequality in 2012.

Besides the variation in working hours, also the correlation between hourly wages and hours worked has an impact on earnings inequality. This correlation has increased in most countries over time, which means that the best paid workers also work longer hours than lower-income workers (Salverda & Checchi, 2015). This change in the labour supply elasticity thus had an exacerbating effect on earnings inequality.

The question remains how the changes in hours inequality and in the wage-hours covariance can be explained. Checchi et al. (2016) interpret their results as a consequence of weaker union power, which prevented a successful bargaining outcome concerning working hours. However, they only provide descriptive evidence on the link between hours inequality and de-unionisation.

Previous studies have already examined the link between de-unionisation and wage inequality. As collective bargaining is expected to compress wages, decreasing union power is associated with higher levels of wage inequality (Card et al., 2004; DiNardo et al., 1996; Fortin & Lemieux, 1997).

Our hypothesis is that union presence also compresses hours inequality. As collective bargaining is expected to decrease hours inequality, union power might affect earnings inequality through an additional channel. This assumption is based on the notion of intensive and extensive margins of labour supply. Powerful unions are expected to prevent employers to adjust employees' working hours according to the firms' demand (intensive margin). Instead, they might aim at expanding the number of jobs (extensive margin), which in turn limits the heterogeneity of hours. However, with decreasing union power, employers have the choice which margin to adjust, which in turn might lead to higher hours inequality (Checchi et al., 2016).

By putting the emphasis on hours inequality, we aim at broadening the debate on earnings inequality. As we shift the attention to hours inequality, the results of this research are expected to broaden our understanding of the factors and channels that influence earnings inequality. Furthermore, by looking at the link between hours inequality and collective bargaining coverage, we investigate whether de-unionisation might affect earnings inequality through an additional channel, beside the established evidence regarding wage inequality.

In section 2 of this paper, we review the existing literature. Then the two methods used for the analysis – variance decomposition analysis and unconditional quantile regressions – are

explained in more detail. In section 4 the data of the German Structure of Earnings Survey (GSES) is described alongside with the presentation of the comparative statistics. The empirical results are presented in section 5. We first assess the role of working hours for earnings inequality in Germany by decomposing earnings inequality into its three components: wages, hours worked and the covariance of both. Then we enhance the decomposition analysis on four different subgroups, based on gender and collective agreement coverage to study the link between declining union power and hours inequality. To provide more robust evidence, unconditional quantile regressions (Firpo et al., 2009, 2018) are performed to estimate the impact of collective agreements along the whole distribution of working hours. This approach enables us to test whether the presence of collective agreements tends to increase working hours at the bottom of the distribution, and reduces them for higher levels of hours, while controlling for individual and firm-specific characteristics. The final section concludes.

2 Previous research

While research on earnings inequality has mostly focused on rising wage dispersions, studies on hours inequality are rather sparse. Initial studies on the role played by working hours for changes in earnings inequality were conducted for Canada (Doiron & Barrett, 1996; Johnson & Kuhn, 2004) or the US (Juhn et al., 1993). For Germany, Fuchs-Schündeln et al. (2010) outline the development of earnings, wage and hours inequality between 1984 and 2004. One of the first variance decompositions in a cross-country setting is performed by Blau and Kahn (2011). Covering eight OECD countries, the authors find that hours inequality explains on average 36% of earnings inequality for men, and 54% for women, with substantial variation between countries. The OECD (2011) took up this approach for its inequality report, providing a variance decomposition for 19 OECD countries. Although wage inequality was found to be the most important factor in determining the level of earnings inequality in most countries, trends in hours worked have a considerable influence on changes in earnings inequality over time. The authors find that working hours declined especially for the bottom quintile of the earnings distribution, which is seen as a major driver for rising inequalities. In Germany, working hours of the bottom earnings quintile decreased by more than 10% between 1984 and 2004.

More recent publications investigate the components of earnings inequality over time and attempt to identify underlying causes of rising hours inequality. A decomposition analysis on earnings inequality for the US, the UK, Germany, and France by Checchi et al. (2016) shows that the changes in hours play a particularly important role in Germany. Whereas average hours have declined only slightly between 1991 and 2012, inequality in working hours has increased considerably, accounting for one third of earnings inequality in 2012. Also, the covariance between wages and hours has changed from negative to positive. This means that Germany has moved from a situation in which those with the lowest earning potential spent more hours at work, thus partially offsetting wage inequality, to one where the best-paid workers also put in the longest hours. The authors interpret their findings as a result of declining union density, which prevented a successful bargaining outcome concerning working hours. Powerful unions are

expected to prevent employers to adjust employees' working hours according to their demand (intensive margin). Instead, they might aim at expanding the number of jobs (extensive margin), which increases their bargaining power. This prevents hours to deviate largely from the legally or contractually specified working hours, which in turn limits the heterogeneity of hours. However, with declining union power it can be assumed that employers have the choice which margin to adjust, which might lead to higher levels of hours inequality (Checchi et al., 2016). The authors underpin their hypothesis by plotting the wage-hour covariance against union density. In a related study, Salverda and Checchi (2015) provide more profound evidence based on a regression analysis. In a (pseudo-)longitudinal approach covering 30 countries, the authors find mitigating effects of union density on hours inequality.

A more recent study by Biewen and Plötze (2019) analyses inequalities in hours and earnings in Germany based on GSES data as well. However, in contrast to our analysis their data covers an earlier time period and therefore, due to data restrictions, also a smaller sample size without parts of the service sector. A variance decomposition of log earnings suggests that changes in working hours can explain 37% of the increased earnings inequality for men, and 45% of the increased earnings inequality for women between 2001 and 2010. To identify potential determinants of increased hours inequality, their analysis also includes an Oaxaca-Blinder decomposition for the within-group and between-group variance of working hours. Strong compositional effects of de-unionisation were found in case of the within-group variance, especially for women. Other characteristics, such as shifts in age, education and occupation can explain the shifts in working hours to some extent, leaving a large part of the change in hours unexplained.

While research on hours inequality and its underlying mechanisms is still relatively sparse, a large body of literature has examined the causes for rising wage inequality (for an overview, see Fitzenberger, 2012). A series of studies reveal that the rise in wage inequality can partly be explained by de-unionisation, as collective bargaining compresses the wage distribution (e.g. Card et al., 2004; DiNardo et al., 1996; Fortin & Lemieux, 1997). Most of these studies on Anglo-Saxon countries are based on data of individual union membership. However, in continental Europe collective bargaining is considerably more important for wage setting than union membership. Therefore, most studies investigating the link between wage inequality and union power in Germany rely on linked employer-employee datasets providing information on bargaining coverage (Antonczyk et al., 2010; Dustmann et al., 2014; Gerlach & Stephan, 2006).

Working hours are an integral part of collective agreements in Germany. While the German Working Hours Act (ArbZG) provides minimum conditions on working time, the bargaining parties can negotiate more favourable conditions in sectoral agreements, which often include regulations on the length of standard weekly working hours (Bispinck & WSI-Tarifarchiv, 2005). However, since the mid-1980's, collective agreements increasingly allowed for flexible working-time arrangements. So-called opening clauses enable companies to deviate from collectively agreed working-time standards (Seifert, 2006). Flexible working-time practices do not only include working-time accounts or varying daily and weekly hours, but also the temporary

extension or reduction of standard working hours (Bispinck & WSI-Tarifarchiv, 2005). Nevertheless, collective agreements at the sectoral and firm level are assumed to mitigate the polarisation in working hours. In small and medium firms without works councils, actual working times are often the result of individual negotiations. Union representatives and works councils, however, are able to set clear standards on flexible working-time practices and monitor its compliance (Berg, 2008). Employees' collective and individual control over working hours is also positively linked to collective bargaining (Berg et al., 2004).

This study contributes to the existing literature in two ways. First, using data from the German Structure of Earnings Survey (GSES) allows us to examine the role of collective bargaining in determining hours inequality, thus going beyond the share of union membership in a given country. The GSES also has the advantage to be mandatory, providing a much larger sample size than the German Socio-Economic Panel. Due to limited coverage of the service sector in earlier waves of the GSES, the sample of Biewen and Plötze (2019) is largely restricted to the industrial sector. However, as part-time jobs mainly occur in the service sector, it is crucial to include them when examining hours inequality. Covering the sampling period of 2006 to 2014 thus allows us to largely cover the service sector. Second, our methodical approach enables us to assess the implications of bargaining coverage on hours inequality that goes beyond descriptive evidence. We apply quantile regressions to identify the impact of collective bargaining along the entire distribution of hours.

3 Methods

3.1 Variance decomposition of earnings inequality

To describe the contribution of hours inequality to earnings inequality, we decompose earnings inequality by its factor components, following the commonly used method of variance decompositions (Biewen & Plötze, 2019; Blau & Kahn, 2011; Johnson & Kuhn, 2004; Juhn et al., 1993). Given that earnings are the product of hours worked and the wage rate, the variance of log earnings e can be written as the sum of the variance of log hours h, the variance of log wages w, and a term capturing the covariance of wages and hours:

$$var(\log(e)) = var(\log(h)) + var(\log(w)) + 2cov(\log(h)), \log(w)).$$

To assess the changes Δ in the variance of log earnings and its components between two time periods, the decomposition becomes

$$\Delta var(\log(e)) = \Delta var(\log(h)) + \Delta var(\log(w)) + \Delta 2cov(\log(h)), \log(w)).$$

The variation in work hours depends on individuals' labour supply decisions, or constraints in realising their preferred hours. The correlation between wages and hours is a further channel through which working hours can either mitigate or enhance overall earnings inequality. A positive covariance term implies that the best paid employees work relatively long hours, compared to low-income workers, which increases earnings inequality additionally. The wage-hour covariance can be the result of labour supply elasticities, the way in which wages influence

employers' hiring decisions, part-time wage penalties or premiums on overtime hours (Blau & Kahn, 2011).

In a next step, we divide the sample by gender and bargaining status to perform separate variance decompositions for these subgroups. This approach allows us to see whether earnings inequality and its components vary between covered and non-covered groups of workers, thus providing a first hint on our hypothesised relation between bargaining coverage and hours inequality.

However, variance decompositions by subgroups have several limitations. First, the four groups might also be different in terms of the distribution of other characteristics, such as age, education, industry etc. Accounting for all these covariates would make the number of groups very large. Moreover, this decomposition technique does not allow for identifying the effects of each covariate's specific contribution, i.e. detailed decompositions. Another limitation refers to the fact that it is not possible to apply this approach to most other inequality measures such as interquartile ranges or the probability density function. This makes it impossible to look at changes at different points in the distribution. In order assess the effect of collective agreements on hours inequality, it seems useful to complement variance decompositions with more advanced decomposition techniques.[3]

3.2 Unconditional quantile regressions

Drawing on *unconditional quantile regressions* (UQR) (Firpo et al., 2009, 2018), we are able to overcome several of the above mentioned restrictions. UQR allows for including a range of covariates to assess their impact on the distribution of a dependent variable, and is not confined to a specific inequality measure. Quantile regressions are a useful tool when we assume that the effects of an independent variable vary along the distribution of the dependent variable. In contrast to OLS, which estimates the effect of x on the mean of y, quantile regressions allow for analysing the effect along the whole distribution of y.

Conventional quantile regressions define quantiles conditional on the control variables (Koenker, 2005). Such *conditional quantile regressions* (CQR) thus redefine the quantiles. With regard to our case, a CQR would estimate how collective agreements affect working hours at different points of the conditional hours distribution, i.e. for employees with different values of working hours but similar covariate values. However, as we are interested on whether collective agreements compress the distribution of working hours, the application of UQR is more appropriate. UQR enables us to investigate the effects of a treatment variable on the unconditional (marginal) distribution of the outcome variable. This means that the quantiles are defined before the regression, regardless of the covariates to be included in the model (Killewald & Bearak, 2014). In contrast to Biewen and Plötze (2019), who explore the factors behind changes in the distribution of hours based on reweighting the conditional hours distribution, UQR focus on the determinants of a distribution at a given point in time.

[3] For an overview on various decomposition methods, see Fortin et al. (2011).

This approach has been introduced by Firpo et al. (2009, 2018), who propose regressions based on the recentered influence function (RIF). The influence function $IF(Y; v, F_Y)$ measures the influence of an individual observation on the distributional statistic of interest $v(F_Y)$, such as quantiles, the variance or Gini. If we add the statistic $v(F_Y)$ back to the influence function, we receive the recentered influence function $RIF(y; v) = v(F_Y) + IF(y; v)$, with its expectation equal to $v(F_Y)$. The RIF regression model then corresponds to the conditional expectation of the $RIF(Y; v, F_Y)$ modelled as a function of the explanatory variables, $E[RIF(Y; v, F_Y)\,|X] = m_\tau(X)$. RIF regressions are based on OLS, but with the dependent variable being replaced by the RIF of the statistic of interest. Instead of estimating the marginal effect of x on the mean of y, this approach estimates the impact of a small change in x on any distributional statistic of y.

In the case of quantiles as our distributional statistic, the influence function for the τ-th quantile is $IF(Y; q_\tau, F_Y)$, which is equal to $(\tau - \mathbb{1}\{Y \leq q_\tau\})/f_Y(q_\tau)$. $RIF(Y; q_\tau, F_Y)$ is thus equal to $q_\tau + IF(Y; q_\tau, F_Y)$. Its conditional expectation $E[RIF(Y; q_\tau, F_Y)\,|X] = m_\tau(X)$ is equivalent to UQR, as the average derivative of the UQR, $E[m'_\tau(X)]$, equals the marginal effect on the unconditional quantile of a slight shift in the distribution of control variables, holding everything else constant (Fortin et al., 2011).[4]

UCR have been used to assess the effect of de-unionisation and other factors such as changes in education, occupation and industry on the increase in male wage inequality in the US (Firpo et al., 2018). Other applications evaluated the impact of minimum wages on earnings distribution (Aeberhardt et al., 2016), or the distributive effects of education on earnings in Argentina (Alejo et al., 2014). As RIF regressions do not allow for clustering standard errors, inference is usually conducted by bootstrapping.

4 Data and descriptive statistics

4.1 Data

For our analysis, we use data from the scientific use file of the linked employer-employee dataset of the German Structure of Earnings Survey (GSES) which is provided by the European Commission via Eurostat.[5] The GSES has several advantages. First, compared to the German Socio-Economic Panel (SOEP), its sampling size is much larger, and participation in the GSES is compulsory. Second, in contrast to administrative data, it also provides data on working hours and on whether a firm applies collective agreements. As the coverage of the service sector is limited in earlier waves of the GSES, we use data for the years 2006, 2010 and 2014. This allows for a comparable sample over time which also includes most service industries where part-time contracts are more common.

As the GSES is a linked employer-employee dataset, its sample is limited to dependent employees. Prior to 2014, only firms with at least 10 employees were included in the GSES. Our

[4] For our analysis, we use the user-written command `rifreg` in Stata provided by Firpo et al. (2009).

[5] Data is collected by the German Federal Statistical Office and transmitted to Eurostat.

data includes precise information on the number of employees in the local unit, but only three categories regarding firm size. To take into account the change in the sampling strategy since 2014, we decided to drop all observations with less than 10 employees in the local unit. We further restrict our dataset to workers between 20 and 60 years, and exclude apprentices.

Our main variables of interest include monthly earnings, hourly wages, working hours, as well as collective bargaining coverage. For monthly earnings, we use data on gross labour income that individuals receive in the reference month. Our working hours variable comprises actual working hours remunerated by the employer in the reference month, including overtime. Here, we exclude extreme observations with working hours of less than 10 and more than 360 per month. We use the factor of 4.35 to calculate weekly hours. As the data is collected on the firm level, the number of working hours only refers to the respective employment relationship, thereby neglecting the hours that individuals might work in another job. Based on those two variables, we construct the hourly wage rate of individuals. We use real wages in 2014 prices. For plausibility reasons, we exclude observations with a wage rate lower than 3 euros. The variable on collective agreements is provided on the firm level, i.e. this variable has the same specification for all employees within the firm, although not all employees might be covered and hence be paid according to a collective agreement. Therefore, collective bargaining coverage is overestimated in our sample. This dummy variable has the value of one if either an industry-wide agreement or a company agreement applies.

In addition, we consider a range of firm and personal characteristics as listed in Table 10 in the Appendix. Personal characteristics include sex, age (4 categories), education (4 categories), occupation (10 categories), temporary/permanent contract, and seniority (4 categories). As firm characteristics we consider firm size (3 categories), region (6 categories), a dummy for (at least partial) public ownership, and industry (9 categories). The total number of observations in our dataset is about 2.7 million in 2006[6], 1.5 million in 2010, and 0.7 million in 2014.

4.2 Descriptive statistics

Table 1 provides an overview on how monthly earnings, hourly wages, and weekly hours developed over the years 2006, 2010 and 2014. The values are also provided separately for men and women, and for covered and un-covered employment relationships, respectively. We can observe an increase in both earnings and wage inequality as represented by several inequality measures. While earnings inequality increased throughout the period under consideration, wage inequality remained rather constant between 2010 and 2014, and it increased much stronger for men compared to women.

Regarding working hours, mean hours declined by 1.3 hours between 2006 and 2014, while the median number of hours remained rather constant in the period under consideration. This indicates a change in the distribution of hours. While the 90/50 ratio remained unchanged over time, the 50/10 ratio has increased. This suggests that the rise in hours inequality is mostly due

[6] This relatively high number of observations is explained by the fact that the education sector was fully covered in the 2006 wave.

to an increasing dispersion in the lower part of the distribution. These developments also become apparent in the histograms and kernel density plots in Figure 1 showing that the bottom tail became thicker over time, while the peak around full-time hours flattened. This applies equally to the samples of men and women, although both show clear differences in the distribution of hours.

Looking at the difference between covered and not covered employment relationships in Table 1 reveals that in almost all dimensions, the group of non-covered employees exhibit higher inequality measures compared to those covered. This is also reflected by the kernel density plots in Figure 2, suggesting that non-covered employment relationships are more prevalent at the lower tail of the hours distribution, and for more than 40 hours per week. In contrast, the densities for employment relationships covered by a collective agreement are higher for full-time hours and part-time employment with more than 15 hours per week.

Table 1: Comparative statistics and inequality measures

Labour Earnings	Full sample			Male			Female			Covered			Not covered		
	2006	2010	2014	2006	2010	2014	2006	2010	2014	2006	2010	2014	2006	2010	2014
Mean	2,907	2,789	2,765	3,480	3,366	3,358	2,183	2,087	2,099	3,131	2,963	3,048	2,616	2,578	2,469
	17.8	20.1	15.5	19.5	26.1	21.3	18.5	19.7	13.4	23.5	32.8	25.2	19.6	22.0	16.9
Median	2,665	2,504	2,476	3,113	2,970	2,955	2,040	1,899	1,896	2,924	2,741	2,784	2,318	2,239	2,169
	18.1	17.7	13.2	20.8	19.1	18.4	20.8	22.1	14.4	24.5	25.6	20.9	15.2	14.5	14.6
Inequality measures															
Gini	0.324	0.352	0.364	0.284	0.316	0.327	0.333	0.355	0.368	0.294	0.333	0.336	0.357	0.370	0.386
	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.004	0.002	0.003	0.005	0.003	0.002	0.003	0.002
MLD	0.225	0.263	0.290	0.167	0.211	0.237	0.239	0.266	0.292	0.182	0.242	0.245	0.272	0.285	0.325
	0.003	0.005	0.003	0.002	0.007	0.005	0.003	0.006	0.003	0.003	0.009	0.005	0.004	0.004	0.003
Theil	0.186	0.219	0.232	0.147	0.181	0.192	0.189	0.215	0.231	0.152	0.195	0.199	0.230	0.247	0.264
	0.002	0.003	0.002	0.002	0.004	0.003	0.002	0.005	0.003	0.003	0.006	0.003	0.003	0.004	0.003
Theil2	0.218	0.264	0.271	0.179	0.222	0.226	0.199	0.240	0.251	0.170	0.220	0.226	0.292	0.326	0.321
	0.004	0.006	0.004	0.004	0.006	0.005	0.004	0.009	0.004	0.004	0.006	0.005	0.008	0.012	0.006
Decile ratios															
DR 90/10	5.5	7.9	11.1	3.5	4.4	4.8	8.4	8.8	9.5	4.3	6.5	6.4	10.2	10.7	11.0
	0.12	0.66	0.07	0.04	0.15	0.20	0.07	0.08	0.09	0.06	0.68	0.33	0.09	0.13	0.17
DR 90/50	1.9	2.0	2.0	1.8	1.9	2.0	1.9	2.0	2.0	1.8	1.9	1.9	2.0	2.1	2.1
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02
DR 50/10	2.9	4.0	5.5	1.9	2.3	2.4	4.5	4.5	4.7	2.4	3.4	3.3	5.1	5.1	5.2
	0.06	0.33	0.03	0.01	0.07	0.10	0.05	0.04	0.04	0.02	0.35	0.17	0.03	0.03	0.07

Table 2 (continued): Comparative statistics and inequality measures

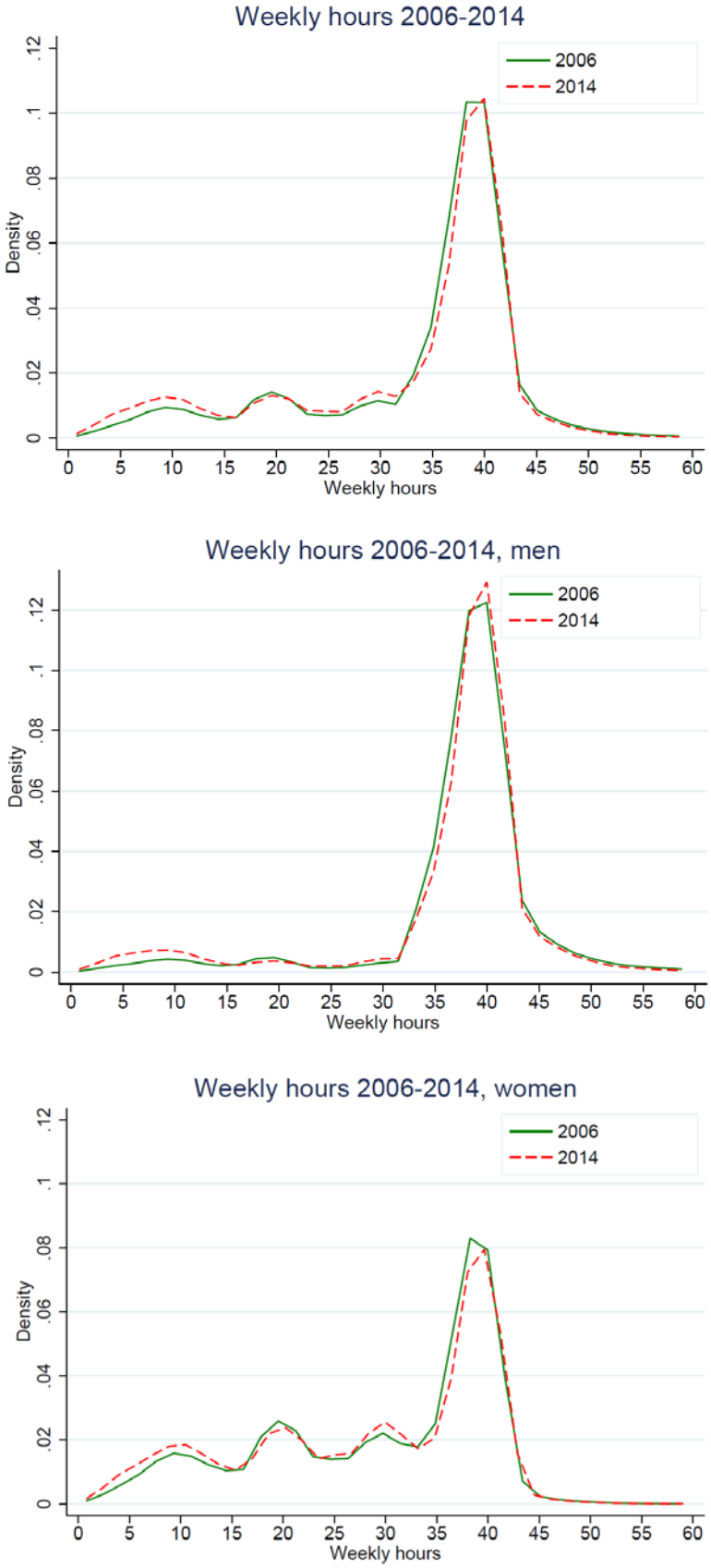
Hourly Wages	Full sample			Male			Female			Covered			Not covered		
	2006	2010	2014	2006	2010	2014	2006	2010	2014	2006	2010	2014	2006	2010	2014
Mean	19.02	18.59	18.38	21.19	20.75	20.57	16.30	15.96	15.92	20.75	20.20	20.39	16.80	16.64	16.26
	0.11	0.11	0.08	0.13	0.13	0.11	0.11	0.10	0.07	0.14	0.15	0.14	0.11	0.13	0.10
Median	16.95	16.28	15.87	18.60	17.88	17.46	15.15	14.63	14.46	19.01	18.32	18.22	14.23	13.87	13.55
	0.12	0.10	0.07	0.17	0.12	0.10	0.13	0.12	0.06	0.17	0.12	0.13	0.07	0.08	0.07
Inequality measures															
Gini	0.264	0.280	0.281	0.269	0.288	0.291	0.236	0.247	0.248	0.237	0.256	0.257	0.282	0.294	0.289
	0.001	0.002	0.001	0.002	0.002	0.002	0.001	0.002	0.001	0.002	0.003	0.002	0.002	0.003	0.002
MLD	0.115	0.128	0.127	0.119	0.136	0.137	0.092	0.100	0.099	0.095	0.110	0.108	0.130	0.140	0.134
	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002
Theil	0.122	0.137	0.138	0.127	0.146	0.147	0.092	0.102	0.104	0.098	0.114	0.115	0.147	0.160	0.153
	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003
Theil2	0.158	0.182	0.181	0.167	0.194	0.194	0.107	0.123	0.124	0.121	0.141	0.145	0.211	0.238	0.217
	0.003	0.004	0.004	0.004	0.005	0.006	0.002	0.004	0.002	0.003	0.003	0.004	0.006	0.010	0.008
Decile ratios															
DR 90/10	3.3	3.5	3.4	3.3	3.6	3.7	2.9	3.0	2.9	2.9	3.4	3.3	3.3	3.4	3.4
	0.02	0.03	0.02	0.03	0.04	0.03	0.03	0.02	0.02	0.04	0.06	0.03	0.03	0.04	0.04
DR 90/50	1.8	1.9	1.9	1.8	1.9	2.0	1.7	1.7	1.7	1.7	1.7	1.8	1.9	2.0	2.0
	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02
DR 50/10	1.9	1.9	1.8	1.8	1.9	1.8	1.8	1.8	1.7	1.8	1.9	1.8	1.7	1.7	1.7
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.01	0.01

Weekly Hours	Full sample			Male			Female			Covered			Not covered		
	2006	2010	2014	2006	2010	2014	2006	2010	2014	2006	2010	2014	2006	2010	2014
Mean	34.1	33.1	32.8	37.5	36.6	36.5	29.7	28.8	28.7	33.9	32.3	32.8	34.3	34.0	32.8
	0.06	0.13	0.08	0.06	0.16	0.10	0.09	0.18	0.10	0.08	0.21	0.13	0.10	0.09	0.08
Median	38.4	37.9	38.4	38.9	38.8	39.3	34.9	31.9	31.8	37.8	37.4	37.5	38.9	38.6	39.1
	0.00	0.03	0.06	0.00	0.09	0.17	0.00	0.39	0.26	0.15	0.10	0.05	0.03	0.01	0.16
Inequality measures															
Gini	0.149	0.165	0.174	0.090	0.104	0.111	0.206	0.221	0.227	0.136	0.166	0.160	0.162	0.161	0.187
	0.001	0.003	0.002	0.001	0.004	0.002	0.002	0.003	0.002	0.002	0.004	0.003	0.002	0.002	0.002
MLD	0.080	0.093	0.109	0.042	0.056	0.071	0.112	0.122	0.136	0.064	0.088	0.090	0.099	0.098	0.129
	0.001	0.003	0.002	0.001	0.004	0.003	0.002	0.003	0.002	0.002	0.004	0.003	0.002	0.002	0.002
Theil	0.056	0.066	0.075	0.028	0.037	0.045	0.084	0.093	0.100	0.047	0.064	0.063	0.068	0.068	0.087
	0.001	0.002	0.001	0.001	0.002	0.002	0.001	0.002	0.002	0.001	0.003	0.002	0.001	0.001	0.001
Theil2	0.045	0.053	0.059	0.022	0.029	0.033	0.071	0.079	0.084	0.038	0.052	0.050	0.054	0.054	0.069
	0.001	0.001	0.001	0.000	0.002	0.001	0.001	0.002	0.001	0.001	0.002	0.002	0.001	0.001	0.001
Decile ratios															
DR 90/10	2.3	2.8	3.4	1.2	1.6	1.8	3.5	4.0	4.0	2.1	2.7	2.6	3.3	3.2	4.1
	0.04	0.11	0.04	0.01	0.15	0.13	0.07	0.09	0.02	0.01	0.14	0.09	0.10	0.09	0.05
DR 90/50	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.3	1.3	1.1	1.1	1.1	1.1	1.1	1.1
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
DR 50/10	2.2	2.7	3.2	1.1	1.4	1.6	3.1	3.2	3.2	2.0	2.5	2.4	3.0	3.0	3.9
	0.03	0.11	0.04	0.01	0.14	0.12	0.06	0.06	0.03	0.01	0.13	0.09	0.10	0.08	0.04

Note: Bootstrapped standard errors in light grey (500 replications, clustered at firm level).

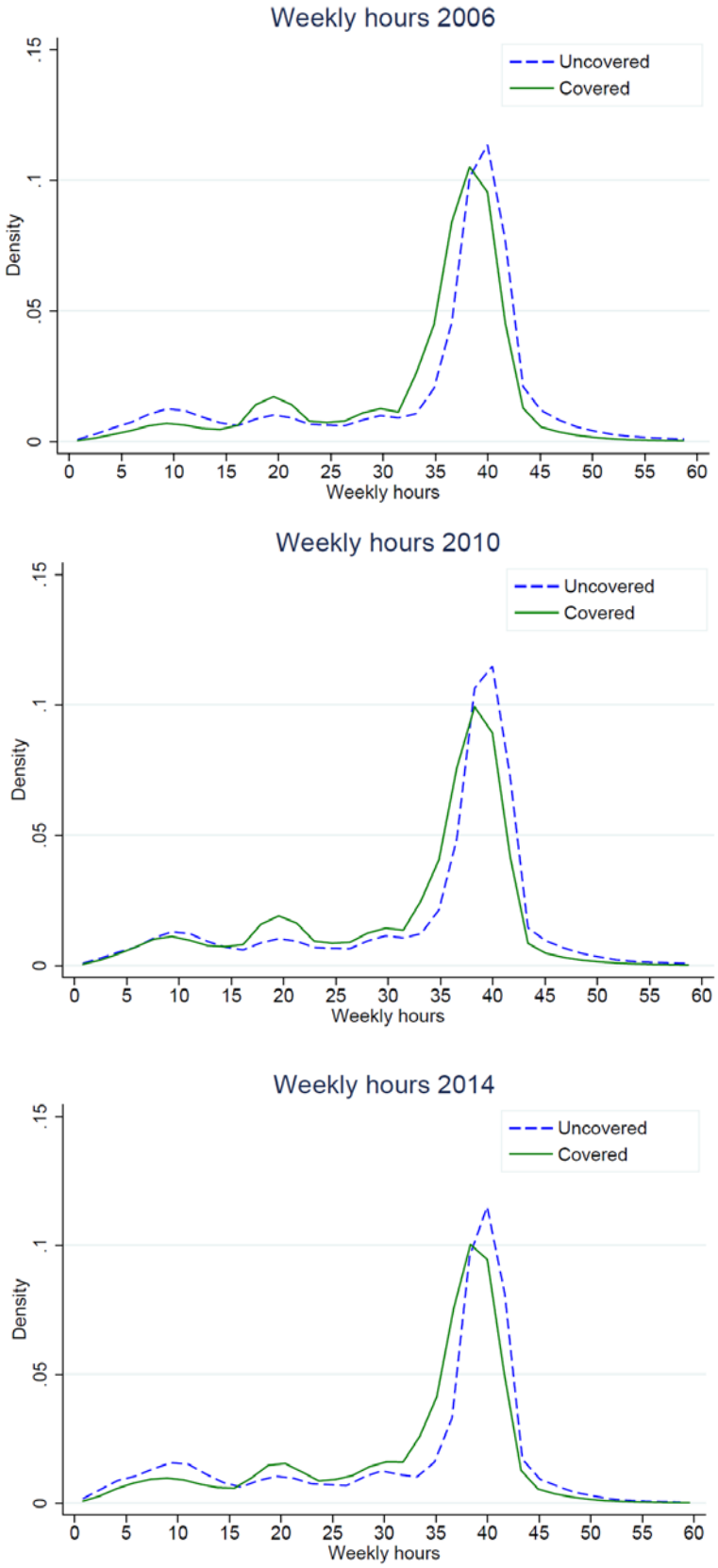
Source: GSES, own calculations.

Figure 1: Kernel density plot on weekly hours, 2006 and 2014



Source: GSES, own calculations.

Figure 2: Kernel density plot on weekly hours by collective bargaining coverage



Source: GSES, own calculations.

Turning to the development of bargaining coverage in Germany, we see that the share of collective bargaining decreased notably during the period of consideration (Table 3). Between 2006 and 2014, the share of employment relationships covered by a collective agreement declined from 56.26% to 51.38%.

Table 3: Share of employment relationships by collective agreement coverage

Year	Not covered	Covered
2006	43.74	56.26
2010	44.98	55.02
2014	48.62	51.38

Source: GSES, own calculations.

To further pursue the question on the relationship between bargaining coverage and the distribution of working hours, we split our sample into four groups according to weekly working hours. Table 4 shows that the share of employees working between 2 and 15 hours, and between 15 and 34 hours has increased. On the other hand, the share of employees working full-time (34-42 hours) or more than 42 hours declined between 2006 and 2014. Again, this indicates that the rise in hours inequality is due to an expansion of employment relationships at the bottom of the hours distribution. At the same time, we can observe that the shares of employees working very short or very long hours is much higher in firms without collective agreements.

Table 4: Development of weekly working hours according to four groups.

2006			
Weekly hours	Not covered	Covered	Total
2-15	11.84	6.50	8.84
15-34	14.39	19.87	17.47
34-42	63.10	68.95	66.39
42+	10.66	4.68	7.30
Total	100.00	100.00	100.00
2010			
Weekly hours	Not covered	Covered	Total
2-15	11.89	10.26	10.99
15-34	15.63	23.56	19.99
34-42	63.94	62.21	62.99
42+	8.54	3.97	6.02
Total	100.00	100.00	100.00
2014			
Weekly hours	Not covered	Covered	Total
2-15	15.50	9.91	12.63
15-34	16.21	21.84	19.10
34-42	60.55	64.02	62.33
42+	7.74	4.23	5.94
Total	100.00	100.00	100.00

Source: GSES, own calculations.

5 Empirical results

5.1 Variance decomposition of earnings inequality

In this section, we report the results of a variance decomposition for the years 2006, 2010 and 2014. Table 5 shows that the relative contribution of wage inequality becomes less important over time, accounting for less than one third to earnings inequality in 2014. In contrast, the relevance of both hours inequality and the wage-hour covariance increases over time. In 2014, the dispersion of hours explains 41.3% of the variance in log earnings, and the wage-hour covariance accounts for 27% of earnings dispersion.

The bottom panel of Table 5 reports the overall changes in the variance of log earnings and its components between 2006 and 2014. We see that almost 50% of the increase in the variance of log earnings is attributable to the changes in the variance of log hours. While changes in the covariance are responsible for 41.6% of the increase in earnings inequality, about 9% can be explained by the change in log wages.

Table 5: Variance decomposition of log monthly earnings: absolute and relative contributions

Year	var(log(e))	var(log(w))	var(log(h))	2cov(log(h), log(w))
2006	0.574	0.222	0.222	0.129
	0.008	0.002	0.004	0.002
		38.65	*38.76*	*22.52*
2010	0.665	0.243	0.258	0.164
	0.014	0.003	0.007	0.003
		36.58	*38.78*	*24.64*
2014	0.752	0.237	0.311	0.203
	0.008	0.002	0.005	0.002
		31.58	*41.32*	*27.04*
Year	**Δvar(log(e))**	**Δvar(log(w))**	**Δvar(log(h))**	2cov(log(h), log(w))
2010–2006	0.091	0.021	0.035	0.035
	0.017	0.003	0.008	0.004
		23.55	*38.88*	*38.04*
2014–2010	0.087	-0.006	0.053	0.040
	0.017	0.003	0.009	0.003
		-6.64	*60.75*	*45.36*
2014–2006	0.178	0.016	0.088	0.074
	0.011	0.003	0.006	0.002
		8.77	*49.58*	*41.63*

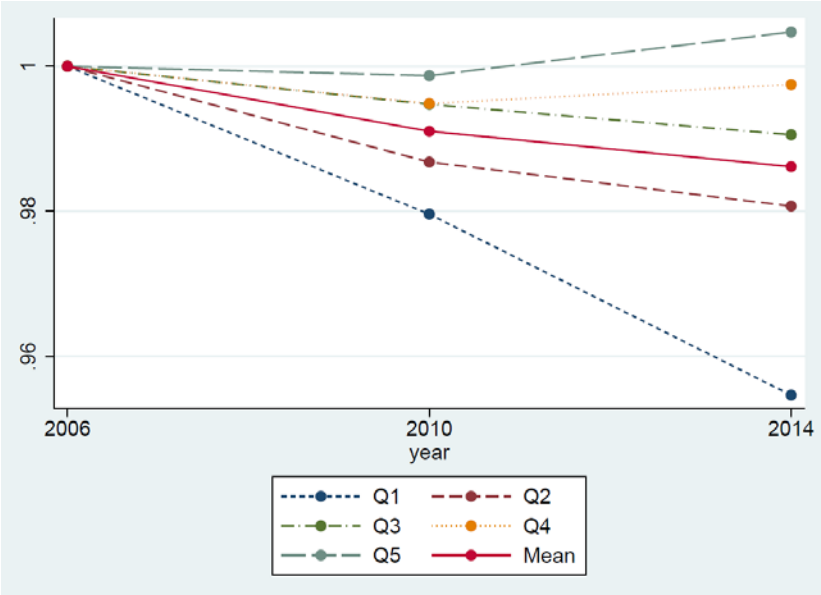
Note: Relative contributions in italics, bootstrapped standard errors in light grey (500 replications, clustered at firm level).

Source: GSES, own calculations.

The results of the variance decomposition show that the covariance between wages and hours is positive for all years and increases over time. This suggests that those with higher wages also spend more hours at work, which magnifies earnings inequality.

When we split our sample into five groups according to log wages, we see that average working hours developed differently for those quintiles (Figure 3). Plotting mean working hours over time reveals a general decline in the average hours worked, which is reflected by the solid line. However, whereas working hours increased slightly for the best paid workers (5th quintile), hours fell most considerably for lower income groups, especially for the first quintile.

Figure 3: Normalised mean log working hours for wage quintiles



Note: Observations were split into quintiles according to log hourly wages. For each wage quintile, the means of log working hours were calculated for the years 2006, 2010 and 2014, normalised to 1 in 2006, and plotted over time.

Source: GSES, own calculations.

5.2 Decomposition of earnings inequality for different population subgroups

In this section, we provide the results of a decomposition for four different subgroups with respect to gender and collective bargaining coverage.

Table 6 shows that the variance of log earnings and log hours, as well as the wage-hour covariance, are always higher for women (except for the covariance of non-covered females in 2014). Men, however, exhibit higher variances of log wages. We also see that, regardless of gender, inequalities are lower for those groups of employees who are covered by a collective agreement. Between 2006 and 2014, inequalities in earnings, hours and the covariance between wages and hours increased for all subgroups. Regarding the variance of log wages, we see an increase for all subgroups between 2006 and 2010, and a decline between 2010 and 2014. For men, a relatively large share of earnings inequality can be accounted for by wage inequality, while for women, the variation in hours is more important. However, the relative contribution of the variance of log hours was rising for all subgroups over time.

Table 6: Decomposition of earnings inequality for four population subgroups

2006		var(log(e))	var(log(w))	var(log(h))	2cov(log(h), log(w))
Male	Not covered	0.505	0.243	0.168	0.095
		0.009	0.003	0.005	0.002
			48.04	*33.20*	*18.72*
	Covered	0.320	0.192	0.088	0.039
		0.009	0.003	0.004	0.002
			59.98	*27.63*	*12.31*
Female	Not covered	0.699	0.182	0.365	0.153
		0.012	0.002	0.007	0.003
			25.98	*52.13*	*21.82*
	Covered	0.498	0.153	0.242	0.102
		0.011	0.003	0.006	0.003
			30.70	*48.67*	*20.50*
2010		**var(log(e))**	**var(log(w))**	**var(log(h))**	**2cov(log(h), log(w))**
Male	Not covered	0.557	0.265	0.179	0.113
		0.010	0.004	0.005	0.002
			47.54	*32.14*	*20.31*
	Covered	0.499	0.230	0.156	0.112
		0.045	0.006	0.020	0.010
			46.23	*31.28*	*22.49*
Female	Not covered	0.694	0.190	0.353	0.152
		0.009	0.003	0.005	0.002
			27.33	*50.79*	*21.87*
	Covered	0.621	0.173	0.289	0.159
		0.029	0.005	0.012	0.006
			27.83	*46.55*	*25.62*
2014		**var(log(e))**	**var(log(w))**	**var(log(h))**	**2cov(log(h), log(w))**
Male	Non-covered	0.707	0.257	0.271	0.179
		0.011	0.004	0.006	0.002
			36.40	*38.33*	*25.26*
	Covered	0.517	0.226	0.169	0.122
		0.030	0.004	0.016	0.006
			43.75	*32.61*	*23.54*
Female	Not covered	0.805	0.182	0.431	0.192
		0.008	0.002	0.005	0.002
			22.66	*53.51*	*23.79*
	Covered	0.630	0.162	0.300	0.167
		0.017	0.002	0.011	0.003
			25.65	*47.71*	*26.51*

Note: Relative contributions in italics, bootstrapped standard errors in light grey (500 replications, clustered at firm level).

Source: GSES, own calculations.

So far, our results show that hours inequalities are higher for employee groups without collective agreements, which supports our hypothesis on the negative relationship between union power and hours inequality. However, covered and non-covered groups of employees also might differ with respect to other characteristics, such as industry or firm size, that might drive patterns of working hours. In the following, we provide the results of unconditional quantile regressions that take into account this issue.

5.3 Unconditional quantile regressions

In this section, we first present the results of an UQR analysis for the full sample, before we provide the results separately for women and men. Table 7 reports the results of a standard OLS regression together with the RIF-coefficients of various quantiles for the years 2006, 2010 and 2014. In each table, the second row indicates the number of weekly hours corresponding to the respective quantile. The clear decline in hours corresponding to the 10th quantile between 2006 and 2014 indicates the growing dispersion of hours taking place especially at the bottom of the distribution.

The results of the OLS regression show that covered employees work on average more than those without collective agreements, as indicated by the positive coefficient of the *covered* variable. In addition, the positive coefficient of the *log(wage)* variable suggests a positive correlation between hourly wages and hours worked. Finally, we also included an interaction term for bargaining coverage and log wage in the regressions. The negative coefficient suggests that the wage-hour correlation is less strong for employment relationships covered by collective agreements.

Turning to the results of UQR reveals that these effects are heterogenous along the distribution of hours. As the coefficients of the *covered* variable suggest, tariff agreements have a positive effect on log hours especially at the lower part of the distribution, and negative effects at the top of the distribution. The coefficients on coverage decline with rising hours, eventually turning negative between 35 and 40 weekly working hours in 2006, and more than 40 hours in 2010 and 2014. These findings suggest that tariff agreements compress the distribution of working hours.

One exception to this pattern are the negative coefficients for the 10th quantile for bargaining coverage in 2010. These finding might be explained by the institutional regulation on marginal employment in Germany. In 2010, the 10th quantile corresponds to 14 working hours per week, which probably includes many so-called 'mini-jobs'.[7] As the threshold for tax-free earnings was equal to €400 in 2010, employees working only few hours had a strong incentive not to exceed this boundary. The higher the wage rate, the lower the number of hours one can work to stay

[7] The special feature of mini-jobs is that employees do not have to pay taxes or social security contributions for this employment. The employer only pays a flat-rate tax, which covers some employer's social security contributions as well as taxes. However, as soon as an employee exceeds the income limit of €400 (€450) in 2010 (2013), the salary must be taxed normally according to the tax progression. Particularly as a second earner (often women) with a full-time working spouse, the marginal tax burden often rises sharply because the total income of the spouses is then used as the basis for calculating tax. Furthermore, the employee must start paying some social security contributions on his or her total income, which increases progressively as his or her income from work increases, up to the ceiling at an income of €800 (€850).

below this income threshold. As wages tend to be higher for employees with tariff agreements, it seems plausible that covered jobs are related to less hours in this part of the hours distribution.

The positive coefficients of *log(wage)* in the UQR are in line with our previous findings on the positive covariance between wages and hours worked. Coefficients are highest for the 10th quantile, while decreasing along the distribution. This suggests that workers with higher wages tend to work longer hours, which further exacerbates earnings inequality. This effect becomes stronger over time, which also supports our previous findings on the increasing wage-hours covariance.

The mostly negative coefficients for the interaction term *covered * log(wage)* indicate that the positive correlation between hours worked and wages is less strong for employment relationships covered by collective agreements. Collective bargaining coverage therefore seems to have an additionally mitigating effect on hours inequality, which increases over time. Overall, these findings support our hypothesis that the presence of collective agreements tends to mitigate hours inequality.

Table 7: OLS and unconditional quantile regression coefficients on log(hours) for full sample.

2006	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		17.7	27.6	34.9	40.0	43.7
Covered	0.057	0.789	0.612	0.032	-0.004	-0.210
	(0.028)**	(0.196)***	(0.031)***	(0.002)***	(0.001)***	(0.007)***
Covered * log(wage)	-0.039	-0.322	-0.262	-0.014	-0.005	0.053
	(0.009)***	(0.078)***	(0.011)***	(0.001)***	(0.000)***	(0.002)***
Log(wage)	0.116	1046	0.560	0.030	-0.001	-0.090
	(0.007)***	(0.205)***	(0.014)***	(0.000)***	(0.000)***	(0.002)***
Female	-0.193	-0.552	-1036	-0.074	-0.018	-0.119
	(0.003)***	(0.115)***	(0.022)***	(0.000)***	(0.000)***	(0.002)***
Constant	4670	1452	3803	4994	5192	5607
	(0.020)***	(0.577)**	(0.031)***	(0.001)***	(0.001)***	(0.007)***
R^2	0.40	0.38	0.29	0.31	0.20	0.07
N	2,740,140	2,740,140	2,740,140	2,740,140	2,740,140	2,740,140

2010	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		14	23.5	33.1	40	42.8
Covered	-0.011	-0.249	0.354	0.156	-0.001	-0.125
	-0.042	(0.072)***	(0.040)***	(0.030)***	-0.001	(0.006)***
Covered * log(wage)	-0.015	0.053	-0.194	-0.114	-0.008	0.03
	-0.014	(0.021)**	(0.014)***	(0.015)***	(0.000)***	(0.002)***
Log(wage)	0.269	1.721	1.333	0.822	0.013	-0.053
	(0.009)***	(0.344)***	(0.045)***	(0.093)***	(0.000)***	(0.002)***
Female	-0.143	-0.118	-0.826	-1.027	-0.019	-0.099
	(0.012)***	(0.030)***	(0.033)***	(0.114)***	(0.000)***	(0.002)***
Constant	3.938	-2.326	0.493	2.921	5.145	5.373
	(0.026)***	(1.250)*	(0.136)***	(0.233)***	(0.001)***	(0.006)***
R^2	0.27	0.21	0.23	0.3	0.15	0.06
N	1,525,832	1,525,832	1,525,832	1,525,832	1,525,832	1,525,832

2014	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		12	22.5	31.5	40	42.5
Covered	0.263	0.49	1.364	0.522	0.003	-0.036
	(0.039)***	(0.041)***	(0.129)***	(0.043)***	(0.001)**	(0.007)***
Covered * log(wage)	-0.101	-0.164	-0.501	-0.21	-0.011	0.003
	(0.013)***	(0.013)***	(0.046)***	(0.016)***	(0.000)***	-0.002
Log(wage)	0.329	0.728	1.717	0.818	0.013	-0.035
	(0.010)***	(0.020)***	(0.137)***	(0.053)***	(0.000)***	(0.002)***
Female	-0.153	-0.074	-0.836	-0.825	-0.022	-0.081
	(0.008)***	(0.007)***	(0.059)***	(0.050)***	(0.000)***	(0.002)***
Constant	3.613	0.823	-1.428	2.548	5.147	5.304
	(0.026)***	(0.078)***	(0.482)***	(0.163)***	(0.001)***	(0.006)***
R^2	0.3	0.21	0.27	0.32	0.21	0.07
N	659,800	659,800	659,800	659,800	659,800	659,800

* p<0.1; ** p<0.05; *** p<0.01

Note: OLS standard errors are clustered at firm level, UCR standard errors are bootstrapped (500 repetitions). In the regressions we control for 9 industries, private/public ownership, 6 regions, firm size (3 groups), seniority (4 groups), temporary employment contract, 10 occupation groups, 4 education categories, and 4 age groups. The base group comprises male employees without collective agreement, between 20 and 29 years old, with secondary education, in the manufacturing sector, with a permanent contract, a tenure up to 10 years, in Northern Germany, and in a mainly privately-owned firm with 10 to 50 employees.

Source: GSES, own calculations.

As working-time patterns for women and men vary widely, it is not surprising that the coefficients for females are negative in all specifications. In the following, we provide regression results for women and men separately.

Table 8 shows the regression results for men. The working hours corresponding to the specified quantiles are markedly higher compared to the full sample, as most men still work full-time or close to full-time. Again, we see positive coefficients for tariff agreements at lower quantiles, declining with increasing hours worked. Coefficients are close to zero already for the 30th quantile, which is due to the higher number of corresponding hours compared to the full sample. Regarding the *log(wage)* variable and the interaction term *covered * log(wage)*, results are similar to the full sample. The corresponding coefficients suggest a positive correlation between wages and hours for the bottom of the distribution, and an additionally mitigating effect of collective agreements via the interaction term, which increases over time.

Also for women (Table 9), collective agreements have on average a positive effect on hours worked, as represented in the OLS setting. This effect is strongest for the 20th and the 30th quantile, corresponding to around 17 to 23 weekly hours. Given that women are much more likely to work part-time and mini-jobs are particularly common among women, it is not surprising that the coefficients in the 10th quantile are negative for 2006 and 2010. As already discussed, the presence of tariff agreements is usually linked to higher hourly wages, and thus employees have to work less hours to stay below the threshold of marginal employment. The fact that in 2014 the coefficient on collective bargaining is statistically insignificant for the 10th quantile is mostly likely due to the increase of the threshold for marginal part-time earnings from €400 to €450 in 2013. For the rest of the hours distribution, we see again positive coefficients for *log(wage)*, except for the 95th quantile, suggesting an inequality-enhancing effect.

The sign of the coefficient of the interaction term *covered * log(wage)* is positive for the 10th quantile for 2006 and 2010. This is also consistent with the earnings threshold of marginal part-time employment. Given that limit, collective agreements in the area of low part-time work lead to a stronger correlation between hours worked and the hourly wage rate. Given the incentive structure of the German tax system, second earners (especially females) are punished by the tax systems in the 'midi-job' sector, which includes earnings between €400 and €800. Therefore, for a given hourly wage, employees have to decide either to work only a few hours or to stay below the earnings limit or to work much more to get well above this limit.

Overall, the results show also for the female sample negative coefficients for the interaction terms, suggesting that tariff agreements mitigate the effect of the positive correlation between hours and wages.

Table 8: OLS and unconditional quantile regression coefficients on log(hours) for men.

2006, men	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		34.7	35.4	37.5	40.5	46.0
Covered	0.055	0.013	0.067	-0.006	-0.062	-0.261
	(0.021)***	(0.001)***	(0.008)***	(0.001)***	(0.001)***	(0.009)***
Covered * log(wage)	-0.032	-0.005	-0.051	-0.006	0.015	0.074
	(0.007)***	(0.000)***	(0.005)***	(0.000)***	(0.000)***	(0.003)***
Log(wage)	0.066	0.007	0.055	0.006	-0.027	-0.099
	(0.006)***	(0.000)***	(0.010)***	(0.000)***	(0.000)***	(0.003)***
Constant	4.813	5.001	4.829	5.064	5.26	5.618
	(0.018)***	(0.000)***	(0.042)***	(0.001)***	(0.001)***	(0.010)***
R^2	0.38	0.23	0.17	0.16	0.14	0.05
N	1,303,976	1,303,976	1,303,976	1,303,976	1,303,976	1,303,976

2010, men	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		27.6	34.9	37.5	40.0	45.0
Covered	0.038	1.197	0.004	-0.022	-0.006	-0.139
	-0.047	(0.439)***	(0.001)***	(0.002)***	(0.000)***	(0.006)***
Covered * log(wage)	-0.024	-0.438	-0.003	-0.002	-0.001	0.038
	-0.015	(0.160)***	(0.000)***	(0.001)***	(0.000)***	(0.002)***
Log(wage)	0.187	1.454	0.02	0.023	0.002	-0.058
	(0.009)***	(0.538)***	(0.000)***	(0.001)***	(0.000)***	(0.002)***
Constant	4.201	-0.962	4.953	4.972	5.159	5.403
	(0.028)***	-2.125	(0.001)***	(0.002)***	(0.000)***	(0.005)***
R^2	0.22	0.2	0.18	0.14	0.11	0.05
N	869,836	869,836	869,836	869,836	869,836	869,836

2014, men	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		24.1	34.9	37.5	40.2	45.1
Covered	0.291	9.355	0.03	0.014	-0.013	-0.079
	(0.052)***	(3.719)**	(0.002)***	(0.003)***	(0.003)***	(0.007)***
Covered * log(wage)	-0.105	-3.101	-0.011	-0.016	0.002	0.02
	(0.017)***	(1.233)**	(0.001)***	(0.001)***	-0.001	(0.002)***
Log(wage)	0.296	7.718	0.03	0.041	-0.007	-0.039
	(0.012)***	(3.064)**	(0.001)***	(0.001)***	-0.004	(0.002)***
Constant	3.704	-27.547	4.91	4.902	5.18	5.334
	(0.032)***	(12.780)**	(0.003)***	(0.005)***	(0.010)***	(0.006)***
R^2	0.25	0.26	0.25	0.16	0.13	0.05
N	350,500	350,500	350,500	350,500	350,500	350,500

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Note: OLS standard errors are clustered at firm level, UCR standard errors are bootstrapped (500 repetitions). In the regressions we control for 9 industries, private/public ownership, 6 regions, firm size (3 groups), seniority (4 groups), temporary employment contract, 10 occupation groups, 4 education categories, and 4 age groups. The base group comprises male employees without collective agreement, between 20 and 29 years old, with secondary education, in the manufacturing sector, with a permanent contract, a tenure up to 10 years, in Northern Germany, and in a mainly privately-owned firm with 10 to 50 employees.

Source: GSES, own calculations.

Table 9: OLS and unconditional quantile regression coefficients on log(hours) for women.

2006, women	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		11.3	19.3	23.5	39.8	40.5
Covered	0.072	-0.516	0.137	0.524	0.033	-0.013
	-0.048	(0.069)***	(0.010)***	(0.038)***	(0.002)***	(0.002)***
Covered * log(wage)	-0.051	0.148	-0.063	-0.253	-0.028	0.001
	(0.017)***	(0.023)***	(0.004)***	(0.015)***	(0.001)***	-0.001
log wage	0.179	0.323	0.186	0.566	0.006	-0.022
	(0.012)***	(0.024)***	(0.003)***	(0.018)***	(0.001)***	(0.001)***
Constant	4.349	2.918	3.956	3.466	5.174	5.242
	(0.030)***	(0.076)***	(0.009)***	(0.045)***	(0.002)***	(0.002)***
R^2	0.33	0.28	0.31	0.21	0.15	0.07
N	1,436,164	1,436,164	1,436,164	1,436,164	1,436,164	1,436,164

2010, women	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		9.9	17.9	20.5	39.0	40.0
Covered	-0.02	-0.401	0.037	0.063	0.032	0.025
	-0.061	(0.026)***	-0.043	(0.015)***	(0.003)***	(0.003)***
Covered * log(wage)	-0.02	0.132	-0.064	-0.048	-0.028	-0.027
	-0.021	(0.009)***	(0.015)***	(0.006)***	(0.001)***	(0.001)***
log wage	0.379	0.261	1.328	0.383	0.039	0.04
	(0.012)***	(0.078)***	(0.060)***	(0.032)***	(0.001)***	(0.001)***
Constant	3.56	2.741	0.28	3.424	5.058	5.116
	(0.032)***	(0.274)***	-0.188	(0.084)***	(0.002)***	(0.002)***
R^2	0.22	0.12	0.22	0.16	0.11	0.12
N	655,996	655,996	655,996	655,996	655,996	655,996

2014, women	OLS	Q10	Q20	Q30	Q80	Q95
Weekly hours		9.9	17.0	20.7	39.8	40.2
Covered	0.228	0.003	1.568	0.302	0.037	-0.025
	(0.053)***	-0.038	(0.128)***	(0.055)***	(0.004)***	-0.026
Covered * log(wage)	-0.094	0.007	-0.593	-0.127	-0.033	0.007
	(0.019)***	-0.013	(0.047)***	(0.022)***	(0.001)***	-0.017
log wage	0.373	0.273	2.132	0.508	0.035	-0.009
	(0.013)***	(0.013)***	(0.104)***	(0.076)***	(0.001)***	-0.02
Constant	3.421	2.521	-3.107	2.918	5.088	5.196
	(0.029)***	(0.038)***	(0.362)***	(0.230)***	(0.003)***	(0.030)***
R^2	0.26	0.13	0.25	0.2	0.15	0.04
N	309,300	309,300	309,300	309,300	309,300	309,300

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Note: OLS standard errors are clustered at firm level, UCR standard errors are bootstrapped (500 repetitions). In the regressions we control for 9 industries, private/public ownership, 6 regions, firm size (3 groups), seniority (4 groups), temporary employment contract, 10 occupation groups, 4 education categories, and 4 age groups. The base group comprises male employees without collective agreement, between 20 and 29 years old, with secondary education, in the manufacturing sector, with a permanent contract, a tenure up to 10 years, in Northern Germany, and in a mainly privately-owned firm with 10 to 50 employees.

Source: GSES, own calculations.

6 Conclusion

In this paper, we analysed to what extent the distribution of working hours affects earnings inequality, and the role of collective bargaining for hours inequality. Our study is based on data from the German Structure of Earnings Survey (GSES) for the years 2006, 2010 and 2014.

A variance decomposition reveals that working hours play an increasingly important role in determining earnings inequality in Germany. Our results show that hours inequality accounts for more than 40% of earnings inequality in 2014. Almost 50% of the increase in earnings inequality between 2006 and 2014 is attributable to changes in the distribution of working hours. The distribution of working hours affects earnings inequality not only through hours inequality, but also through the correlation between hours worked and hourly wages. If the latter term is positive, meaning that well-paid workers also work longer hours, this has a magnifying effect on earnings inequality. Germany exhibits a positive and increasing wage-hour covariance, which is responsible for 27% of earnings inequality in 2014. At the same time, the role of wage inequality in determining earnings inequality declines over time.

Looking at differences between genders, it is not surprising that working hours are much more dispersed for women than for men. Hours inequality is thus especially important in determining female earnings inequality, whereas earnings inequality among men is more strongly driven by the variation in wages. Over time the importance of wage inequality in explaining earnings inequality has declined for both genders.

Our results also suggest that union power is able to compress hours inequality. We applied unconditional quantile regressions to analyse the effect of bargaining coverage along the whole distribution of hours, while controlling for a range of firm and personal characteristics. We find that coefficients for collective bargaining are positive at the bottom of the hours distribution, turning negative for higher amounts of working hours. These heterogenous effects along the hours distribution suggest that collective bargaining exerts a compressing effect on hours inequality. Moreover, the presence of collective agreements also seems to mitigate hours inequality through an additional channel. We find mostly negative coefficients on the interaction term for bargaining coverage and log wage, suggesting that the presence of collective agreements mitigates the unequalising effect of the positive wage-hour correlation.

This study emphasises the so-far neglected, but increasingly important role of working hours for earnings inequality in Germany. It shows that policies aimed at reducing earnings inequality should not only focus on wage inequality, but also take into account the unequal distribution of working hours. Furthermore, this study enhances our understanding of the sources of rising hours inequality, which is crucial in order to develop adequate policy measures.

As we use firm-level data, our data only provides information on the hours worked within a specific employment relationship. There is no information on secondary employment of workers, and therefore it is only possible to analyse the distribution of hours for these employment relationships, but not on a personal level, A further restriction concerns the fact that we only have information on collective bargaining coverage at the firm level. This probably overstates the coverage of collective agreements. However, compared to previous studies, such as

Biewen/Plötze (2019), our dataset has the advantage of covering a large part of the service sector, which is particularly important for the issue of inequality. Despite the limitations of the date, some valuable insights can be gained.

Our analysis has focused on the variance and different quantiles of the hours distribution. Future research might extend the analysis of hours inequality also to other inequality measures. In addition, to examine the development of hours inequality and its drivers more profoundly, future studies should consider longer time periods.

Overall, our results suggest that union presence is not only able to compress wage inequality, as shown by previous research, but might also reduce hours inequality. As the dispersion of hours has been shown to become more important in determining earnings inequality in Germany, these insights are of increasing relevance.

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Appendix

Table 10: Overview on the firm and personal characteristics

Variable	
Personal characteristics	
Sex	Male Female
Age	20-29 30-39 40-49 50-59
Education	Lower secondary Upper secondary Tertiary education Education unknown
Occupation	Elementary occupations Managers Professionals Technicians and associate professionals Clerical support workers Service and sales workers Skilled agricultural, forestry and fishery workers Craft and related trades workers Plant and machine operators and assemblers Unknown
Type of employment contract	Permanent Temporary
Seniority	0-9 years 10-20 years 21-30 years 31+ years
Firm characteristics	
Collective agreement	No collective agreement Collective agreement
Firm size	<50 50-250 >250
Region	West (HE, RP, SL) North (SH, HH, BR, NS, B) South (BW, BY) East (MV, BR, S, SA, T) Middle (NRW) Mining (in West Germany)

Public/private ownership	Public ownership Private ownership
Industry	Mining & quarrying Manufacturing Energy & water Construction Trade Catering Education Health & social work Other services

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