The impact of unionisation changes on wage inequality within the UK

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Abstract

The past literature has typically reported an inequality reducing impact of unionisation for males but frequently find either small, or in some cases are inequality enhancing, impact for females. This study aims to understand whether these relationships still hold in the UK due to the changing pattern of union membership. We justify this because females are now a larger proportion of unionised workers in the UK. The gap between unionisation rates in the public and private sector has increased, concurrent to a steeper decline in private sector unionisation levels. The literature highlights two main causal channels - the between-sector effect and the within-sector effect. Following Card, Lemieux and Riddell (2020), we estimate the union effect through a skill group model using four years of cross-sectional data from the UK Labour Force Survey (LFS) over the period of 2001-2019. The results indicate that the union effect continues to be inequality reducing for males, but the overall effect on the variance of wages has decreased over the time period from 14% to 9%. Conversely, the overall inequality reducing union impact on female wage distribution has increased causing the two gender effects to converge by 2019. This overall effect is predominately caused by changes in public sector unionisation and wage dispersion, with the private sector less affected by unionisation changes over the period, especially in the case of the female private sector. The estimations of the wage flattening model support the finding that unions have reduced dispersion across skill groups in the public sector as the overall wage structure has flattened over time. Finally, we make use of the Workplace Employment Relations Survey (WERS) to overcome data definitional limitations of the LFS as a comparison. These results indicate that whilst the coefficients are generally smaller than those from the LFS, a union effect still exists. The findings of this paper suggest that changing unionisation characteristics within the UK has caused the convergence of union effect between genders overall and within the public sector. The inequality enhancing union effect for females appears to have significantly reduced, especially in the case of the public sector. To further expand this study, UK longitudinal data could be used to control for other aspects of unobserved heterogeneity.

1. Introduction and Rationale

In recent years, the level of organised union activity has spiked as workers withhold labour as a means to bargain for higher wages (ONS, 2023). The increase in union activity can be attributed to the rise in cost of living in the United Kingdom (UK), which has disproportionally affected low-income households. This is against a backdrop of higher long-run earnings inequality within the UK, characterised by a widening income gap between the highest and lowest earners (IFS, 2022). Despite the increased use of union tools in the labour market, union membership has declined to the lowest levels on record in 2022 (BEIS, 2022). Past research has found the decline in unionisation membership to contribute to increased wage inequality. This paper seeks to add to an established area of research through understanding the relationship between UK unionisation and wage inequality in the recent period.

A union is a labour market institution providing representation for workers, through negotiating with employers on behalf of its members for improved wages and working conditions. This can be achieved through organised strikes, negotiating labour contracts and advocating for legislation which benefits workers. Unions provide workers with a stronger voice, which plays an important role in improving labour market conditions. Union power is dependent on proportion of workers it represents which can vary significantly by industry and sector (Freeman and Medoff, 1981; Stewart, 1987; Forth and Millward, 2002).

This area of research increased in popularity in the UK following labour legislation enacted since 1979, which significantly reduced the power and influence of unions (Towers, 1989). In the past two decades, the composition of the unionised workforce has shifted. In 1995, a higher percentage of union members were male. In the current period, females now make up

a larger proportion of union members. Additionally, the difference between trade union membership in the public and private sector has increased, as private sector employees move away from union membership at a relatively faster rate than the public sector.

Considering the changes in the unionisation composition discussed above and influenced by the research conducted by Card, Lemieux and Riddell (2020), this paper will assess the impact of gender, skill groups and sector in influencing the union-wage differential. The hypothesis examined in this paper is that the inequality-reducing union effect has reduced for males but increased for females due to the changing composition of union membership. This will be investigated through a number of techniques. As this paper focuses on the impact of gender and skill, the dataset is organised into age-education groups to form an understanding of the impact of unions within skill groups and across the skill distribution. This will first provide an analysis of the total union effect by skill group. A weighted least squares regression is then used to estimate the wage flattening effect of unions. The next chapter provides an overview of the economic theory and the research that has aided the development of this study. Next, the report outlines the dataset and provides more depth on the methodology used to answer the research question. This will be followed by a discussion of the findings, the limitations of this study and a conclusion that discusses the implication of the findings on the hypothesis.

2. Literature Review

Literature on the causes and impact of unionisation is extensive. However, the majority of these studies focus on the impact of de-unionisation on UK wage outcomes in the late 20th century, with limited studies estimating this relationship in the UK over the more recent decades.

a. Economic theory

Theory suggests two directions through which unions can impact wage differentials. Where unions represent a large number of workers in a sector, it can utilise collective bargaining to increase wages for those at the lower end of the pay distribution, therefore reducing the wage differential between those at the bottom and the top. This is known as the within-sector effect of unions. Others have stressed the monopoly aspect of unionisation widening wage differentials due to the insider-outsider effect (Johnson, 1975; Hayek, 1980; Minford, 1983). In certain industries, unions can act as the single supplier of labour therefore determining the wage rate. As unions will often obtain higher than equilibrium wages for members, the wage disparity between union and non-union members increases. This is known as the between-sector effect of unions.

Unions may also impact wages indirectly. As unions increase the wages of lower paid workers, jobs available within the union sector reduce, increasing labour supply in the non-union sector and reducing wages further for non-union individuals. This amplifies the between-sector effect of unions. Lastly, unions may reduce the wage differential through the 'union threat effect' in which employers raise wages to detract the threat of unionisation from workers (Rosen, 1969: Freeman and Medoff, 1981 and Farber 2003).

The total union effect is determined through a combination of the within and between-sector effect. These two effects work in opposite directions as the between-sector effect increases wage differentials whilst the within-sector effect reduces wage differentials.

b. A review of the literature

The majority of research in this area has found the within-sector effect to dominate the between-sector effect, leading to positive overall effect of unionisation through inequality reduction. This argument was first given weight by Freeman (1980) who examined the effect of unionism on the dispersion of wages among U.S male workers in the private sector. Freeman's findings suggested that for manufacturing workers, the dispersion reducing within-sector effect dominates the dispersion increasing between-sector effect therefore bringing about an overall decrease in wage inequality for this group of individuals. For non-manufacturing workers, the net effects were found to be negligible.

Whilst Freeman's research focused on the U.S, this relationship also applies to the U.K. Gosling and Machin (1995) found that the distribution in earnings in the U.K was more compressed amongst semi-skilled union workers compared to the non-union counterpart. However, due to data unavailability at the time of research, it was difficult to determine if the between or within-sector effect held more dominance. Research since then has provided an understanding of how each of these effects contribute to the total effect. Card, Lemieux and Riddell (2003) compared the union effects across the UK, U.S and Canada and found similar results across the three countries. The UK relationship was estimated between 1983 and 2001 using data from the General Household Survey and the Labour Force Survey. The findings found that the within-sector effect dominated the union-wage relationship for males. Over the sample period, the total union effect reduced from 31% to 14% but the total union effect continued to be inequality reducing throughout.

A mixture of industrial and personal characteristics, such as presence and recognition of a union in the workplace, influences the propensity of workers to unionise (Disney, Gosling

and Machin, 1995; Schnabel and Wagner, 2007). Personal characteristics, such as gender and age, were found to systemically relate to union membership in cross-sectional studies for many countries (Chaison and Rose,1991; Wheeler and Mcclendon,1991; Riley 1997).

These characteristic differences affect the size of the union effect. Firstly, past literature has revealed that the male union-wage relationship does not manifest for females. Gosling and Lemieux (2001) found that the impact of de-unionisation on the variance of wages in the U.K was considerably smaller for females at 0.3% compared to males at 2.7%. Card, Lemieux and Riddell (2003) also found that unions exert a small dis-equalising effect on female wages. This is caused by a larger between-sector effect due the structure of the female unionised workforce, compared to the larger within-sector effect for males, which causes an inequality inducing union effect.

The union wage gap is also affected by sector. Past research has found the union effect to be larger in the public sector, with a wage premium of 5.2% compared to 3.5% in the private sector when accounting for human and job characteristic control variables (Blanchflower and Bryson, 2001). Recent research by Card, Lemieux and Riddell (2020) focuses on the sectoral differences by estimating the wage flattening effect of unions in the U.S and Canada and found that unions flatten wages considerably more in the public sector.

Research in this field often uses cross-sectional data to develop a model of the total union effect. The common method utilised is DiNardo's (1996) reweighting technique which adjusts for skill imbalances and unionisation probabilities. However, complications arise due to unobserved differences in traits between unionised and non-unionised workers with the same skills, potentially overstating the union effect. Freeman (1985) utilised longitudinal data

analysis to address the unobserved differences which showed that unions do have a levelling effect, but it is not as significant as estimates from cross-sectional studies. Card, Lemieux and Riddell (2020) note that the union-wage differential depends on union representation across skill groups, and the effect on wage for low versus highly paid skill groups. Using this method often obtains lower estimates of the union effect in comparison to the simple two-sector model utilised in past research, which does not account for compositional differences.

This study will utilise Card, Lemieux and Riddell's (2020) methodology and expand on the literature in a number of ways. Firstly, the majority of UK specific research in this area has focused on the period between the 1980s to the early 2000s. This study will provide an updated understanding on the topic using recent data from the past two decades. The union wage relationship has been estimated in the majority of past UK studies by either gender or sector. This study estimates the relationship through both gender and sector, which provides a wider understanding of the union impact on UK wage inequality.

3. Data

The research question is primarily investigated using data from the UK Labour Force Survey (LFS). The LFS is the largest labour survey in the UK and contains micro-level information on the employment circumstances of adults in private households (ONS, 2022). The LFS is produced quarterly, with households remaining in the survey for five successive quarters. Within each quarter, there is a cohort of households entering the survey and a cohort of households leaving the survey providing an 80% overlap in the sample for each quarter.

For past studies in this area of research, the LFS has been the preferred data source due to its public availability and large number of control variables (Blanchflower, 2010). One of the

main advantages is the consistent measure of unionisation since 1993. Additionally, the LFS holds a larger sample size in comparison to alternative studies such as the Annual Survey of Hours and Earnings.

Questions on unionisation are asked annually in the fourth quarter only and therefore this quarter represents each sample year. Whilst the LFS provides data on unionisation from 1993, the first sample year used in this report is 2001 as the present literature on this topic has provided an understanding of the union effect prior to 2001 (Card, Lemieux and Riddell 2003; Gosling and Lemieux, 2001). This report looks at the period from 2001 to 2019, through analysing four years of cross-sectional data across this period.

Whilst the number of individuals in each given quarter totals approx. 50,000-100,000, only a subset of these individuals provide information on union membership and earnings during the fourth quarter. This is partially due to the organisation of the survey which means questions on earnings are only asked to those in the first and fifth wave of the study in each quarter, and partially due to the non-response rate of individuals. Due to the low response rate in the 2020 pandemic and post-pandemic years, the sample period is restricted to 2019 (ONS, 2023).

Hicks et al (2005) raise concerns about the potential misclassification of workers between the public and private sector in the LFS, which misleadingly raises the number of public employees. To understand the impact of this misclassification on the coefficients, the unadjusted wage gap is compared to the same calculation in the Workplace Employment Relations Survey (WERS). The WERS collects data from employers and employees in a representative sample of the workplace. The sector categorisation of employees in the WERS provides a more reliable estimation of sector employment as this information is provided by

employers. However, the last period surveyed in the WERS is 2011 which limits the understanding of unionisation trends in recent years. Nevertheless, the 2011 WERS is compared to the 2011 LFS as an attempt to aid this study in determining the reliability of the LFS estimates.

The final sample looks across the years 2001, 2008, 2015 and 2019 to form an understanding of the union relationship over this period. The final sample for each year covered in this study contains approx. 6,000-10,000 individuals. Within these samples the gender distribution is approx. equal.

The main dependent variable of interest is hourly wages. Wages are adjusted to the 2015 price level using the Consumer Price Index to ensure comparability across cohorts. Individuals who report wages below £2 an hour and above £60 an hour are excluded from this study to minimise the effect of outliers. For all sample years, less than 3% of individuals report wages below and above this threshold. Sample weights are utilised throughout this study.

To obtain skill group analysis, the sample is organised into groups based on a continuous age variable (age) and a categorical qualification variable (qual). The age variable here aims to represent the experience of an individual. The number of age-education groups varies by year due to sample size. These age-education groups will be referred to as skill groups across this paper.

4. Methodology

This paper tests the hypothesis that the inequality-reducing union effect has reduced for males but increased for females due to the changing composition of union membership.

a. Conceptual Framework

The paper utilises the potential outcomes approach, a widely recognised method in this field. This approach is used by Card, Lemieux and Riddell (2003, 2020), which has motivated the methodology applied in this paper. The framework suggests that each worker has two potential outcomes; the wage a worker would earn in a unionised job (W^U) and the wage earned if they were in a non-unionised job (W^N), which derives the following equation

$$Wi = U_i W_i^U + (1 - U_i) W_i^N \quad (1)$$

Where U equals the current unionisation rate. To measure the impact of unions on wage inequality, the difference in variances between the two sectors can be used, with V representing the variance in the union sector and V^N representing the same for the non-union sector. At any one point in time, only one of these outcomes are observable depending on union status. This creates a problem in understanding the unobserved counterfactual scenario as V^N is likely to depend on the wage offers in the union sector. However, as noted by DiNardo, Fortin and Lemieux (1996) and DiNardo and Lemieux (1997), an estimate of the non-unionised variance $V^N(U)$ can be formed through utilising the observed non-union wages being paid to workers in the non-union sector. However, this method may not reveal the true union effect due to it ignoring the impact of the union sector in forming non-union wages (Card, Lemieux and Riddell, 2020). Due to the difficulty in obtaining the true estimate of V^N the analysis is this paper will focus on comparisons between V, the observed variance of wages and V^N – the variance that would prevail if everyone was paid according to the current non-union wage structure.

To estimate the variance of wages in the non-union sector, consideration must be given to union worker compensation if they were instead in the non-union sector. The assumption employed by Card, Lemieux and Riddell (2003, 2020) of union status being "as good as randomly assigned" conditional upon gender, sector and skill is used here. However, when calculating the wage and variance difference for each skill group model, the variance of non-union wages in the specific skill group may not equal V^N if the distribution of workers across skill groups differs from the distribution of the overall workforce. Card, Lemieux and Riddell (2020) note that a simple way to estimate V^N is to reweight individual observations using the weight for non-union workers in a particular skill group (represented by c) to account for these differences. This is implemented in this paper through using a reweight method of $(1/(1-U(c))$ where $U(c)$ represents the unionisation rate for a particular skill group.

This paper utilises the methods developed by Card, Lemieux and Riddell (2020) to provide an estimation of the impact of unions on the mean and variance of wages. The methods utilised is discussed in more detail below.

b. Estimating the union effect

Union effect on mean wages

Unadjusted and adjusted union gaps are utilised to understand the union effect on mean wages. The unadjusted union wage gap can be calculated through the difference in mean wages between the union and non-union group, or through using a simple OLS regression

$$ln(real\ hourly\ wage) = \beta_0 + \beta_1 union + e \quad (2)$$

where the log of real hourly wages is regressed on a dummy variable of union membership. An adjusted union wage gap is also calculated

$$\ln(real\ hourly\ wage) = \beta_0 + \beta_1\ union + \beta_2\ age + \beta_3\ qual + \beta_4\ agequal + e \quad (3)$$

where equation (3) includes an age-education interaction variable to control for skill differentials. Whilst the union wage gap can be affected by large number of factors, as noted in the literature, this study is focused on understanding the impact of skill, gender and sector and therefore these are the control variables considered in this paper. As the primary purpose in this paper is to understand the union effect, only the union coefficient from these equations will be reported and discussed. Details on the variables used within (2) and (3) are reported in Table 1 below.

Table 1: Variables used

Variable name	Variable explanation	Variable included in:
Lrwage	Log of hourly wage adjusted for CPI. Restricted to hourly real wage of £2-£60.	(2) (3) as the dependent variable
Union	Binary union membership variable. 1=Union member, 0=Non-union member	(2) (3) as the main independent variable of interest
Male	Gender Dummy Variable. 1=Male, 0=Female	(2) (3) Regressions restricted based on these variables
Priv	Sector Dummy Variable. 1=Private, 0=Public	
age	Continuous age variable ranging from 16-64.	(3) Used to formulate skill groups
qual	5 educational categories ranging from 1=No qualifications, 2=GCSE or equivalent, 3=GCE, A level or equivalent, 4=Higher education and 5=Degree or equivalent	

Skill group model

The skill group model provides an understanding of the union effect when considering age-educational differentials. This model recognises that workers of different skill levels may experience varied effects of unionisation.

This model is formed of the within and between-sector union effect mentioned in the literature earlier, as well as a term measuring the dispersion across groups. This last term reflects the rise in inequality if the union wage gain varies by skill groups. These components can be modelled through the equation below

$$V - V^N = Var[U(c)\Delta w(c)] + 2Cov[W^N(c), U(c)\Delta w(c)] + E[U(c)\Delta v(c)] + E\left[U(c)\left(1 - U(c)\right)\Delta w(c)^2\right] \quad (4)$$

where $V - V^N$ is the difference in variance as discussed in Section 5a. $E[U(c)\Delta v(c)]$ is the average within-sector effect which calculates the mean of the difference in variance of union and non-union wages for each skill group (represented by c), multiplied by the unionisation rate in that skill group. The term $E\left[U(c)\left(1 - U(c)\right)\Delta w(c)^2\right]$ reflects the between-sector effect and is calculated by the difference in the mean union and non-union wages for each skill group. The terms $Var[U(c)\Delta w(c)] + 2Cov[W^N(c), U(c)\Delta w(c)]$ together form the group dispersion effect which measures the difference in variances between mean union and non-union wages as well as the covariance between mean non-union wage and the difference in mean skill group wages.

Wage flattening effect of unions

The wage flattening effect quantifies the impact of unions on the wage distribution. This method has been obtained from Card, Lemieux and Riddell (2020) who utilise this model to estimate the union wage differentials in US and Canada, with the method replicated here for the UK.

The following regression model is used

$$DW(c) = \beta_1 + \beta_2[W^N(c) - \bar{W}^N] + e(c) \quad (5)$$

where $DW(c)$ is the difference in the mean wages between union and non-union workers in skill group c. The term $[W^N(c) - \bar{W}^N]$ represents the difference in the mean non-union wage for a specific skill group and the mean non-union wage across all skill groups. This equation is estimated through weighted least squares, using the frequency of non-union workers in each skill group as the weight. The smaller the coefficient of β_2, the larger the wage flattening effect of unions on the union wage distribution compared to the same non-unionised distribution. β_1 provides an estimate of the union non-union wage differential, when the average non-union wage of the skill group equals the overall average non-union wage (Card, Lemieux and Riddell, 2020). An increase in β_1 suggests a larger union-non union wage gap in the middle of the skill distribution.

c. Robustness checks

First, the normality of the dependent variable, hourly wages was assessed using a histogram. As hourly earnings displayed skewness in level form, the regressions in this paper employ the log of hourly wage.

When including the age-qualification interaction in equation (3), age is shown to be highly multicollinear with a Variance Inflation Factor (ViF) above 10. To address this issue, age has been centred in this equation through adjusting each observation by the mean age. This helps to address the collinearity present. The union coefficient is unaffected when using this method.

When utilising cross sectional data, it is important to determine if heteroscedasticity is present. For all models, across each sample year the White test statistic is lower than 0.05 which violates the assumption of homoscedasticity. To mitigate this, the OLS equations utilises HAC robust standard errors. The wage flattening effect model uses a WLS regression which handles heteroscedasticity within the data.

The Ramsey RESET Test for functional form suggests that there may be functional form errors across the adjusted wage gap regressions, which should be taken into account when determining the reliability of results. This may be due to heteroscedasticity in the data which biases standard errors and can invalidate the F test on which the RESET test relies on (Cameron and Trivedi, 2005).

The p statistic from the F test for all regressions used in in this paper is below 0.05, suggesting that the model used displays statistically significant results.

5. Results

Table 2: Union effects by gender, private and public sectors combined

	2001		2008		2015		2019	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Union membership rate	0.308	0.296	0.282	0.306	0.235	0.277	0.208	0.285
*Wage gap**								
(2) Unadjusted union gap	0.132	0.294	0.113	0.272	0.154	0.257	0.116	0.201
(3) Adjusted Union gap	0.047	0.134	0.039	0.102	0.053	0.103	0.029	0.064
Standard deviation (SD) of log wages								
Non-Union workers	0.585	0.503	0.580	0.505	0.602	0.527	0.556	0.511
Union workers	0.436	0.469	0.442	0.467	0.443	0.448	0.449	0.441
SD Union gap	-0.149	-0.033	-0.138	-0.038	-0.159	-0.078	-0.106	-0.070

**coefficients for all union wage gap calculations are significant at the 1% level*

Table 3: Union effects, by gender and sector

	2001		2008		2015		2019	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
PUBLIC SECTOR								
Union membership rate	0.646	0.570	0.621	0.561	0.549	0.565	0.472	0.548
*Wage gap**								
(2) Unadjusted union gap	0.118	0.304	0.066	0.253	0.096	0.224	0.144	0.193
(3) Adjusted union gap	0.082	0.156	0.049	0.134	0.055	0.126	0.097	0.105
Standard deviation (SD) of log wages								
Non-Union workers	0.509	0.456	0.505	0.472	0.489	0.495	0.470	0.445
Union workers	0.424	0.460	0.430	0.451	0.419	0.428	0.432	0.417
SD Union gap	-0.085	0.004	-0.074	-0.021	-0.070	-0.067	-0.037	-0.028
PRIVATE SECTOR								
Union membership rate	0.223	0.144	0.189	0.139	0.164	0.118	0.142	0.130
*Wage gap**								
(2) Unadjusted union gap	0.065	0.157	0.058	0.114	0.110	0.150	0.056	0.101
(3) Adjusted union gap	0.044	0.122	0.032	0.038	0.071	0.072	0.015	0.032
Standard deviation (SD) of log wages								
Non-Union workers	0.591	0.514	0.587	0.513	0.612	0.533	0.567	0.528
Union workers	0.427	0.453	0.440	0.457	0.451	0.475	0.452	0.475
SD Union gap	-0.164	-0.060	-0.147	-0.056	-0.162	-0.058	-0.115	-0.053

**coefficients for all union wage gap calculations are significant at the 1% level*

Prior to discussing the results of the models shared in Section 4b, it may be useful to first discuss the patterns of union membership shown by the first row of Table 2 and 3. The overall male union membership rate has declined by 10% over the sample period, whilst the female unionisation rate remains relatively stable with a decline of only 1%. These changes also occur in the public sector, with the male unionisation rate reducing by 17.4% compared

to 2.2% for females. At the end of the period, the divergence in union rates between genders has increased, which is likely to affect the overall union effect.

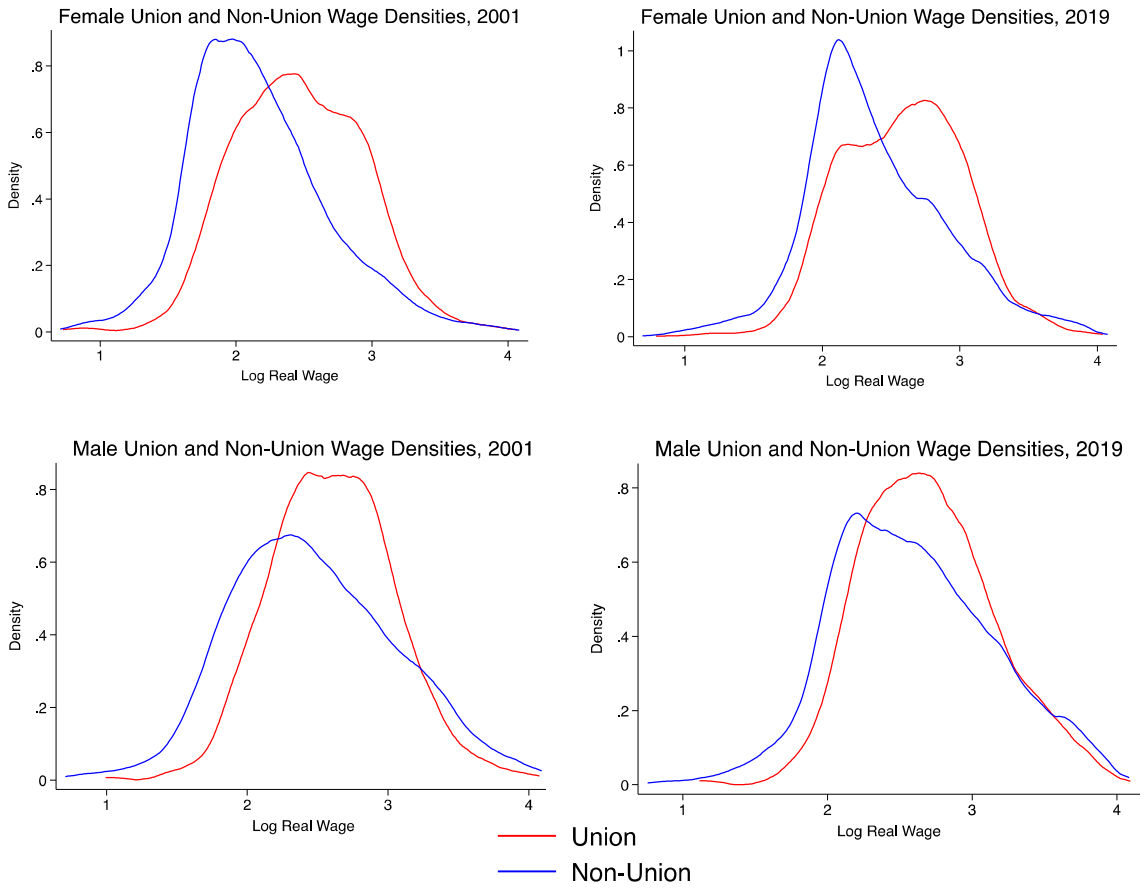

Figure 1: Union and Non-Union densities by log wage

Figure 1 shows the distribution of female and male union and non-union workers by log wages for 2001 and 2019. For females, union density has become increasingly skewed to the right over the sample period. This suggests that the modal wage for unionised females has increased. This may be due to a high number of females holding employment in highly skilled jobs that typically occur in the more unionised public sector, such as teaching and nursing. For female non-union members, there is a narrower peak in 2019 which suggests that wages have become more dispersed. For males, the distribution change is less pronounced but the slight rightward shift in the union curve between the periods suggests that there are higher union wages. The peak of the male non-union wage density in 2019 is higher

compared to 2001, which indicates there is a greater concentration of workers around the median wage level.

a. Union effect on mean wages

The next rows in Table 2 and 3 displays the union effect on mean wages through the unadjusted and adjusted union wage gap. In the overall data the mean log wages of union members remain consistently higher than non-union wages over the period. This provides a positive unadjusted union gap over the sample period, as shown in Table 2. However, the unadjusted union gap is declining over the period, suggesting that the growth in non-union wages is surpassing that of union wage growth.

When considering sectoral differences in Table 3, the union gap is predominantly larger in the public sector. With the higher union membership rate, it is expected that unions may hold more influence in increasing wages in the public sector. The public sector union wage gain is larger than the private sector but declines over time from 5.3% to 4.6% for males and from 8.9% to 5.7% for females. Interestingly, the union gap for public sector males from 2008 onwards increases. This is in line with the declining non-union male wages seen in the overall data.

b. Wage dispersion between groups

As shown by Table 2 the standard deviation of wages is consistently larger across non-union workers compared to union workers over the period. However, the standard deviation of male union workers is increasing over the period whilst reducing for non-union workers suggesting that union dispersion-reducing effect is weakening. Conversely, the standard deviation of female union wages declined by 6.0%, whilst it increased by 1.6% for female non-union

workers causing a larger union gap over time. This suggests that the within-sector effect of unions on female wages is increasing as unions reduce the wage dispersion.

This finding holds in the public sector. The female union standard deviation in this sector is initially positive suggesting that union wages were more dispersed. Between 2001 and 2015 the variance between unionised and non-unionised workers increased, before marginally decreasing in 2019 as shown in Table 3. The private sector female standard deviation union gap remains relatively constant over the period. For males, the standard deviation union gap declines in both the public and the private sector over time as both sectors follow the combined sector trend in Table 2.

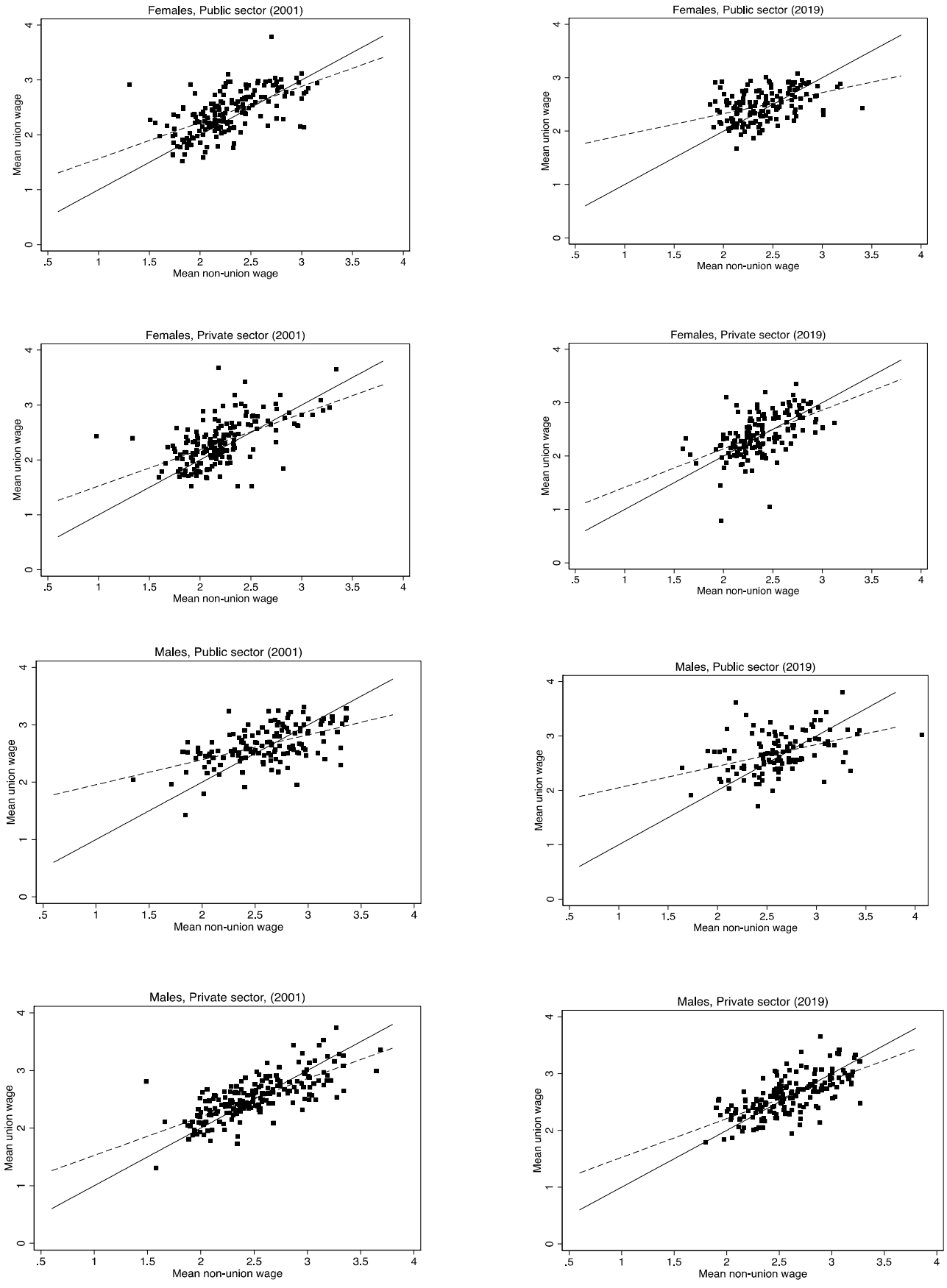

Figure 2: Union and Non-Union wage structure, by gender and sector.

c. Wage flattening effect of unions

The wage flattening effect estimates the difference in wage distribution for unionised skill groups compared to the non-unionised counterpart. The more negative the coefficient of the mean non-union wage, the larger the union wage flattening effect.

The graphs in Figure 2 above plots the union and non-union average wage for each skill group, which is produced using a method developed by Card, Lemieux and Riddell (2020). Points lying on the solid 45-degree line suggests an equal distribution of wages between union and non-union workers in that skill group. If the distribution of points is less steep than the solid line, there is a sign of a union wage flattening effect. This is because unions increase the pay of lower skilled workers – those towards the bottom end of the pay distribution closer in pay to that of higher paid workers.

For all sectors across both 2001 and 2019, the scatter of points is less steep than the 45-degree line, suggesting that unions flatten the wage distribution across genders and sectors. However, the size and movement of the flattening effect varies by sector. The public sector shows a significant flattening effect, especially for females, which has increased over time. This suggests that in the public sector, unions raise the wages of lower skilled workers relatively more than the wages of higher skilled workers, which is bringing about this flattening effect. For females, the distribution of points has tightened during the period, suggesting the overall dispersion of wages has decreased. The wage structure for females in the private sector has become marginally more steep suggesting there is increased dispersion in wages.

Using the methodology developed by Card, Lemieux and Riddell (2020) which is discussed in Section 4b, Table 4 quantifies the union impact by estimating the wage flattening effect

Table 4: Wage flattening effects

*=p<0.1 **=p<0.05 ***=p<0.01	2001		2019	
	Private	**Public**	**Private**	**Public**
Male Workers				
Intercept	0.022	0.082***	0.035*	0.082**
(standard error)	(0.021)	(0.023)	(0.020)	(0.029)
Coefficient on Non-Union Wage	-0.235***	-0.531***	-0.222***	-0.444***
(standard error)	(0.042)	(0.060)	(0.060)	(0.087)
R-squared	0.139	0.356	0.075	0.187
Implied Gap: 0.5 below mean	0.139	0.348	0.146	0.304
Implied Gap: 0.5 above mean	-0.096	-0.183	-0.077	-0.140
Female Workers				
Intercept	0.082***	0.134***	0.039*	0.104***
(standard error)	(0.020)	(0.020)	(0.023)	(0.020)
Coefficient on Non-Union Wage	-0.305***	-0.275***	-0.201**	-0.464***
(standard error)	(0.072)	(0.065)	(0.075)	(0.073)
R-squared	0.096	0.092	0.044	0.212
Implied Gap: 0.5 below mean	0.235	0.272	0.141	0.335
Implied Gap: 0.5 above mean	-0.070	-0.003	-0.060	-0.129

The coefficient of non-union wage for all models is statistically significant at the 5% level. As noted in Section 4b, the intercept provides an estimate of the non-union wage gap when $[W^N(c) - \bar{W}^N]$ equals zero. For females in the public sector, the union non-union average wage gap reduces from 13.4% to 10.3%. This is in line with the reduction in the union wage gaps discussed in Section 5a. For public sector females at the lower end of the wage

distribution (0.5 below the mean wage) the implied wage gap has increased, suggesting unions are now more effective at increasing the pay for lower skilled workers. In contrast, for those above the mean, the wage flattening coefficient is negative and reduces over the sample which suggests that higher skilled female union workers are earning less than their non-union counterpart over time. For private sector females the coefficient on non-union wage has increased over the period suggesting a reduction in the wage flattening effect. This suggests unions have less effect in reducing differentials in this sector which is supported by the graphs in Figure 2.

For males, the compression effect reduces marginally over the period in both sectors, but the negative coefficient suggests that unions continue to flatten the wage distribution. The flattening effect in the public sector remains considerably large at the end of the period, with a coefficient twice the size of that in the private sector. The intercept remains constant in the public sector at 8.2%. The implied gap for those earning below the mean has reduced over the period suggesting union impact on increasing lower skilled male public sector workers wages is reducing. Simultaneously, the implied gap for higher skilled male workers has increased which increases overall wage dispersion.

d. Union impact on wage inequality

Table 5: Total union effect using the skill differential model, by gender

	2001		2008		2015		2019	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Overall variance	0.299	0.261	0.299	0.260	0.328	0.270	0.289	0.250
Total union effect	-0.042	-0.011	-0.037	-0.015	-0.035	-0.026	-0.025	-0.021
Decomposition of total effect								
Within-sector effect	-0.032	-0.025	-0.031	-0.025	-0.028	-0.031	-0.022	-0.028
Between-sector effect	0.007	0.010	0.006	0.008	0.009	0.007	0.006	0.008
Dispersion across groups	-0.018	0.004	-0.012	0.001	-0.016	-0.002	-0.009	-0.001

Table 6: Total union effect using the skill differential model, by gender and sector

	2001		2008		2015		2019	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
PUBLIC SECTOR								
Overall variance	0.210	0.233	0.213	0.228	0.222	0.206	0.194	0.209
Total union effect	-0.043	-0.007	-0.038	-0.013	-0.015	-0.032	-0.019	-0.009
Decomposition of total effect								
Within-sector effect	-0.012	-0.017	-0.012	-0.018	0.002	-0.022	-0.008	-0.012
Between-sector effect	0.022	0.020	0.021	0.015	0.024	0.015	0.026	0.016
Dispersion across groups	-0.054	-0.010	-0.047	-0.011	-0.041	-0.025	-0.036	-0.013
PRIVATE SECTOR								
Overall variance	0.313	0.258	0.316	0.257	0.348	0.279	0.306	0.273
Total union effect	-0.029	-0.008	-0.024	-0.011	-0.024	-0.011	-0.018	-0.009
Decomposition of total effect								
Within-sector effect	-0.024	-0.013	-0.022	-0.015	-0.021	-0.016	-0.017	-0.016
Between-sector effect	0.008	0.011	0.008	0.009	0.013	0.009	0.008	0.010
Dispersion across groups	-0.013	-0.006	-0.009	-0.005	-0.016	-0.004	-0.009	-0.004

Here the analysis shared in the previous sections is brought together to understand the overall impact of unions on wage inequality in the present period. As discussed in the methodology, this total effect is understood through the skill group model which accounts for skill differentials between workers. The total effect is shown in Table 5 and 6.

Looking first at the results for males, the overall variance has reduced over the period, but the total effect suggests that unions still continue to reduce inequality. The decrease in union effect in this model is driven by a change in the within-sector effect, which suggests that the degree of union wage dispersion is increasing relative to that of non-union counterparts. The male between-sector effect remains relatively stable throughout the period at approx. 0.6. The overall impact of unions on male inequality has fallen over the period from 14% in 2001 (-0.043/0.299) to 9% (-0.025/0.289) in 2019. An increase in the dispersion across skill groups for males in the public sector, as well as a change in the within-sector effect has caused the total effect on the variance of wages to decline in this sector by 11% (21% in 2001, compared to 10% in 2019). The male public sector total effect was initially significantly larger than the private sector total effect in 2001, but this has now converged over time. The large union effect in 2001 for males was caused by the reduced dispersion across groups which has increased over time suggesting a broader wage distribution. So, whilst the total effect of unions for males is still inequality reducing currently, the direction of movement suggests that this may not be the case for much longer. Additionally, the results of the wage flattening regression in Section 5b support the findings of a decreasing overall effect of unions in both sectors.

The trend differs for females. The overall effect in Table 5 suggests that the total union effect on female wage inequality has increased. At the start of the period, unions reduce wage inequality by 4% compared to the end of the period, where the union impact on the overall variance has increased to 9%. The 2001 male and female union effect difference equalled 10% and by the end of the period, the overall union effect for females is in line with the male union impact. The total effect is predominately caused by an increase in the within-sector effect which suggests that unionised skill groups are less dispersed than the non-union

counterpart. This is supported by the results of the wage flattening model which suggests an increase in the flattening effect across the skill distribution. The results between 2001-2015 diverge from past literature where the two-sector model has suggested that the between-sector effect dominates for females, as both the public sector and total effect results suggest that the within-sector effect dominated. For private sector females, the total union effect has remained marginal over the period at 3% suggesting that unions continue to have minimal effect in this sector. Whilst the public sector union effect in 2019 is similar to the effect seen in 2001, during the period the union effect on female wage distribution was as high as 16% in 2015. However, this union effect reversed between 2015 and 2019 with the between-sector effect dominating which may suggest that the increase seen between 2001-2015 no longer exists. This increase in union effect in 2015 was primarily due to smaller dispersion across groups suggesting that there was a tighter wage distribution compared to the present day.

The results of the skill differential models suggest that the magnitude of the gender union effect difference is now small compared to that which was seen in the past literature. This finding is in line with the results found for the US and Canada by Card, Lemieux and Riddell (2020).

e. Limitations

Table 7: Comparison of WERS and LFS coefficients[1]

*=p<0.1 **=p<0.05 ***=p<0.01	**Public sector**	**Private sector**
Male workers		
OLS (WERS)	0.040**	0.048***
OLS (LFS)	0.082***	0.116***
Entity Fixed Effects (WERS)	0.073***	-0.032*
Female workers		
OLS (WERS)	0.195***	0.176***
OLS (LFS)	0.256***	0.166***
Entity Fixed Effects (WERS)	0.240***	0.123***

Section 3 mentioned a potential issue with misclassification of public-private sector employment in the LFS data. Using WERS data, the unadjusted union gap values are compared across the 2011 LFS and WERS in Table 7. The WERS OLS coefficients are smaller than the comparable LFS results for the public sector across both genders. This is also the case for private sector males. However, the WERS OLS union wage estimate for females in the private sector is larger than the LFS estimate. All coefficients remain significant at the 5% level. If these differences are similar across the entire sample period, the LFS coefficients may be overstated for the public sector and understated for the female private sector.

The model utilised in this paper relies on the assumption that union status is as good as randomly assigned, conditional on skill, gender and sector of employment and therefore all workers have the same unobservable skills. However, this is unlikely to hold in reality. One

[1] The same methodology used to deal with LFS data is applied to the WERS data. However, as WERS wage data is categorical, the mean of each category has been taken with the top wage band adjusted using a 1.5 factor.

factor that may impact the union effect is workplace differentials, as noted by Blanchflower and Bryson (2007). Using the methodology developed by Blanchflower and Bryson (2007), the 2011 WERS is used to estimate the unadjusted union gap coefficients using an entity fixed effect model to control for workplace heterogeneity. As noted by Table 7 the coefficients decrease for all estimates in comparison to the LFS unadjusted union gap coefficient, but only marginally for the public sector females and males. However most notably the male coefficient in the private sector is negative under the fixed effect model, but this value is not statistically significant at the 5% level.

In prior literature, economists have suggested that union workers may possess greater hidden skills compared to non-union workers (Lewis, 1986). As unions aim to reduce the wage dispersion, highly skilled workers may not be adequately compensated in the union pay structure. Card, Lemieux and Riddell (2003) note that this perspective implies that the level of employer selectivity could increase when the total effect of unions is larger. If unions raise wages more for lower-skilled workers, employers may alter their hiring strategies by only hiring from the top performers of the lower-skilled group to maximise their productivity return on paying higher wages. These practices could falsely magnify the wage premium, where the higher wages seen in the union sector is a reflection of the workers hired rather than solely the union effect. The results from Lemieux (1998) study suggests that some of the reduction in wage variability within the union sector can be attributed to selectivity, rather than a direct effect within the sector.

Research that uses longitudinal and fixed effect analysis find that the total union effect reduces, but an inequality reducing union effect still occurs. Therefore, the estimates found in this paper are likely to be overstated, but still present.

6. Conclusion

This paper looks to understand the total effect of unions on wage inequality in the present period. Previous literature, which has focused on this effect in the late 20th century suggested that UK unions continued to be inequality reducing for males but at an increasingly smaller rate over time. In contrast, the literature for females suggested that unions had a small and potentially inequality increasing effect on wage inequality.

The results are unable to reject the null hypothesis that the total inequality reducing union effect has reduced for males but increased for females over the period. As Table 6 shows, the reduction in inequality reducing effects for males and the opposite increase for females has caused the overall union effect to converge to the same rate of 9% in 2019. For females, this movement has been caused mostly by changes in the public sector, as the private sector showed minimal union effect over the entire period. This is in line with the union compositional changes in which, unions have a reduced impact in the private sector. The results from the skill differential model provides support for the inequality reducing aspect of unions in the public sector as the implied union non-union wage gap suggests unions increase the wages of lower paid female workers more than higher paid workers. However, this trend in the union effect reduced between 2015 and 2019 as the total union effect returned to being relatively small in the public sector. It is uncertain whether 2019 is an anomaly or if this is the true union effect in the current period. The union effect for both private and public sector males is reducing suggesting a reduction in the impact of unions for males. This is in line with the understanding of unions now being less male concentrated.

It must be considered that due to the limitations of the LFS and unobserved heterogeneity between union and non-union workers, that the results may be overstated. Therefore, the actual union effect is likely to be smaller than the results shown in Table 5 and 6.

Whilst data limitations exist in this area currently, UK longitudinal analysis could be used to control for further aspects of unobserved heterogeneity and expand this study. Finally, linking employer-employee data over a considerable period may help to provide a better understanding of the union-wage relationship.

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