Industrial Relations: A Journal of Economy and Society

ORIGINAL ARTICLE OPEN ACCESS

Do High Minimum Wages Harm the Progression of Minimum Wage Workers? Evidence From the United Kingdom

Silvia Avram[1] | Susan Harkness[2]

[1]University of Essex, Essex, UK | [2]University of Bristol, Bristol, UK

Correspondence: Silvia Avram (savram@essex.ac.uk)

Received: 14 May 2024 | **Revised:** 8 January 2025 | **Accepted:** 13 January 2025

Funding: This work was supported by Low Pay Commission (CR18028) and Economic and Social Research Council (ES/S012486/1).

Keywords: discrete-time models | low pay | minimum wage | wage growth | wage progression

ABSTRACT

Using panel data from the United Kingdom between 2009 and 2019, we study how substantial increases in the real and relative value of the minimum wage impacted on the wage progression of covered workers. We find that progression out of minimum wage jobs is frequent, although most workers remain low paid. Using hazard rate models, we find a short-lived negative effect on progression associated with the introduction of the National Living Wage in 2016. In subsequent years, we find no evidence of significant adverse effects. We find similar results when we model wage growth directly.

JEL Classification: C41, J31, J38, J68

1 | Introduction

Minimum wages are an important policy tool governments can use to influence wage inequality. Both cross-national research (Autor, Manning, and Smith 2016; DiNardo, Fortin, and Lemieux 1996; Lucifora, McKnight, and Salverda 2005) and evaluations of individual policy reforms (Biewen, Feirzenberger, and Rümmele 2022; Dolton, Bondibene, and Wadsworth 2012; Giupponi et al. 2024; Stewart 2012) suggest minimum wages significantly compress the wage distribution and reduce wage inequality. They can also be effective in closing specific wage gaps, such as those between men and women (Bargain, Doorley, and Philippe 2019; Caliendo and Wittbrodt 2021) or between different ethnic and racial groups (Clark and Nolan 2021; Wursten and Reich 2023).

Standard economic theory suggests minimum wages are likely to also have negative side effects, primarily on employment but possibly also along other dimensions, such as hours worked, training, and pay progression. While a large body of research has focused on employment effects (see Manning 2021; Metcalf 2008 for reviews), other dimensions are relatively underresearched. In this article, we focus on wage progression, and exploit the substantial increases in the real and relative value of the minimum wage that occurred in the United Kingdom between 2009 and 2019 to quantify effects.

In 2015, the UK government committed to ending low pay by sequentially raising the minimum wage applicable to workers aged over 25 relative to median hourly earnings. The introduction of the National Living Wage (NLW) that followed in April 2016 led to the largest hike in the minimum wage since its introduction in 1999, with the value of the minimum wage increasing by 7.5% over its previous level. Subsequent rises saw further changes in its relative value, and in 2019, the NLW stood at 60% of the median hourly earnings (Low Pay Commission 2021, 80), one of the highest minimums in the OECD (OECD 2022). At the same time, the share of workers covered by the NLW increased, with the number of affected workers rising from 1.0 to 1.6 million workers in the year to 2016, or from 4% to 7% of workers

(Low Pay Commission 2019). These changes marked a major policy change with the lowest paid workers estimated to have received a 10% pay rise and the share of low-paid workers falling rapidly in the following year (D'Arcy 2018). However, as the coverage of the NLW has grown, there has been rising concern that higher minimum wages may make it difficult for workers to progress to higher paid jobs and that more workers would be stuck in minimum wage jobs.

To date, few studies, for the United Kingdom or elsewhere, have examined how changes in the minimum wage have affected wage progression. Prior studies have instead primarily been concerned with how minimum wages affect (un)employment, the wages of the low paid, or wage inequality (Dickens, Machin, and Manning 1994; Dolton, Bondibene, and Wadsworth 2012; Manning 2005, 2021; Metcalf 2008). In this article, we examine how the introduction of the NLW and subsequent raises, which led to a rapid increase in the real value of the minimum wage, affected the progression and wage growth of minimum wage workers in the United Kingdom. Leveraging panel data from Understanding Society from 2009 to 2019, we use competing hazard models to examine whether changes in the level of the minimum wage affected the probability of minimum wage workers progressing to higher pay, and wage equations to examine their wage growth. As the minimum wage is set nationally, we use geographical and temporal variations in local wage levels to identify effects. Lower wage areas are more exposed to minimum wage increases, and we expect increases in the minimum wage to have a greater effect on the chances of wage progression in low wage areas compared to high wage areas. We measure the local wage level with the rate of minimum wage coverage, that is, the share of workers earning at or below the minimum wage.

We find that the 2016 minimum wage hike may have temporarily increased the probability of remaining in a minimum wage job and decreased the probability of progressing to a higher paid job. However, any adverse effects appear to have been short-lived, disappearing in subsequent years. This result is robust to a variety of specifications. We present some suggestive evidence showing that training might be one of the mechanisms involved: workers are less likely to receive training in years surrounding the NLW introduction (2015 and 2016), and training is consistently associated with a higher probability to progress. Our wage growth models show that minimum wage workers in lower wage areas have similar levels of wage growth as their peers in richer areas. Overall, we conclude that there is little evidence to suggest minimum wage increases between 2009 and 2019 affected the long-term progression of minimum wage workers in the United Kingdom.

2 | Literature Review

In competitive labor markets, firms are assumed to pay workers their marginal product, with wage growth assumed to result from investment in human capital and job search behavior (Bagger et al. 2014). Increases in the minimum wage may alter wage dynamics particularly if some workers are paid more than their marginal product or job search behavior is altered (Swaffield 2014). The behavior of both firms and workers may change in response to higher minimum wages. Below, we discuss how individuals and firms (or supply and demand) may respond to hikes in the minimum wage and the implications for wage growth.

2.1 | Supply-Side Responses

Minimum wages compress the lower part of the wage distribution (Dickens and Manning 2004; Lee 1999; Machin and Manning 1994; Manning 2012; Teulings 2003) with smaller wage differentials reducing the (perceived or actual) returns to human capital accumulation, job search, and job-to-job mobility. As minimum wages rise, those individuals with low potential earnings may see relatively small gains to additional training or work experience, reducing their incentives to acquire human capital, including schooling (Neumark and Wascher 2003). For similar reasons, higher minimum wages may reduce workers' incentives to search for a new job, decreasing or delaying the chances of workers finding an improved job match and progressing to higher pay. Moreover, as job-to-job mobility is a key determinant of worker bargaining power, reduced mobility will depress wage growth among those who remain with the same employer (Burdett and Mortensen 1998; Ghosh 2007; Karahan et al. 2017). Finally, higher minimum wages may induce more people to join the labor force increasing competition for jobs at or near the minimum wage (Jones et al. 2013).

2.2 | Demand-Side Responses

Firms facing higher minimum wages may respond in varying ways. On the one hand, firms facing higher wage bills may try to reduce costs by reducing employment, working hours, or non-wage costs, such as training, with implications for minimum wage workers' ability to accumulate human capital. If firms shed labor in response to minimum wage hikes, workers will accumulate less work experience and, in the case of job separations, lose firm-specific human capital. While most studies find higher minimum wages have had no or only very limited effects on employment rates among working age adults (Manning 2021; Metcalf 2008), the effects on working hours are more ambiguous with some studies suggesting higher minimum wages may be associated with lower working hours (Stewart and Swaffield 2008). There may also be adverse effects on training if, as theory predicts, on-the-job training is partly financed by workers through lower wages. If minimum wages prevent workers from accepting a sufficiently low wage, they may receive less training, which may have a negative impact on their future wage growth. On the other hand, higher minimum wages may incentivize firms to invest in training or capital equipment to boost worker productivity and bring it in line with higher wages. Evidence, however, suggests that labor saving technologies may favor both upskilling and deskilling (Acemoglu and Restrepo 2020; Autor, Levy, and Murnane 2003), and the effect that higher wage floors may have on wage growth is therefore ambiguous. Similarly, the evidence on how minimum wages impact training is inconclusive with some studies finding negative effects (Hara 2017; Neumark and Nizalova 2007), others no or very small effects (Bellman et al. 2017; Fairris and Pedace 2004; Grossberg and Sicilian 1999), and others showing that affected workers

actually received more training (Arulampalam, Booth, and Bryan 2004). Finally, as minimum wages increase, the share of workers covered will grow, reducing the pool of jobs that minimum wage workers may otherwise may have been able to progress to. This reduction in demand may affect minimum wage workers' chances of progression.

In sum, while supply-side changes may reduce incentives for minimum wage workers to progress, changes in labor demand have more uncertain effects. In this study, we provide empirical evidence on the effect of the introduction of the NLW and subsequent minimum wage increases on progression by exploiting variations in its rate of coverage across commuting zones over time. If minimum wages have an adverse impact on wage growth, we expect these effects to be felt most acutely in areas and at times where rates of coverage are high.

3 | Data and Methods

We use the first 10 waves of Understanding Society, the UK Household Longitudinal Study (UKHLS)[1], covering the period 2009–2019. UKHLS is the largest longitudinal survey in the United Kingdom, following approximately 26,000 households. It collects rich information about demographic and labor market characteristics and histories. Previous evaluations of the minimum wage in the United Kingdom typically use the Annual Survey of Hours and Earnings (ASHE), an employer survey that covers 1% of the employed workforce. While having lower sample sizes than ASHE, UKHLS provides richer information on individual characteristics. Since we identify the effect of minimum wage increases from geographical variation in wage levels, it is important to control for individual characteristics that might be differently distributed, and which may confound the results. Using UKHLS allows us to control for education, health, partnership status, number and ages of children, and household income, all of which are unavailable in ASHE but likely to influence the ability to progress from a minimum wage job.

Another advantage of UKHLS over ASHE is the ability to distinguish employment exits from attrition. ASHE only covers employees and thus employment exits and "true" attrition are confounded. Attrition is a concern in panel surveys (Knies 2017) and if the rates of attrition for minimum wage workers differ across areas our estimates may be biased. Understanding Society provides longitudinal weights that account for attrition bias (ASHE does not provide longitudinal weights). We do not use these weights, except in our descriptive results, because of sample loss: individuals who leave the panel and return later are assigned a weight of zero. To maximize the number of observations, we do not use weights in either our competing risks models or in our wage growth analysis. However, weighted results are very similar (see Table A4 in Appendix 2).

3.1 | Sample Selection and Exclusion Criteria

Following official estimates and previous studies on the impact of the minimum wage on earnings, we focus on employees entitled to the adult rate[2]. The age at which workers become entitled to the adult pay rate changed during the period we study, increasing from 21 to 25 after the introduction of the NLW in 2016. To ensure consistency, we focus on individuals aged 25 and older who were entitled to the adult rate throughout the period we study. Excluding individuals younger than 25 also has the advantage of removing students who might temporarily find themselves in a minimum wage job, but who are likely to progress to better paid employment once they complete their studies. We exclude individuals after they reach the State Pension Age, even if they continue working. Our sample therefore includes employed men aged 25–64 and employed women aged 25–59. This leaves us with an unbalanced sample consisting of 4317 individuals and 7489 observations where the person is observed to be in a minimum wage job. To be able to observe a transition, we require at least one consecutive observation after the year a subject is observed to be in a minimum wage job. This leaves us with a final sample of 2886 individuals. From minimum wage jobs, we observe 1746 transitions to low-paid work, 588 transitions to "high" pay and 371 transitions to nonemployment. Transitions are relatively evenly spread across years. In our full specification, we lose some observations[3] due to missing values on the covariates and are left with 2738 individuals, 1656 transitions to low pay, 574 transitions to "high" pay and 345 transitions to nonemployment.

3.2 | Issues in Measuring Hourly Pay for Low-Wage Workers

The minimum wage is defined at the hourly level. Hourly pay measures are not directly available in the UKHLS, except for a subsample of respondents who are paid by the hour (about a third of the sample). An *implicit* measure of hourly pay can be derived for all workers from reported usual monthly or weekly pay and usual working hours. However, it is well known this *implicit* measure suffers from division bias, resulting in implausibly small values and an overestimation of the incidence of low-paid employees (Skinner et al. 2002; Stewart and Swaffield 2002). This issue is particularly important in our case as we focus on wage progression and wage growth at the bottom of the distribution. To correct for this, we adapt an imputation procedure proposed by Skinner et al. (2002). The procedure assigns an imputed value to observations missing the direct measures of hourly pay by matching them to a *donor* observation with a valid non-missing value. In the first step, we regress the direct measure of hourly pay on the implicit measure and other individual and job characteristics: gender, age (quadratic), qualifications (six categories), region, marital status, number of children aged under 5, occupation (three-digit SOC codes), industry (two-digit SIC codes), firm size, public sector, part-time employment, and year. We then use this regression to predict hourly wages for all individuals in our sample who have non-missing values for the predictor variables. We use the predicted hourly wage to match observations missing direct hourly pay to a donor observation whose direct hourly wage is observed. Donors are selected randomly from the 10 nearest "*neighbors*." A neighbor is defined as an observation with a value of the predicted hourly wage within ±50p of the target's predicted hourly wage. To avoid outliers affecting our results, we exclude donors whose residuals (calculated as the difference between the observed and predicted hourly rate) lie in the top and bottom 1% of the distribution. To reduce variance inflation, we follow Skinner et al. (2002) and

repeat the imputation 20 times. Our final imputed values are the means of the 20 imputations. We carry out the imputation separately for each year (note that a year usually straddles two waves in the UKHLS data). To account for measurement error introduced by the imputation, we bootstrap all our main estimates (including the wage imputations) based on 100 replications. To account for the longitudinal nature of our data, we sample individuals rather than observations.

We find that the imputation significantly improves on both the direct and the implicit measures: the imputed measure exhibits both the low density below the minimum wage level and the spike at the minimum we would expect to see (Figure A1 in Appendix 1 shows the distribution of hourly pay for our three measures: direct, implicit and imputed wages between April 2016 and March 2017 and the value of the minimum wage; similar results are obtained for all the years in our data, shown in Appendix 1: Figure A2). A second way of checking on the quality of the imputation is to examine the share of workers covered by the minimum wage. We compare the share of workers on minimum pay according to our measure with the same measure derived using the ASHE, the main source of official statistics on wages in Figure A3 in Appendix 1. The share of minimum wage workers is almost identical using the two sources between 2012 and 2016. However, the share of minimum wage workers is around 1-percentage point higher in UKHLS compared to ASHE at the start and end of the period we study. This could be because our imputation procedure results in a too high number of minimum wage workers, but it could also be due to ASHE underestimating the number of minimum wage workers, especially in more recent years (Forth et al. 2024). Further results comparing our measure of hourly wages with the hourly wage measure in ASHE are available in Appendix 1.

3.3 | Outcome Variables

In our descriptive analysis, we differentiate between short- and long-range progression by distinguishing between progressing to low-paid and high-paid employment. *Low-paid employment* is defined as employment paying an hourly wage above the minimum but below a low-pay threshold that we define, as is common in the literature, as two-thirds of median hourly earnings. *High-paid* employment is employment paying above the low-pay threshold. For simplicity and to avoid potential problems caused by the small number of cases who are observed to progress from minimum wage to high-paid employment, we focus on progression to above minimum wage employment in our discrete-time model. Estimates of a discrete-time model that distinguishes between low and high pay employments can be found in Figure A6 in Appendix 2.

To limit the potential for spurious transitions generated by measurement error, we count a transition as taking place only if the observed hourly wage is 5p higher than the category threshold. A similar approach has been adopted by Bryan and Taylor (2006) and Dolton, Bondibene, and Wadsworth (2012). One concern is that individuals may change more than one job between interviews. While information about hourly wages is available only for the jobs held at interview time, we have information about all employment and nonemployment spells between the interviews. Less than 5% of our sample experience more than one employment/job transition between interviews. We include these cases in our descriptive analysis using transition matrices, but we drop them when estimating the discrete-time model, since we do not observe the wage corresponding to the job immediately after the minimum wage job.

3.4 | Local Area Indicators of Economic Activity

We use travel to work areas (TTWAs) as the local geographical indicator. TTWAs are geographical units constructed based on census commuting flows data and are meant to approximate local labor markets (Prothero 2016). There are 243 TTWAs based on the 2001 census and 228 based on the 2011 census. For each year between 2009 and 2019, we calculate the share of minimum wage workers in each TTWA using the ASHE[4]. ASHE is a large employer survey covering approximately 1% of Great Britain's[5] employed workforce that collects payroll-based information on hourly wages. We use TTWA indicators based on workplace location[6] in ASHE to compute the share of minimum wage workers in an area. For TTWA year combinations where the number of observations in ASHE is smaller than 100, we follow Giupponi et al. (2024) and merge them with a neighboring TTWA based on the observed commuting patterns in ASHE. The share of minimum wage workers is calculated as the proportion of workers with a wage lower or equal to the current minimum wage plus 5p (the same approach is adopted by the Low Pay Commission in their 2021 report). The share of minimum wage workers captures the "exposure" of the local labor market to minimum wage hikes. We then merge this information into the UKHLS, using TTWA and year. TTWA indicators in UKHLS[7] refer to residential rather than workplace location.

3.5 | Estimation Strategy

In the United Kingdom, the minimum wage is set at the national level and only varies over time. However, the proportion of workers affected by the minimum wage, and increases in it, vary with the strength of the local economy. We exploit this variation to estimate the impact of minimum wage increases, including the introduction of NLW on the wage progression of minimum wage workers. We use the area share of minimum wage workers as a measure of exposure to the minimum wage and estimate the probability of progressing from a minimum wage job to higher paid employment, while also accounting for moves to nonemployment.

Our main results focus on *progression* out of minimum wage jobs, defined as transitions from employment paying the minimum wage to employment paying above the minimum. This transition does not have to involve a job or employer move. Transitions have the advantage they are easily interpretable from a mobility perspective and are not sensitive to within category measurement error of hourly wages. However, focusing on transitions can also have drawbacks. The estimated probabilities will be affected by changes in the structure of the wage distribution. We therefore supplement our analysis of transitions with further analyses that model wage growth directly. Both estimation strategies are described in more detail below.

3.6 | Transition Models: Competing-Risks Discrete-Time Models

We use transition matrices and a competing-risks discrete-time model to examine the progression out of minimum wage jobs. The effects of minimum wage increases are identified by comparing how transition probabilities change in areas with different shares of minimum wage workers. This strategy assumes that absent NMW/NLW changes, wage progression probabilities across local areas move in a similar way. However, one concern is that results will be driven by differences in local economic trends: if areas with higher shares of minimum wage workers grow faster/slower, this will create an association between transition probabilities and the area share of minimum wages. To correct for this potential bias, we control not only for individual and job characteristics but also for the local area's contemporaneous median wage level. Note that our measure of minimum wage exposure, the share of minimum wage workers, is not directly related to the area's median wage. Formally, we estimate models of the following form:

$$h_{st} = \frac{\exp\left(\alpha_{st} + \beta_s X_{it} + \lambda_{st} + \gamma_{st}\text{MWShare}_{a,t-1} + \theta_s \text{MedWage}_{a,t}\right)}{\left(1 + \sum_{ss=1}^{S} \exp\left(\alpha_{sst} + \beta_{ss} X_{it} + \lambda_{sst} + \gamma_{ss}\text{MWShare}_{a,t-1} + \theta_{ss}\text{MedWage}_{a,t}\right)\right)} \quad (1)$$

where h_{st} is the hazard of leaving a minimum wage job at time t for destination s. s takes one of two possible values: employment paid above the minimum and nonemployment. $\text{MWShare}_{a,t-1}$ represents the share of minimum wage workers in area a at time $t-1$ and λ_{st} are year fixed effects. The coefficient of interest, γ_{st}, captures the extent to which transition probabilities differ between areas with high and low shares of minimum wage workers. Our specification allows these probabilities to vary by year because, if minimum wage hikes affect wage progression, we should see larger effects in 2016 when the NLW was introduced.

X_{it} represents a rich vector of individual characteristics, measured at time t, capturing levels of human capital (age, qualification, occupation, previous unemployment); barriers to employment that may affect productivity (household composition including the presence of children and very young children, health status); or other factors that are widely known to affect pay, via discrimination or other channels (gender, ethnicity, immigration status). We also include controls for region and job characteristics (industry, sector, and firm size) that help capture both personnel policies and other important factors that may affect opportunities for wage progression. The rich set of covariates enables us to control in detail for compositional differences among areas. Finally, we include the number of months in-between interviews as a control variable. While most interviews occur, after 12 months, the number can vary between 5 and 23. While this heterogeneity should not be correlated with area, we control for it for completeness.

As a robustness check, we reestimate all our models using the local area share of minimum wage workers in 2009 interacted with the "bite" of the minimum wage (calculated at the national level). The "bite" of the minimum wage is the ratio between the minimum and median wages. If increases in the minimum wage do affect the progression chances of minimum age workers, we expect this effect to be larger in areas with a higher share of minimum wage workers in 2009 when the bite is higher. Note that the bite varies within the year because the minimum wage changes within the year. We match the correct applicable bite based on the year and month of the interview. As we do not observe the exact month of the transition, we use the lagged rather than the current value of the bite. The lagged bite is the value of the bite in the previous wave of the survey. This induces further within-year variation in the lagged bite measure because of the variability in the between interviews interval length. We control for interval length in our specifications.

$$h_{st} = \frac{\exp\left(\alpha_{st} + \beta_s X_{it} + \lambda_{st} + \gamma_{st}\text{MWShare}_{a,2009} * \text{MWBite}_{t-1} + \theta_s \text{MedWage}_{a,t}\right)}{\left(1 + \sum_{ss=1}^{S} \exp\left(\alpha_{sst} + \beta_{ss} X_{it} + \lambda_{sst} + \gamma_{ss}\text{MWShare}_{a,2009} * \text{MWBite}_{t-1} + \theta_{ss}\text{MedWage}_{a,t}\right)\right)} \quad (2)$$

$MWBite_{t-1}$ represents the "bite" of the minimum wage in $t-1$ (measured at the national level). This specification is equivalent to a Bartik shift-share instrument, where $\text{MWShare}_{a,2009}$ represents the original shares and MWBite_{t-1} the shift weights (Goldsmith-Pinkham, Sorkin, and Swift 2018). Using the bite of the minimum wage risk effects being driven by changes in the median, rather than by changes in the minimum. However, in the period we study, median wages have been relatively stagnant, whereas the minimum wage increased considerably.

Our specifications control for the time spent in a minimum wage job. We do not have information on how long an individual has been in a minimum wage job in the first wave. However, we do have information about the length of time an individual spent in the current job. We use this to approximate the time spent in a minimum wage job before entering the study.

3.7 | Wage Growth Equations

We also estimate hourly wage growth equations using the same geographical and temporal variation in the share of minimum wage jobs. Wage growth models have the advantage of using all the available information on hourly wages. However, they also have drawbacks. Measurement error in the hourly wages will bias estimates toward zero. Wage growth models also have the disadvantage that they can only be estimated for individuals who are in continuous employment, and so are more vulnerable to selection effects. These can lead to spurious relationships that may be positive (if the minimum wage induces low-paid workers to leave employment) or negative (if a higher minimum wage induces lower paid workers to remain in the labor market when they otherwise would have dropped out). To address the latter issue, we use a Heckman regression to correct for selection effects, using household nonlabor income, gross labor income of other household members, and age of youngest child interacted with gender as instruments.

Formally, we estimate the following models:

$$\Delta \log(y_{it}) = \alpha + \beta X_{it-1} + \lambda_t + \gamma_t \text{Mshare}_{a,t-1} + \theta \text{MedWage}_{a,t} + \psi \text{IMR}_{it} + \varepsilon_{it} \quad (3)$$

where Δ is the first difference operator, y_{it} is the hourly wages of worker i in year t, X_{it} is a vector of individual and job

characteristics as described above, IMR_{it} is the inverse Mills ratio, λ_t are year fixed effects, $Mshare_{a,t-1}$ is the share of minimum wage workers in area a and year $t-1$, and $MedWage_{a,t}$ is the median wage of area a in year t. In addition to the covariates used in the transition models, we also control for the month of interview to account for the fact that employers may implement wage increases at particular times of the year.

4 | Results

4.1 | Descriptive Results

We start by looking at trends in minimum wage pay. The share of workers paid at or below the minimum has climbed from around 4% in 2009 to 8% in 2018. Figure 1 shows how the share of minimum wage workers varied across TTWAs in 2009 and 2019. The share of minimum wage workers increased throughout Great Britain but there are significant geographical differences. The share of minimum wage workers is higher in parts of the northeast, Cornwall, Wales, and Scotland and much lower around London and the southeast.

Next, we examine the transition probabilities out of minimum wage jobs and their variation over time and across areas. Figure 2 shows average 1-year unadjusted transition probabilities to low (but above minimum wage) paid employment, "high-paid" employment and nonemployment, as well as the probability to remain in a minimum wage job for each year between 2010 and 2019. Standard errors are obtained using bootstrapping with 100 replications. Every year, around half of the minimum wage workers progress to a better-paid job, around 40%–50% remain in minimum wage employment, and between 7% and 11% transition to nonemployment. Among those progressing to a better-paid job, approximately four-fifths remain in low-paid employment (albeit paid above the minimum wage). Looking at change over time, the proportion of workers progressing to low pay above the minimum fell from around 40% to around 30% after 2016 following the introduction of the NLW. Chances of moving to "high-paid" employment are relatively stable over time. In any 1 year, only around 10%–14% of minimum wage workers succeed in securing a "high-paid" job. Calculating transition probabilities over longer periods, 2 and 3 years, yields similar results. Figure 3 shows the proportion of workers who were paid above the minimum each year

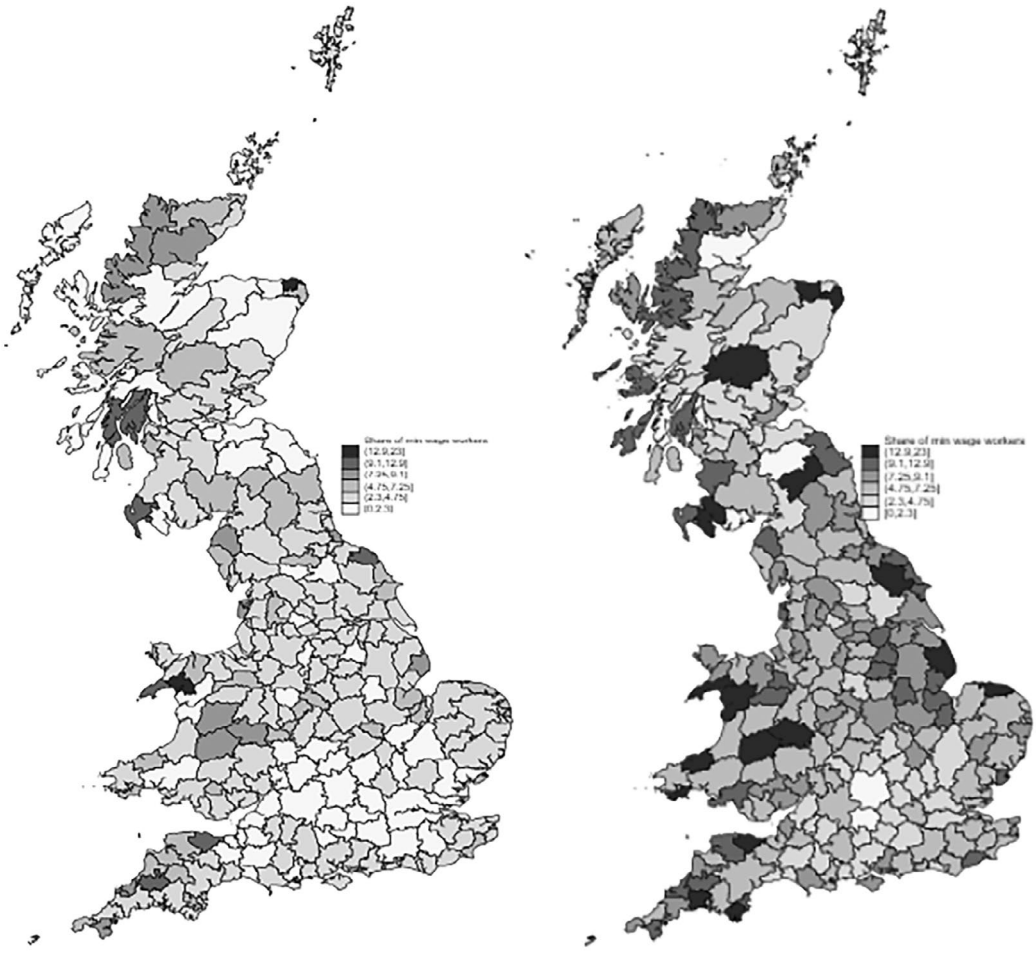

FIGURE 1 | Proportion of minimum wage workers by travel to work area in 2009 and 2019. *Source:* ASHE: 2009–2021.

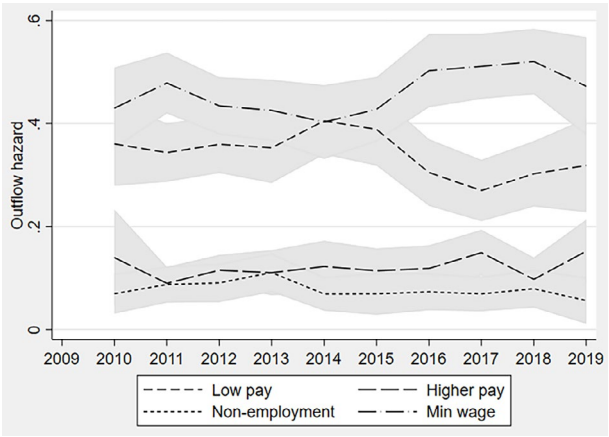

FIGURE 2 | One-year transition probabilities to minimum wage, low paid, 'high' paid and nonemployment by year. Minimum wage jobs are defined as those paid below the minimum wage plus 5p; low pay jobs are paid above the minimum wage but below two-thirds of the median hourly wages; higher paid jobs are those paying an hourly wage above two-thirds of the median. *Source:* Authors' calculations, UKHLS, Waves 1-10. The shaded area shows the 95% confidence interval. Standard errors are computed using bootstrapping with 100 replications. [Color figure can be viewed at wileyonlinelibrary.com]

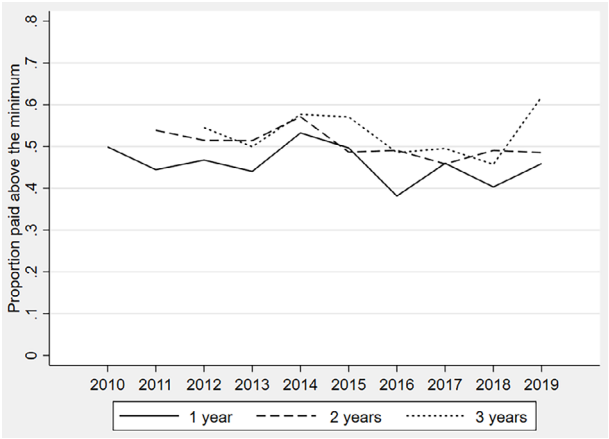

FIGURE 3 | One-, two-, and three-year transition probabilities to employment above the minimum, by year. Employment above the minimum is defined as employment paid with an hourly wage higher than the minimum wage in force plus 5p. *Source:* Authors calculations, UKHLS, Waves 1–10. [Color figure can be viewed at wileyonlinelibrary.com]

but were in a minimum wage job 1 year, 2 years and, respectively, 3 years before. The probability to progress to employment paid above the minimum wage over longer periods is on average 5-percentage point higher compared to 1-year probability, with similar trends over time. These patterns suggest that there may be some churning in and out of minimum wage jobs among the low paid.

4.2 | Minimum Wage Effects on Wage Progression

To investigate how increases in the minimum wage affect progression probabilities, we estimate a discrete time competing risks model with three states: minimum wage employment, employment paid above the minimum, and nonemployment. In an extension, we also distinguish between low pay and high pay employments (results are available in Figure A6 in Appendix 2). If a high minimum wage discourages wage progression, larger effects would be expected in areas with higher shares of minimum wage workers. Consequently, when minimum wages increase, the probability of progressing to better paid employment should fall most in areas where the share of minimum wage workers is highest.

Figure 4 presents the average marginal effects from our first specification, which uses the lagged share of minimum wage workers in an area (a full set of coefficients is available in Table A2 in Appendix 2). We bootstrap standard errors based on 100 replications. To examine the effects of the introduction of the NLW in 2016, we allow coefficients to vary by year. The estimates are generally close to zero and statistically insignificant. The exception is 2016, when the average marginal effect on the probability of remaining in a minimum wage job is positive and statistically significant. For each 1-percentage point increase in the share of minimum wage workers in the local TTWA, the probability of remaining in a minimum wage job increased by around 3-percentage point, or approximately 10%. The counterpart of this increase is a 3-percentage point fall in the probability of moving to employment paid above the minimum. There was no statistically significant effect on the probability of transitioning to nonemployment. After 2017 however, the estimates revert to being close to zero and statistically insignificant. Taken together, the results suggest that the introduction of the NLW had a moderate and temporary negative effect on the probability of minimum wage workers progressing to low-paid employment above the minimum wage.

As a robustness check, and to ensure our results are not driven by changes in hours, we reestimated the same specification on an adjusted sample where observations with a change in hours worked larger than 10% in the same employment relationship have been dropped. Results are unchanged (see Table A4 in Appendix 2, model M3). We also reestimate the model, including employment rates for the population aged 16–64 at the TTWA-year level. Employment rates are taken from the ONS NOMIS platform[8]. Unfortunately, we are only able to match observations after 2014 (data are unavailable prior to 2012 and our ASHE TTWA indicators do not match those in NOMIS in 2012 and 2013). Results are virtually identical (see Table A4 in Appendix 2, model M4). Finally, to check for potential bias coming from differential attrition, we reestimate the original specification using the longitudinal weights provided by UKHLS. Note that this considerably reduces the sample size as individuals who exit the sample and re-enter subsequently are assigned a weight of zero. Results are shown in Table A4 in Appendix 2, Model 2 and are substantively very similar to our main specification.

Although the results suggest that the introduction of the NLW did not have a persistent influence on workers chance of progressions it may be that changes in the local economy are driving the share of minimum wage workers and the probability to moving to better paid work. As a robustness check,

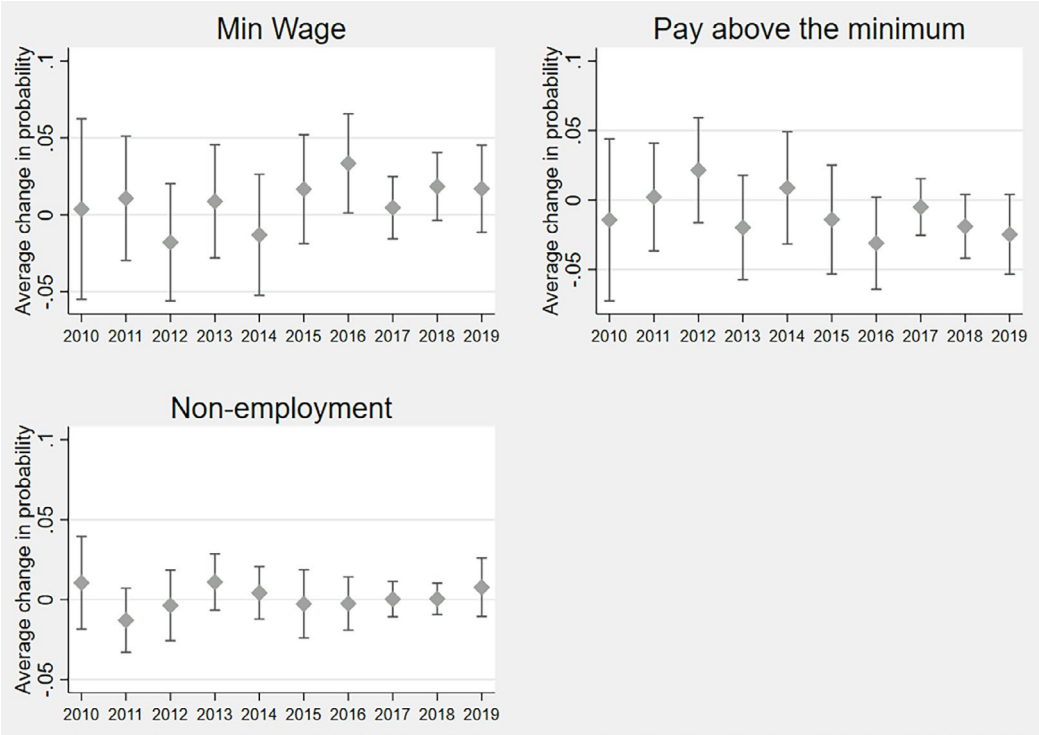

FIGURE 4 | Average marginal effects (and 95% confidence intervals) of the lagged share of minimum wage workers, by year. Minimum wage jobs are defined as having an hourly pay less than the adult rate minimum wage level plus 5p. Standard errors are computed using bootstrapping with 100 replications. *Source:* Authors calculations, UKHLS, Waves 1–10. [Color figure can be viewed at wileyonlinelibrary.com]

we estimate a model where the share of the minimum wage workers in 2009 is interacted with the lagged national bite of the minimum wage in the current year. The model includes year fixed effects to account to economic conditions but assumes increases in the minimum wage have similar effects on progression every year. If minimum wage increases hamper wage progression, we expect areas that had a higher share of minimum wage workers in 2009 to display lower transition probabilities when the bite increases. Figure 5 shows this is not the case (a full set of coefficients can be found in Table A3 in Appendix 2). Increases in the national bite seem to have smaller effects in areas with a higher share of minimum wage workers in 2009, although none of the estimated coefficients are statistically significant.

Overall, we find limited evidence that increases in the minimum wage have affected progression to higher paid work during our study period (2009–2019). The introduction of the NLW might have increased the probability to remain in a minimum wage job by 10%. However, this effect is short-lived and disappears in subsequent years. If increases in the minimum wage had any effect on reducing the chances of minimum wage workers to move to higher paid jobs, it appears to have been transitory.

4.3 | Wage Growth Models

To complement the results from our competing risks discrete-time model, we directly model the wage growth of minimum wage workers. We model the nominal increase in hourly wages from year $t-1$ to year t for all workers on minimum wages in year $t-1$. For workers who remain on minimum wages, the increase will be purely driven by the statutory increase in the minimum wage. For workers who progress, the increase will be driven by both the statutory increase and their progression. Note that although in theory a fall in hourly wages for those who remain continuously employed should not be possible, in practice we have a few cases where reported or imputed wages are below the minimum, so a nominal fall is possible. Although the proportion of minimum wage workers who transition to nonemployment is relatively small, we do account for self-selection via the Heckman correction.

Table 1 shows estimated effects on the 1-year change in hourly wages of the lagged share of minimum wage workers in the local area (a full list of estimated coefficients can be found in Table A5 in Appendix 2). There is no evidence of any differential wage growth for workers in different TTWAs. The main effect is negative but statistically insignificant, while the interactions are both statistically insignificant and very close to zero. Thus, there is no evidence that the wage growth of minimum wage workers in areas with a high share of minimum wage workers is different from that of workers in areas with lower shares.

The second model similarly tests whether the share of minimum wage workers affects progression but uses the share of minimum wage workers in the local area in 2009 interacted with the lagged bite of the minimum wage calculated at the national level (a full list of estimated coefficients can be found in Table A6 in Appendix 2). The interaction term captures whether workers in areas with a higher share of minimum wage jobs in 2009 experience different wage growths compared to those in other areas

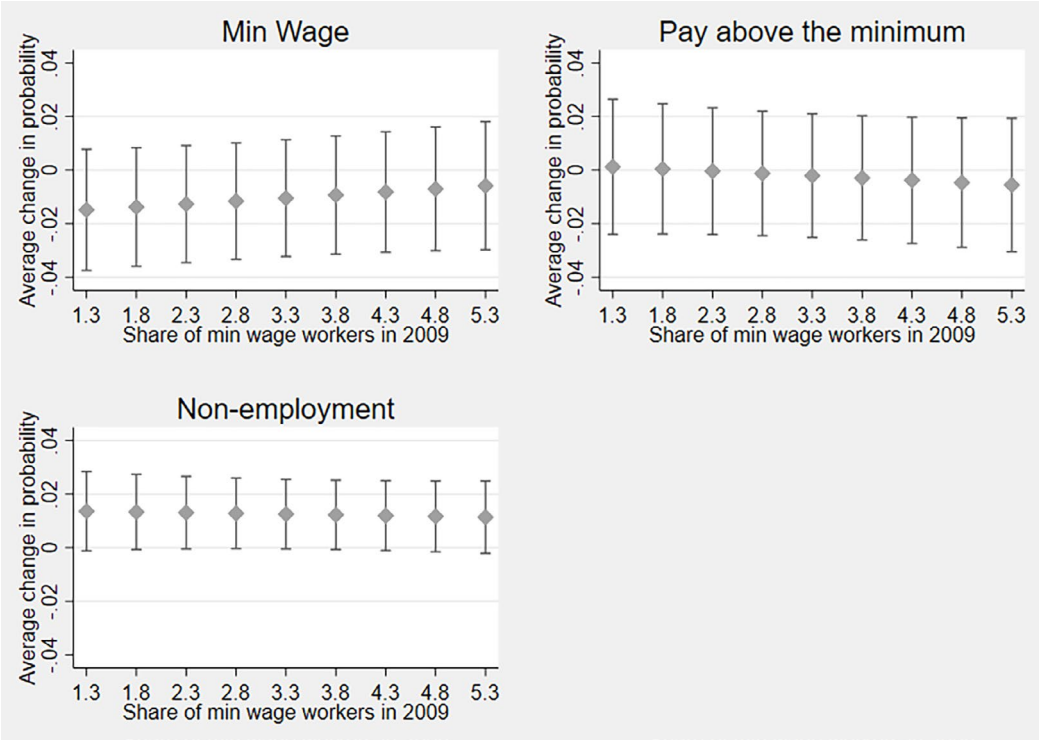

FIGURE 5 | Average marginal effects (and 95% confidence intervals) of the lagged national minimum wage bite by area's share of minimum wage workers in 2009. Minimum wage jobs are defined as having an hourly pay less than the adult rate minimum wage level plus 5p. Standard errors are computed using bootstrapping with 100 replications. *Source:* Authors' calculations, UKHLS, Waves 1–10. [Color figure can be viewed at wileyonlinelibrary.com]

when the bite increases. The results show that this was not the case. The interaction term is positive (indicating higher growth for workers in areas where the share of minimum wage workers is higher) but statistically insignificant and close to zero (0.001 log points or 0.2% relative to average yearly wage increases over the period).

5 | Discussion

The minimum wage policy is one of the most important tools that governments have available to influence wage inequality. A substantive body of research has shown higher minimum wages compress the wage distribution, and are associated with smaller gender and ethnic/racial pay gaps (Blau and Kahn 2003; Schäfer and Gottschall 2015). More recently, Giupponi et al. (2024) have shown that the introduction of the NLW in the United Kingdom and subsequent upratings significantly lifted the wages of workers in the bottom quintile of the distribution. Yet, concerns have also been raised about potential side effects, from an increase in unemployment to disincentive effects that would reduce human capital investments and discourage workers from seeking better job opportunities (Neumark and Wascher 2003; Neumark and Nizalova 2007). In this article, we examine the relationship between minimum wages and pay progression using UK policy reforms between 2009 and 2019 as a case study.

Our results do not support the hypothesis that the increased rate of the minimum wage and higher coverage of the workforce has meant workers are more likely to be stuck on the minimum wage. We find that, generally, minimum wage workers are able to progress, but most remain low paid. In any given year, approximately half of minimum wage workers transition to jobs that are paid more than the minimum, but that most of these transitions (approximately four-fifths) are to jobs that are 'low-paid,' with earnings below two-thirds of median wages. Consistent with the literature on employment effects, we find no evidence that minimum wage increases affect the probability of transitioning to nonemployment. Our findings also align with previous studies examining transitions out of minimum wage employment in the United Kingdom in the noughties, which found minimum wage workers moved off the minimum wage quickly, but that most moved to jobs paid only slightly above the minimum (Bryan and Taylor 2006; Jones et al. 2004).

Overall, we find limited evidence that the minimum wage increases influenced the chances of minimum wage workers progressing at work. In our competing risks model, we find the introduction of the NLW temporarily increased the probability to remain in a minimum wage job by around 10% with this effect disappearing in subsequent years. In our wage growth specifications, we did not find any evidence that minimum wage increases affected the wage growth: minimum wage workers in areas with a higher exposure to minimum wage increases experienced similar pay increases as minimum wage workers in areas with lower exposure. The lack of substantial negative effects on progression may be partly explained by spillover effects. Previous studies found that minimum wage hikes increased not only the wages of workers previously paid below the minimum, but also of those paid above. These spillover effects have been documented to extend well above the minimum wage level, reaching the 20th or 30th percentile (Avram

TABLE 1 | Estimated coefficients of minimum wage effects on the wage growth of minimum wage workers.

Variable	Model 1	Model 2
Lagged share of MW workers by TTWA		
2011	0.004 (0.011)	
2012	0.007 (0.010)	
2013	0.016 (0.015)	
2014	0.009 (0.010)	
2015	−0.004 (0.010)	
2016	0.001 (0.011)	
2017	0.008 (0.009)	
2018	0.006 (0.009)	
2019	0.001 (0.010)	
Share of MW workers in 2009		−0.021 (0.036)
National lagged bite		−0.005 (0.004)
Share MW in 2009 X Bite		0.000 (0.001)
N	3964	3964

Note: Standard errors in parenthesis; standard errors are computed using bootstrapping with 100 replications.
Source: Authors' calculations based in UKHLS, Waves 1–10.

and Harkness 2019; Butcher, Dickens, and Manning 2012; Giupponi et al. 2024).

The mechanisms behind pay progression from minimum pay (and low pay more generally) are of theoretical and policy interest. Our results indicate that, as expected, less educated workers and workers with large families are less likely to progress. We also find that workers are more likely to progress in large firms and in the public sector. It is possible that public and large private employers are able to offer internal pay ladders that can help minimum wage workers progress to better paid employment. Previous studies found that low-paid jobs could act as a stepping stone toward higher paid employment (Cai, Mavromaras, and Sloane 2018). Our results suggest that minimum wage jobs with large employers and public bodies are more likely to act as stepping stones compared to other minimum wage jobs.

Previous research has shown job mobility to be an important mechanism behind pay progression (Ghosh 2007; Topel and Ward 1992). This is confirmed in our data. Minimum wage workers are more likely to progress to better paid employment if they switch employers: 14% of those who progress to employment above the minimum change employers, compared to 5% among those remaining on minimum pay. However, we do not find any evidence that the higher probability of remaining in minimum wage employment we observe in 2016 is driven by a change in employer switching behavior, as employer change rates are very similar throughout the period we study (around 6%–7%; a more elaborate analysis is not possible due to data sparseness).

Another mechanism of interest is training. We find that training is highly predictive of the probability to progress into better paid employment and remains so after including our full set of covariates (21% of those who progress undergo some form of training vs. 17% of those who remain on min wage). We also find that once we control for training, the coefficient for 2016 in our first discrete time specification halves and is no longer statistically significant, suggesting that the 2016 minimum wage hike may have induced workers to receive/acquire less training and, in turn, this might have temporarily limited their pay progression.

One limitation of our study is that, as the largest increases in the minimum wage occurred in the later years of our panel, our results are generally limited to the short and medium terms. In the longer term, firms may try and absorb the higher labor costs generated by the minimum wage by increasing productivity (Riley and Bondibene 2017). The effects that such an increase may have on working conditions are not clear, especially in the service sector, as the reorganization of processes could lead both to increased training/upskilling and to deskilling, with technology used to restrict worker's autonomy and independence and increased pressure to comply with unreasonable targets. Evidence on the longer term effects on wage progression are limited, with evidence from the US based on data from the 1970s and 1980s, suggesting that there may be lower wage growth among minimum wage workers compared to their better paid peers (Even and Macpherson 2003; Grossberg and Sicilian 1999). Similarly, Neumark and Nizalova (2007) concluded that exposure to higher minimum wages at young ages during the 1970s and 1980s in the US depressed future earnings. While in this study, we find no evidence of adverse wage effects future studies should examine how the UK's minimum wage hikes have influence wages in the longer term.

Acknowledgments

The authors would like to thank the Tim Butcher, Richard Dickens, Sarah Brown, Rob Joyce, Karen Mumford, and participants of the 2019, 2020, and 2021 Low Pay Commission Research Workshops. The authors gratefully acknowledge funding from the Low Pay Commission (CR18028) and Economic and Social Research Council via the ESRC Centre for Micro-Social Change (ES/S012486/1).

Data Availability Statement

The data that support the findings of this study are openly available through the UK Data Service at http://doi.org/10.5255/UKDA-SN-6614-124, http://doi.org/10.5255/UKDA-SN-6689-13, and http://doi.org/10.5255/UKDA-SN-6675-12.

Endnotes

[1] University of Essex, Institute for Social and Economic Research (2019).

[2] The minimum wage does not apply to the self-employed, so we exclude them from our analysis.

[3] The vast majority of the "losses" are due to observing some individuals in a single wave (usually, the first); as we focus on wage changes over time to determine progression; such cases are uninformative for our analysis.

[4] Office for National Statistics (2019).

[5] ASHE does not collect information in Northern Ireland.

[6] Whittard and his colleagues find that there is likely some measurement error in work location in ASHE due to pre-filling in the survey: workers employed by large multisite employers are more likely to have their work location erroneously recorded. This measurement error could potentially generate some mild attenuation bias. Whittard et al. (2023).

[7] University of Essex, Institute for Social and Economic Research (2020).

[8] https://www.nomisweb.co.uk/datasets/apsnew; accessed 13 September 2024.

References

Acemoglu, D., and P. Restrepo. 2020. "Robots and Jobs: Evidence From US Labor Markets." *Journal of Political Economy* 128, no. 6: 2188–2244.

Arulampalam, W., A. L. Booth, and M. L. Bryan. 2004. "Training and the New Minimum Wage." *Economic Journal* 114, no. 494: C87–C94.

Autor, D. H., F. Levy, and R. J. Murnane. 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration." *Quarterly Journal of Economics* 118, no. 4: 1279–1333.

Autor, D. H., A. Manning, and C. L. Smith. 2016. "The Contribution of the Minimum Wage to US Wage Inequality Over Three Decades: A Reassessment." *American Economic Journal: Applied Economics* 8, no. 1: 58–99.

Avram, S., and S. Harkness. 2019. *The Impact of Minimum Wage Upratings on Wage Gowth and the Wage Distribution*. London: Low PAy Commission.

Bagger, J., F. Fontaine, F. Postel-Vinay, and J.-M. Robin. 2014. "Tenure, Experience, Human Capital, and Wages: A Tractable Equilibrium Search Model of Wage Dynamics." *American Economic Review* 104, no. 6: 1551–1596.

Bargain, O., K. Doorley, and V. K. Philippe. 2019. "Minimum Wages and the Gender Gap in Pay: New Evidence From the United Kingdom and Ireland." *Review of Income and Wealth* 65, no. 3: 514–539.

Bellman, L., M. Bossler, H.-D. Gerner, and O. Hübler. 2017. "Training and Minimum Wages: First Evidence From the Introduction of the Minimum Wage in Germany." *IZAJournal of Labor Economics* 6: 8.

Biewen, M., B. Feirzenberger, and M. Rümmele. 2022. "Using Distribution Regression Difference-In-Differences to Evaluate the Effects of a Minimum Wage Introduction on the Distribution of Hourly Wages and Hours Worked." IZA Discussion Paper Series, 15534.

Blau, F. D., and L. M. Kahn. 2003. "Understanding International Differences in the Gender Pay Gap." *Journal of Labor Economics* 21, no. 1: 106–144.

Bryan, M. L., and M. Taylor. 2006. "Identifying and Explaining Pattern of NMW Receipt in Britain, 1999–2004." Report for the Low Pay Commission.

Burdett, K., and D. T. Mortensen. 1998. "Wage Differentials, Employer Size, and Unemployment." *International Economic Review* 39, no. 2: 257–273.

Butcher, T., R. Dickens, and A. Manning. 2012. "Minimum Wages and Wage Inequality: Some Theory and an Application to the UK." Centre for Economic Performance Discussion Paper, 1177.

Cai, L., K. Mavromaras, and P. Sloane. 2018. "Low Paid Employment in Britain: Estimating Stqate-Dependence and Stepping Stone Effects." *Oxford Bulletin of Economics and Statistics* 80, no. 2: 283–326.

Caliendo, M., and L. Wittbrodt. 2021. "'Did the Minimum Wage Reduce the Gender Wage Gap in Germany?'." CEPA Discussion Papers (40; Potsdam: Center for Economic Policy Analysis).

Clark, K., and S. Nolan. 2021. "The Changing Distribution of the Male Ethnic Wage Gap in Great Britain." IZA Discussion Paper Series, 14276.

D'Arcy, C. 2018. *Low Pay Britain 2018*. London: Resolution Foundation.

Dickens, R., S. Machin, and A. Manning. 1994. "Minimum Wages and Employment: A Theoretical Framework With an Application to the UK Wages Councils." *Internatonal Journal of Manpower* 15, no. 2–3: 26–48.

Dickens, R., and A. Manning. 2004. "Spikes and Spillovers:The Impact of the National Minimum Wage on the Wage Distribution in a Low-Wage Sector." *Economic Journal* 114, no. 494: C95–C101.

DiNardo, J., N. M. Fortin, and T. Lemieux. 1996. "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach." *Econometrica* 64, no. 5: 1001–1044.

Dolton, P., C. R. Bondibene, and J. Wadsworth. 2012. "Employment, Inequality and the UK Minimum Wage Over the Medium-Term." *Oxford Bulletin of Economics and Statistics* 74, no. 1: 78–106.

Even, W. E., and D. A. Macpherson. 2003. "The Wage and Employment Dynamics of Minimum Wage Workers." *Southern Economic Journal* 69, no. 3: 676–690.

Fairris, D., and R. Pedace. 2004. "The Impact of Minimum Wages on Job Training: An Empirical Exploration With Establishment Data." *Southern Economic Journal* 70, no. 3: 566–583.

Forth, J., A. Bryson, F. R. Van Phan, C. Singleton, L. Stokes, and D. Whittard. 2024. "Revisiting Sample Bias in the UK's Annual Survey of Hours and Earnings, With Implications for Estimates of Low Pay and the Bite of the National Living Wage." ESCoE Discussion Paper, 2024-10.

Ghosh, S. 2007. "Job Mobility and Careers in Firms." *Labour Economics* 14, no. 3: 603–621.

Giupponi, G., R. Joyce, A. Lindner, T. Waters, T. Wernham, and X. Xu. 2024. "The Employment and Distributional Impacts of Nationwide Minimum Wage Changes." *Journal of Labor Economics* 42, no. S1: S293–S333.

Goldsmith-Pinkham, P., I. Sorkin, and H. Swift. 2018. "Bartik Instruments: What, When, Why, and How." NBER Working Papers (24408: National Bureau of Economic Research).

Grossberg, A. J., and P. Sicilian. 1999. "Minimum Wages, on-The-Job Training, and Wage Growth." *Southern Economic Journal* 65, no. 3: 539–556.

Hara, H. 2017. "Minimum Wage Effects on Firm-Provided and Worker-Inititated Training." *Labour Economics* 47: 149–162.

Jones, M. K., R. J. Jones, P. L. Latreille, P. D. Murphy, and P. J. Sloane. 2004. "The Analysis of Flows Into and out of the National Minimum Wage." Report for the Low Pay Commission.

Jones, M. K., R. J. Jones, P. L. Latreille, P. D. Murphy, and P. J. Sloane. 2013. "A Regional Analysis of Flows Into and out of the UK National Minimum Wage." *Applied Economics* 45, no. 21: 3074–3087.

Karahan, F., R. Michaels, B. Pugsley, A. Şahin, and R. Schuh. 2017. "Do Job-To-Job Transitions Drive Wage Fluctuations Over the Business Cycle?" *American Economic Review: Papers and Proceedings* 107, no. 5: 353–357.

Knies, G. 2017. *Understanding Society. The UK Household Longitudinal Study Waved 1–7 User Guide*. Colchester: Institute for Social and Economic Research.

Lee, D. S. 1999. "Wage Inequality in the United States During the 1980s:Rising Dispersion or Falling Minimum Wage?" *Quarterly Journal of Economics* 114, no. 3: 977–1023.

Low Pay Commission. 2019. "National Minimum Wage. Low Pay Commission Report 2019."

Low Pay Commission. 2021. "National Minimum Wage. Low Pay Comission Report 2021."

Lucifora, C., A. McKnight, and W. Salverda. 2005. "Low-Wage Employment in Europe: A Review of the Evidence." *Socio-Economic Review* 3, no. 2: 259–292.

Machin, S., and A. Manning. 1994. "The Effects of Minimum Wages on Wage Dispersion and Employment: Evidence From the U.K. Wages Council." *Industrial Relations Review* 47, no. 2: 319–329.

Manning, A. 2005. *Monopsony in Motion: Imperfect Competition in the Labour Markets*. Princeton: Princeton University Press.

Manning, A. 2012. "'Minimum Wage: Maximum Impact', in Resolution Foundation."

Manning, A. 2021. "The Elusive Employment Effect of the Minimum Wage." *Journal of Economic Perspectives* 35, no. 1: 3–26.

Metcalf, D. 2008. "Why Has the British National Minimum Wage Had Little or no Impact on Employment?" *Journal of Industrial Relations* 50, no. 3: 489–512.

Neumark, D., and O. Nizalova. 2007. "Minimum Wage Effects in the Longer Run." *Journal of Human Resources* 42, no. 2: 435–452.

Neumark, D., and W. L. Wascher. 2003. "Minimum Wages and Skill Aquisition: Another Look at Schooling Effects." *Economics of Education Review* 22, no. 1: 1–10.

OECD. 2022. "Minimum Wages Relative to Median Wages."

Office for National Statistics. 2019. *Annual Survey of Hours and Earnings, 1997–2018: Secure Access. [data collection]*. 14th ed. Colchester: UK Data Service. SN: 6689. https://doi.org/10.5255/UKDA-SN-6689-13.

Prothero, R. 2016. *Travel to Work Area Analysis in Great Britain: 2016*. London: Office for Bational Statistics.

Riley, R., and C. R. Bondibene. 2017. "Raising the Standard: Minimum Wages and Firm Productivity." *Labour Economics* 44: 27–50.

Schäfer, A., and K. Gottschall. 2015. "From Wage Regulation to Wage Gap: How Wage-Setting Institutions and Structures Shape the Gender Wage Gap Across Three Industries in 24 European Countries and Germany." *Cambridge Journal of Economics* 39, no. 2: 467–496.

Skinner, C., N. Stuttard, G. Beissel-Durrant, and J. Jenkins. 2002. "The Measurement of Low Pay in the UK Labour Force Survey." *Oxford Bulletin of Economics and Statistics* 64, no. s1: 653–676.

Stewart, M. B. 2012. "Wage Inequality, Minimum Wage Effects, and Spillovers." *Oxford Economic Papers* 64, no. 4: 616–634.

Stewart, M. B., and J. K. Swaffield. 2002. "Using the BHPS Wave 9 AdditionalQuestions to Evaluate the Impact of the National Minimum Wage." *Oxford Bulletin of Economics and Statistics* 64, no. Supplement: 633–652.

Stewart, M. B., and J. K. Swaffield. 2008. "The Other Margin: Do Minimum Wages Cause Working Hours Adjustment for Low-Wage Workers?" *Economica* 75, no. 297: 148–167.

Swaffield, J. K. 2014. "Minimum Wage Hikes and the Wage Growth of Low-Wage Workers." *Bulletin of Economic Research* 66, no. 4: 384–405.

Teulings, C. N. 2003. "The Contribution of Minimum Wages to Increasing Wage Inequality." *Economic Journal* 113, no. 490: 801–833.

Topel, R. H., and M. P. Ward. 1992. "Job Mobility and the Careers of Young Men." *Quarterly Journal of Economics* 107, no. 2: 439–479.

University of Essex, Institute for Social and Economic Research. 2019. *Understanding Society: Waves 1–10, 2009–2019 and Harmonized BHPS: Waves 1–18, 1991–2009. [data collection]*. 13th ed. Colchester: UK Data Service. SN: 6614. https://doi.org/10.5255/UKDA-SN-6614-124.

University of Essex, Institute for Social and Economic Research. 2020. *Understanding Society: Waves 1–10, 2009–2019 and Harmonized BHPS: Waves 1–18, 1991–2009: Special License Access, Travel to Work Areas. [data collection]*. 12th ed. Colchester: UK Data Service. SN: 6675. https://doi.org/10.5255/UKDA-SN-6675-12.

Whittard, D., F. Ritchie, V. Phan, et al. 2023. "The Perils of Pre-Filling: Lessons From the UK's Annual Survey of Hours and Earning Microdata." *Statistical Journal of the International Association of Official Statistics* 39, no. 3: 661–677.

Wursten, J., and M. Reich. 2023. "Racial Inequality in Frictional Labor Markets: Evidence From Minimum Wages." *Labour Economics* 82: 102344.

Appendix 1

Imputation of Hourly Wages

Hourly wages that are computed by dividing weekly or monthly wages by the number of hours worked are known to suffer from division bias. This results in a distribution that is too smooth (i.e., the peak around the minimum wage is too small) and a too high proportion of implausibly low values. To mitigate against division bias, we use the imputation method suggested by Skinner et al. (2002). We have used both nearest neighbor and predictive mean matching. The results are very similar. In the following, we show results using nearest neighbor matching.

Figure A1 shows the distribution of hourly wages for the year 2016/2017 using our imputed measure, the directly observed hourly wage measure in the data and the measured obtained by dividing monthly wages by hours of work (implicit measure). The imputed measure has some desirable properties compared to the implicit measure: sparseness to the left of the minimum and a significantly higher peak just to the right of the minimum. The directly observed measure has a very high peak around the minimum as most individuals paid by the hour are likely to have lower wages. Similar patterns are observed for the other years (Figure A2).

We next compare our imputed measure with estimates based on the Annual Survey of Hours and Earnings (ASHE). ASHE is a much larger survey containing information on approximately 1% of the labor force. It also has relatively accurate information on hourly wages reported by employers.

Figure A3 shows the proportion of workers on minimum hourly pay (calculated as pay below the minimum wage +5p), using the imputed

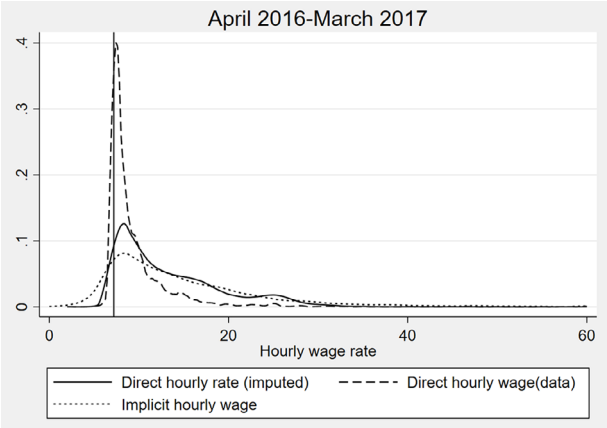

FIGURE A1 | Hourly pay distribution according to three measures: Direct (data only), implicit and direct + imputed values, 2016/2017. The direct measure is the hourly pay as reported by respondents in the data; the implicit measure is derived by dividing usual pay by usual working hours; the NLW is shown as a vertical black line. *Source:* Authors' calculations based on UKHLS, waves 1–10. [Color figure can be viewed at wileyonlinelibrary.com]

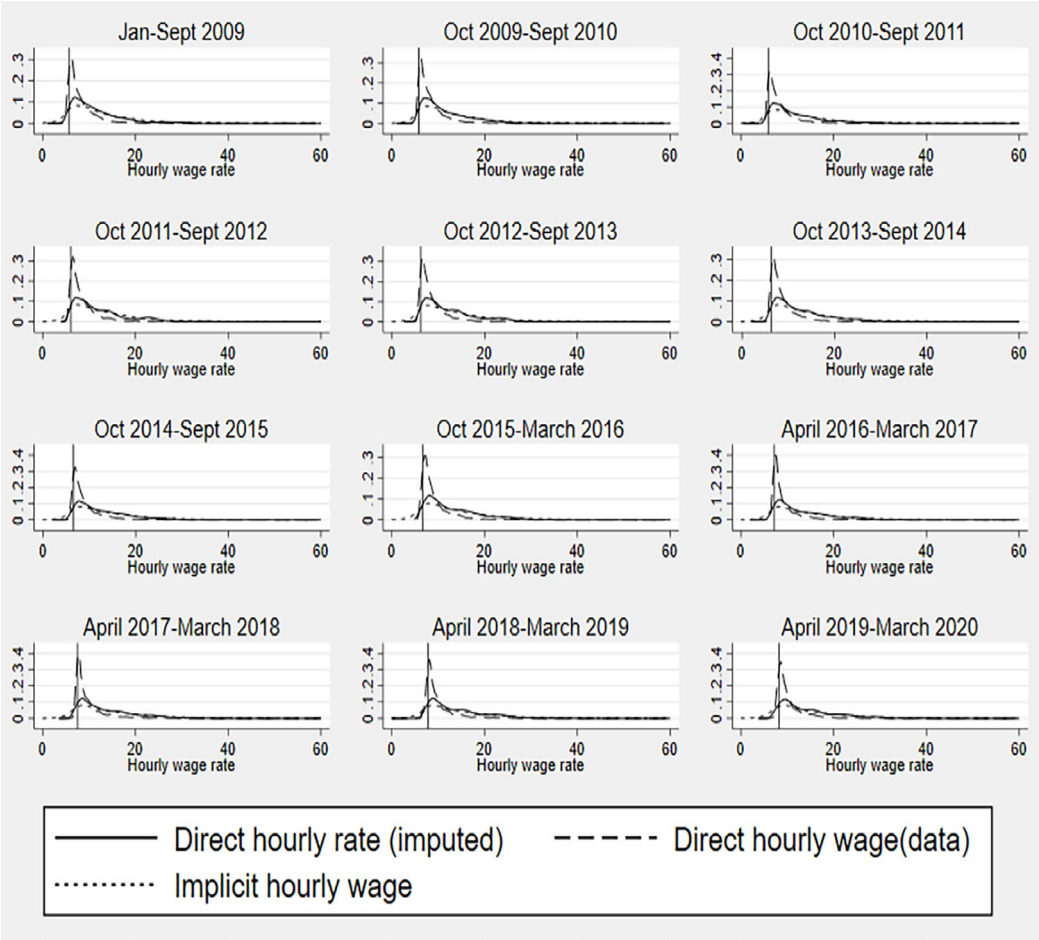

FIGURE A2 | Hourly pay distributions according to three measures: 'direct', 'implicit', and 'direct' + imputed values between 2009 and 2018. Each graph corresponds to a period when the nominal minimum wage has been constant; the value of the minimum wage in force is shown as the vertical black line. *Source:* Authors calculations based on UKHLS, Waves 1–10. [Color figure can be viewed at wileyonlinelibrary.com]

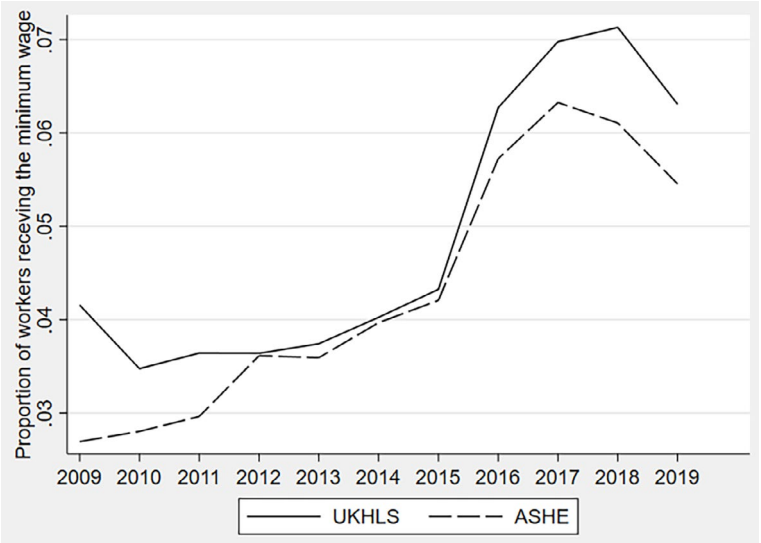

FIGURE A3 | Proportion of workers paid at or below the minimum hourly wage by year, UKHLS and ASHE. The share of minimum wage workers is calculated as the proportion of workers aged 25–64 paid at or below the minimum (defined as the value of the minimum wage +5p). In ASHE, it includes only main jobs and periods unaffected by absence. *Source:* UKHLS and ASHE. [Color figure can be viewed at wileyonlinelibrary.com]

hourly measure in UKHLS and hourly wages observed in ASHE. The proportion of minimum wage workers is almost identical between 2012 and 2016 but diverges slightly at the start and end of the period. The share of minimum wage workers is around 1 percentage lower in ASHE compared to UKHLS. Trends are, however, very similar with the share of minimum wage workers increasing until 2017/2018 and falling subsequently.

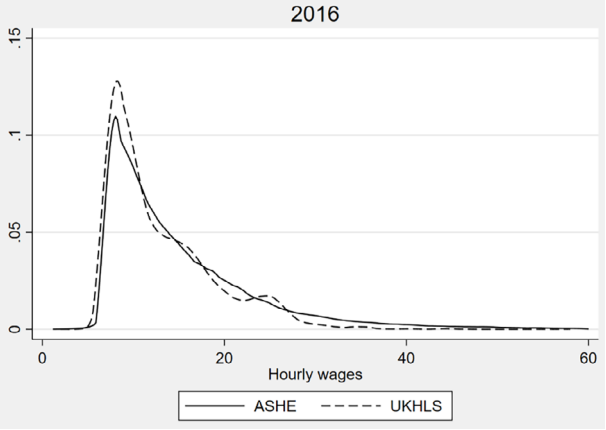

FIGURE A4 | Distribution of hourly wages in UKHLS and ASHE, 2016. *Source:* UKHLS and ASHE. [Color figure can be viewed at wileyonlinelibrary.com]

Figure A4 provides further information. It shows the distribution of hourly wages in the UKHLS and ASHE in 2016. UKHLS data are collected throughout the year (i.e., it includes periods before and after the minimum wage increase in April 2016), whereas ASHE refers to April 2016. It is clear that the proportion of individuals paid at or just above the minimum is higher in UKHLS compared to ASHE. In contrast, there are fewer individuals with comparatively high wages. The pattern is repeated in other years, as shown in Figure A5.

Finally, we examine the outflows from minimum wage jobs in ASHE and UKHLS. Because in our ASHE dataset personal indicators were changed in 2011, we are unable to compute transition rates for 2011 and 2012. Transition rates for the remaining years are shown in Table A1.

Progression rates from minimum wage jobs to employment above the minimum but below the low-pay threshold are around 10 points higher in UKHLS compared to ASHE. Trends, however, are very similar. Progression rates fell substantially in 2016 in both datasets, albeit the fall is twice as high in UKHLS compared to ASHE (approximately 16- vs. 8-percentage point). Higher progression rates to low-paid employment in UKHLS are mirrored in lower rates of remaining on minimum wage pay. Progression rates from minimum wage pay to 'higher pay', that is, employment paid above the low-pay threshold, are remarkably similar in the two datasets.

The existing patterns suggest that UKHLS might overestimate progression out of minimum wage and into employment paid above the minimum but below the low-pay threshold and underestimate the share of minimum wage workers that do not progress. However, the main trends are very similar in the two data sources. Progression rates fell sharply in 2016 and remained lower subsequently.

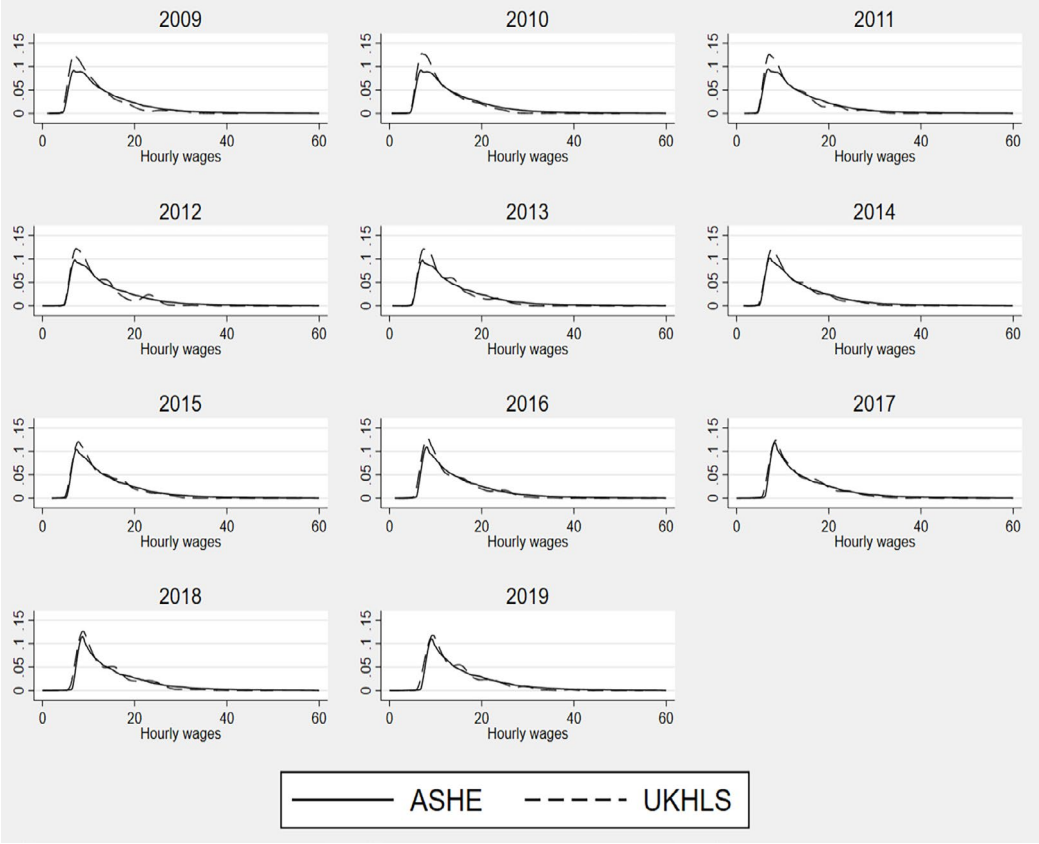

FIGURE A5 | Distribution of hourly wages in UKHLS and ASHE, 2009–2019. *Source:* UKHLS and ASHE. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE A1 | Transition rates out minimum wage pay by year, UKHLS and ASHE.

	Progression to low pay		Progression to higher pay		Remain on minimum wage	
Year	**UKHLS**	**ASHE**	**UKHLS**	**ASHE**	**UKHLS**	**ASHE**
2010	44.19%	33.43%	11.71%	12.89%	44.10%	53.69%
2011	40.39%	—	10.72%	—	48.89%	—
2012	43.57%	—	9.54%	—	46.89%	—
2013	41.07%	29.60%	12.87%	9.77%	46.06%	60.63%
2014	43.32%	29.88%	14.65%	12.04%	42.03%	58.08%
2015	44.65%	28.47%	11.86%	13.40%	43.49%	58.13%
2016	28.99%	20.40%	14.54%	14.66%	56.47%	64.94%%
2017	33.40%	22.84%	18.32%	17.77%	48.28%	59.40%
2018	31.21%	21.09%	13.85%	18.77%	54.94%	60.14%
2019	32.21%	19.80%	19.67%	22.52%	48.06%	57.68%
N	2834	26,576				

Note: We do not observe transitions into nonemployment in ASHE; to ensure comparability, cases observed to be in nonemployment in UKHLS are set to missing.
Source: UKHLS and ASHE.

Appendix 2

Additional Results

TABLE A2 | Estimated coefficients of a discrete-time model of transitions out of a minimum wage job using the lagged area share of minimum wage workers (Model 1).

	Coefficient	SE	*p*	95% CI	
Progression to PAY ABOVE THE MINIMUM					
Time in min wage job	−0.203	0.078	0.009	−0.355	−0.050
Time in min wage squared	0.008	0.005	0.140	−0.003	0.018
Female	−0.115	0.099	0.245	−0.310	0.079
Age	−0.070	0.040	0.077	−0.149	0.008
Age square	0.001	0.000	0.110	0.000	0.002
Education					
Other higher degree	−0.003	0.194	0.986	−0.384	0.377
A-level	−0.274	0.170	0.106	−0.607	0.058
GCSE	−0.376	0.171	0.028	−0.711	−0.041
Other qualification	−0.348	0.206	0.092	−0.752	0.057
No qualification	−0.654	0.195	0.001	−1.036	−0.272
Has child under 5	−0.083	0.126	0.512	−0.330	0.165
Number of children					
1	0.161	0.122	0.188	−0.078	0.400
2	0.100	0.119	0.400	−0.133	0.333
3	0.364	0.152	0.016	0.067	0.661
Self-reported health status	−0.139	0.091	0.128	−0.318	0.040
Ethnic minority (0/1)	−0.115	0.170	0.499	−0.448	0.218
Immigrant (0/1)	0.024	0.170	0.887	−0.310	0.358
Has previous unemployment spell (0/1)	−0.397	0.082	0.000	−0.557	−0.236

(Continues)

TABLE A2 | (Continued)

	Coefficient	SE	*p*	95% CI	
Firm size (logged)	0.048	0.018	0.007	0.013	0.083
Public sector	0.509	0.159	0.001	0.198	0.820
Temporary contract	0.285	0.175	0.103	−0.058	0.628
Part-time work	−0.422	0.094	0.000	−0.606	−0.238
Industry					
Manufacturing-food, beverages, textile	−0.334	2.022	0.869	−4.296	3.629
Manufacturing-basic industrial	0.162	2.046	0.937	−3.847	4.171
Manufacturing-complex industrial	−0.323	2.007	0.872	−4.256	3.610
Construction and gas, electricity and water services	0.394	2.115	0.852	−3.752	4.540
Wholesale and retail trade	−0.110	2.018	0.957	−4.066	3.846
Transportation and storage	−0.088	2.067	0.966	−4.140	3.964
Accommodation and food services	−0.281	2.013	0.889	−4.226	3.664
Information and communication	0.827	5.594	0.882	−10.136	11.791
Finance and insurance and real estate	0.847	2.111	0.688	−3.291	4.985
Professional, scientific, and technical services	0.246	2.089	0.906	−3.848	4.340
Administrative and support services	−0.054	2.027	0.979	−4.027	3.919
Public administration, education, health and social work	−0.086	2.000	0.966	−4.006	3.835
Arts and other	−0.190	2.020	0.925	−4.149	3.769
Region					
North West	0.095	0.183	0.604	−0.264	0.454
Yorkshire and the Humber	0.326	0.189	0.086	−0.046	0.697
East Midlands	0.124	0.194	0.521	−0.256	0.505
West Midlands	−0.016	0.185	0.933	−0.379	0.348
East of England	0.264	0.236	0.263	−0.198	0.726
London	0.186	0.301	0.537	−0.405	0.776
South East	0.334	0.231	0.147	−0.118	0.786
South West	0.128	0.211	0.543	−0.285	0.541
Wales	0.075	0.197	0.705	−0.312	0.462
Scotland	−0.101	0.221	0.647	−0.533	0.331
Year					
2011	−0.335	0.570	0.557	−1.452	0.782
2012	−0.766	0.557	0.169	−1.859	0.326
2013	−0.310	0.599	0.605	−1.485	0.865
2014	−0.580	0.620	0.349	−1.796	0.635
2015	−0.105	0.629	0.868	−1.338	1.129
2016	−0.089	0.645	0.890	−1.354	1.175
2017	−0.692	0.476	0.147	−1.626	0.242
2018	−0.096	0.603	0.873	−1.278	1.085
2019	0.099	0.670	0.882	−1.214	1.412
Number of months in-between interviews	0.050	0.027	0.057	−0.002	0.103
Lagged share of min wage workers	−0.041	0.147	0.781	−0.329	0.247
Lagged share of min wage workers# Year					
2011	0.018	0.170	0.917	−0.315	0.351
2012	0.133	0.153	0.385	−0.168	0.434

(Continues)

TABLE A2 | (Continued)

	Coefficient	SE	*p*	95% CI	
2013	−0.026	0.176	0.882	−0.372	0.319
2014	0.092	0.174	0.599	−0.250	0.434
2015	−0.032	0.178	0.859	−0.380	0.317
2016	−0.109	0.173	0.527	−0.447	0.229
2017	0.019	0.140	0.893	−0.256	0.294
2018	−0.048	0.160	0.766	−0.361	0.265
2019	−0.059	0.162	0.715	−0.376	0.258
Median TTWA wage level	0.001	0.001	0.225	0.000	0.002
Constant	1.843	2.349	0.433	−2.760	6.447
Transitions to nonemployment					
Time in min wage job	−0.254	0.117	0.030	−0.483	−0.024
Time in min wage job squared	0.009	0.008	0.262	−0.007	0.025
Female	−0.337	0.199	0.091	−0.728	0.053
Age	−0.061	0.071	0.391	−0.199	0.078
Age square	0.001	0.001	0.507	−0.001	0.002
Education					
Other higher degree	−0.042	0.365	0.909	−0.757	0.673
A-level, etc.	−0.302	0.337	0.370	−0.963	0.358
GCSE, etc.	−0.495	0.280	0.077	−1.045	0.054
Other qualification	−0.175	0.339	0.607	−0.840	0.490
No qualification	−0.478	0.354	0.176	−1.171	0.215
Has child under 5	−0.024	0.214	0.912	−0.444	0.396
Number of children					
1	0.391	0.223	0.081	−0.047	0.829
2	0.258	0.212	0.223	−0.157	0.672
3	0.601	0.317	0.057	−0.019	1.222
Self-reported health status	0.247	0.168	0.143	−0.083	0.576
Ethnic minority (0/1)	0.211	0.254	0.406	−0.287	0.708
Immigrant (0/1)	0.283	0.260	0.276	−0.226	0.793
Has previous unemployment spell (0/1)	1.708	0.187	0.000	1.341	2.074
Firm size (logged)	−0.083	0.051	0.102	−0.183	0.017
Public sector	0.295	0.294	0.315	−0.281	0.872
Temporary contract	0.913	0.201	0.000	0.518	1.308
Part-time work	−0.217	0.161	0.178	−0.533	0.099
Industry					
Manufacturing-food, beverages, textile	12.879	3.099	0.000	6.804	18.953
Manufacturing-basic industrial	12.999	3.108	0.000	6.907	19.091
Manufacturing-complex industrial	12.446	4.766	0.009	3.105	21.788
Construction and gas, electricity and water services	11.970	6.809	0.079	−1.376	25.316
Wholesale and retail trade	13.105	3.054	0.000	7.119	19.091
Transportation and storage	13.748	3.060	0.000	7.750	19.746
Accommodation and food services	12.853	3.024	0.000	6.926	18.781
Information and communication	13.927	7.945	0.080	−1.645	29.498
Finance and insurance and real estate	12.258	6.857	0.074	−1.181	25.697

(Continues)

TABLE A2 | (Continued)

	Coefficient	SE	*p*	95% CI	
Professional, scientific, and technical services	12.059	6.937	0.082	−1.537	25.654
Administrative and support services	13.123	3.044	0.000	7.156	19.089
Public administration, education, health and social work	12.787	3.078	0.000	6.755	18.819
Arts and other	13.117	3.138	0.000	6.966	19.267
Region					
North West	0.274	0.370	0.458	−0.450	0.999
Yorkshire and the Humber	0.298	0.405	0.461	−0.495	1.092
East Midlands	−0.248	0.398	0.534	−1.029	0.533
West Midlands	0.274	0.400	0.494	−0.510	1.058
East of England	0.072	0.514	0.889	−0.935	1.079
London	0.198	0.554	0.721	−0.888	1.284
South East	0.063	0.515	0.903	−0.947	1.073
South West	−0.194	0.444	0.662	−1.064	0.676
Wales	−0.182	0.437	0.678	−1.039	0.675
Scotland	0.329	0.401	0.412	−0.457	1.114
Year					
2011	1.114	1.033	0.281	−0.910	3.138
2012	0.130	1.103	0.906	−2.032	2.291
2013	−0.480	1.018	0.637	−2.474	1.515
2014	−0.955	1.125	0.396	−3.160	1.250
2015	−0.061	1.156	0.958	−2.327	2.204
2016	−0.323	1.174	0.783	−2.624	1.978
2017	−0.868	1.048	0.408	−2.922	1.186
2018	−0.067	0.980	0.945	−1.989	1.854
2019	−0.488	1.311	0.710	−3.058	2.081
Number of months in-between interviews	−0.004	0.054	0.934	−0.110	0.101
Lagged share of min wage workers	0.123	0.267	0.644	−0.401	0.648
Lagged share of min wage workers# Year					
2011	−0.303	0.306	0.322	−0.902	0.296
2012	−0.129	0.331	0.697	−0.778	0.520
2013	0.001	0.275	0.998	−0.539	0.540
2014	−0.014	0.312	0.965	−0.625	0.597
2015	−0.205	0.316	0.516	−0.825	0.414
2016	−0.238	0.314	0.447	−0.853	0.376
2017	−0.127	0.275	0.643	−0.667	0.412
2018	−0.158	0.267	0.555	−0.681	0.366
2019	−0.066	0.306	0.830	−0.665	0.534
Median TTWA wage level	0.000	0.001	0.815	−0.002	0.002
Constant	−13.090	3.940	0.001	−20.811	−5.369
$N = 4270$					

Note: Coefficients from an independent competing risks discrete-time model, with the lagged share of minimum wage workers by area; Minimum wage jobs are defined as having an hourly pay less than the adult rate minimum wage level plus 5p; low-paid employment is defined as job with an hourly pay above the minimum but < 2/3 of the median hourly pay (as calculated by the Office for National Statistics); higher pay employment consists of jobs paying above the low-pay threshold.
Source: Authors' calculations based on UKHLS, Waves 1–10 and ASHE 2009–2019

TABLE A3 | Estimated coefficients of a discrete-time model of transitions out of minimum wage using the area share of minimum wage workers in 2009 interacted with the lag of the bite of the minimum wage at the national level and controlling for area wage levels (model 2).

Progression to pay above the minimum	Coefficient	SE	*p*	95% CI	
Time in min wage job	−0.203	0.078	0.009	−0.356	−0.050
Time in min job square	0.008	0.005	0.139	−0.003	0.018
Female	−0.120	0.099	0.225	−0.314	0.074
Age	−0.067	0.040	0.089	−0.145	0.010
Age square	0.001	0.000	0.127	0.000	0.002
Education					
Other higher degree	0.002	0.192	0.992	−0.373	0.377
A-level	−0.277	0.168	0.098	−0.606	0.052
GCSE	−0.379	0.170	0.026	−0.712	−0.046
Other qualification	−0.351	0.205	0.087	−0.754	0.051
No qualification	−0.654	0.194	0.001	−1.034	−0.274
Has child under 5	−0.075	0.125	0.546	−0.319	0.169
Number of children					
1	0.155	0.122	0.202	−0.083	0.393
2	0.092	0.118	0.438	−0.140	0.324
3	0.349	0.154	0.024	0.046	0.651
Self-reported health status	−0.133	0.092	0.148	−0.312	0.047
Ethnic minority (0/1)	−0.120	0.171	0.481	−0.455	0.214
Immigrant (0/1)	0.027	0.172	0.873	−0.310	0.364
Has previous unemployment spell (0/1)	−0.395	0.083	0.000	−0.557	−0.232
Firm size (logged)	0.048	0.018	0.006	0.014	0.083
Public sector	0.511	0.157	0.001	0.203	0.820
Temporary contract	0.282	0.173	0.104	−0.058	0.622
Part-time work	−0.419	0.093	0.000	−0.600	−0.237
Industry					
Manufacturing-food, beverages, textile	−0.329	2.029	0.871	−4.305	3.647
Manufacturing-basic industrial	0.161	2.052	0.938	−3.861	4.183
Manufacturing-complex industrial	−0.328	2.014	0.871	−4.275	3.619
Construction and gas, electricity and water services	0.410	2.118	0.847	−3.742	4.561
Wholesale and retail trade	−0.116	2.022	0.954	−4.080	3.848
Transportation and storage	−0.093	2.069	0.964	−4.148	3.962
Accommodation and food services	−0.277	2.018	0.891	−4.232	3.677
Information and communication	0.871	5.663	0.878	−10.227	11.970
Finance and insurance and real estate	0.830	2.113	0.694	−3.311	4.971
Professional, scientific, and technical services	0.247	2.090	0.906	−3.850	4.344
Administrative and support services	−0.049	2.033	0.981	−4.033	3.935
Public administration, education, health and social work	−0.088	2.004	0.965	−4.015	3.839
Arts and other	−0.190	2.025	0.925	−4.159	3.778
Region					
North West	0.064	0.178	0.718	−0.284	0.412
Yorkshire and the Humber	0.300	0.188	0.111	−0.069	0.669
East Midlands	0.080	0.186	0.668	−0.285	0.445
West Midlands	−0.020	0.182	0.911	−0.376	0.335
East of England	0.247	0.232	0.286	−0.207	0.702
London	0.171	0.299	0.566	−0.414	0.757

(Continues)

TABLE A3 | (Continued)

Progression to pay above the minimum	Coefficient	SE	*p*	95% CI	
South East	0.323	0.226	0.154	−0.121	0.766
South West	0.150	0.204	0.463	−0.250	0.550
Wales	0.098	0.194	0.612	−0.281	0.477
Scotland	−0.083	0.216	0.700	−0.507	0.340
Year					
2011	−0.286	0.226	0.205	−0.729	0.156
2012	−0.344	0.277	0.215	−0.887	0.199
2013	−0.492	0.261	0.060	−1.005	0.020
2014	−0.282	0.266	0.288	−0.803	0.238
2015	−0.350	0.297	0.238	−0.932	0.231
2016	−0.750	0.311	0.016	−1.359	−0.141
2017	−0.839	0.415	0.043	−1.653	−0.025
2018	−0.755	0.453	0.095	−1.642	0.132
2019	−0.641	0.516	0.214	−1.653	0.370
Median TTWA wage level	0.001	0.001	0.216	0.000	0.002
Number of months in-between interviews	0.051	0.027	0.060	−0.002	0.104
Share of minimum wage workers in 2009	0.508	0.592	0.391	−0.653	1.668
Lagged bite of the minimum wage at the national level	0.054	0.062	0.390	−0.069	0.176
Share of min wage workers# Lagged national bite	−0.010	0.011	0.335	−0.031	0.011
Constant	−1.088	4.213	0.796	−9.344	7.169
Transitions to nonemployment					
Time in min wage job	−0.245	0.117	0.037	−0.475	−0.015
Time in min wage job squared	0.009	0.008	0.287	−0.007	0.025
Female	−0.356	0.201	0.077	−0.750	0.038
Age	−0.056	0.067	0.407	−0.188	0.076
Age square	0.000	0.001	0.529	−0.001	0.002
Education					
Other higher degree	−0.015	0.361	0.966	−0.723	0.692
A-level	−0.313	0.340	0.357	−0.979	0.353
GCSE	−0.504	0.284	0.076	−1.061	0.053
Other qualification	−0.181	0.336	0.590	−0.839	0.477
No qualification	−0.468	0.354	0.186	−1.163	0.226
Has child under 5	0.001	0.217	0.997	−0.425	0.426
Number of children					
1	0.375	0.222	0.091	−0.060	0.810
2	0.233	0.208	0.262	−0.175	0.641
3	0.583	0.319	0.068	−0.043	1.208
Self-reported health status	0.281	0.165	0.089	−0.043	0.605
Ethnic minority (0/1)	0.203	0.252	0.421	−0.291	0.697
Immigrant (0/1)	0.294	0.265	0.267	−0.225	0.813
Has previous unemployment spell (0/1)	1.703	0.187	0.000	1.337	2.069
Firm size (logged)	−0.086	0.051	0.092	−0.185	0.014
Public sector	0.329	0.286	0.250	−0.232	0.890
Temporary contract	0.897	0.202	0.000	0.500	1.293
Part-time work	−0.228	0.159	0.152	−0.540	0.084

(Continues)

TABLE A3 | (Continued)

Progression to pay above the minimum	Coefficient	SE	*p*	95% CI	
Industry					
Manufacturing-food, beverages, textile	13.285	3.070	0.000	7.267	19.303
Manufacturing-basic industrial	13.419	3.073	0.000	7.396	19.442
Manufacturing-complex industrial	12.840	4.737	0.007	3.556	22.125
Construction and gas, electricity and water services	12.388	6.780	0.068	−0.901	25.676
Wholesale and retail trade	13.502	3.040	0.000	7.544	19.460
Transportation and storage	14.142	3.067	0.000	8.130	20.153
Accommodation and food services	13.280	3.017	0.000	7.366	19.194
Information and communication	14.202	8.087	0.079	−1.647	30.052
Finance and insurance and real estate	12.506	6.867	0.069	−0.953	25.966
Professional, scientific, and technical services	12.473	6.985	0.074	−1.218	26.164
Administrative and support services	13.519	3.040	0.000	7.561	19.478
Public administration, education, health and social work	13.174	3.067	0.000	7.164	19.185
Arts and other	13.529	3.109	0.000	7.437	19.622
Region					
North West	0.212	0.374	0.570	−0.520	0.944
Yorkshire and the Humber	0.267	0.408	0.513	−0.532	1.067
East Midlands	−0.287	0.399	0.472	−1.069	0.496
West Midlands	0.297	0.402	0.459	−0.490	1.084
East of England	0.035	0.514	0.946	−0.972	1.043
London	0.231	0.566	0.683	−0.877	1.340
South East	−0.023	0.508	0.964	−1.019	0.972
South West	−0.234	0.449	0.602	−1.114	0.646
Wales	−0.143	0.430	0.740	−0.985	0.699
Scotland	0.296	0.398	0.458	−0.485	1.076
Year					
2011	0.079	0.392	0.840	−0.689	0.846
2012	−0.632	0.442	0.153	−1.498	0.235
2013	−0.840	0.454	0.064	−1.731	0.050
2014	−1.324	0.473	0.005	−2.251	−0.396
2015	−1.433	0.505	0.005	−2.423	−0.444
2016	−2.029	0.537	0.000	−3.082	−0.976
2017	−2.692	0.773	0.000	−4.208	−1.177
2018	−2.340	0.903	0.010	−4.111	−0.570
2019	−2.283	0.996	0.022	−4.235	−0.332
Median TTWA wage level	0.000	0.001	0.810	−0.002	0.002
Number of months in-between interviews	0.006	0.053	0.907	−0.099	0.111
Share of minimum wage workers in 2009	0.161	0.967	0.867	−1.734	2.056
Lagged bite of the minimum wage at the national level	0.228	0.115	0.047	0.003	0.453
Share of min wage workers# Lagged national bite	−0.005	0.017	0.786	−0.039	0.029
Constant	−24.329	6.853	0.000	−37.761	−10.897
$N = 4270$					

Note: Coefficients from an independent competing risks discrete-time model, with the area share of minimum wage workers in 2009 interacted with the national bite. Minimum wage jobs are defined as having an hourly pay less than the adult rate minimum wage level plus 5p; low-paid employment is defined as job with an hourly pay above the minimum but less than two-thirds of the median hourly pay (as calculated by the Office for National Statistics); higher pay employment consists of jobs paying above the low-pay threshold.

Source: Authors' calculations based on UKHLS, Waves 1–10 and ASHE 2009–2019.

TABLE A4 | Average marginal effects from four specifications: Standard (M1), using longitudinal weights (M2) dropping observations with an observed changed in hours in the same employment relationship larger than 10% (M3), and adding employment rates at the TTWA-year level (M4).

	Minimum wage	Pay above the minimum	Nonemployment	Minimum wage	Pay above the minimum	Nonemployment
		M1			**M2**	
2010	0.004	−0.014	0.011	0.007	−0.023	0.016
2011	0.011	0.002	−0.013	0.006	0.019	−0.025
2012	−0.018	0.021	−0.004	−0.003	0.014	−0.011
2013	0.009	−0.020	0.011	0.023	−0.033	0.010
2014	−0.013	0.009	0.004	0.016	−0.030	0.014
2015	0.017	−0.014	−0.003	0.038	−0.032	−0.005
2016	0.033	−0.031	−0.002	0.047	−0.040	−0.007
2017	0.005	−0.005	0.000	0.015	−0.005	−0.011
2018	0.018	−0.019	0.001	0.017	−0.016	−0.001
2019	0.017	−0.025	0.008	0.046	−0.036	−0.010
N	4270	2832				
		M3			**M4**	
2010	−0.016	0.004	0.012			
2011	0.019	−0.008	−0.011			
2012	−0.011	0.018	−0.008			
2013	0.005	−0.019	0.014			
2014	−0.012	0.010	0.002	−0.014	0.010	0.005
2015	0.021	−0.027	0.006	0.016	−0.017	0.000
2016	0.053	−0.049	−0.005	0.029	−0.027	−0.002
2017	0.005	−0.005	0.000	0.005	−0.005	−0.000
2018	0.027	−0.028	0.001	0.017	−0.017	0.000
2019	0.017	−0.028	0.011	0.017	−0.024	0.007
N	3412			2758		

Note: Employment rates refer to the population aged 16–64 and have been taken from the ONS NOMIS platform (https://www.nomisweb.co.uk/datasets/apsnew); unfortunately, we are only able to match observations starting in 2014.
Source: Authors' calculations based on UKHLS, Waves 1–10 and ASHE 2009–2019.

TABLE A5 | Coefficients from a model of log hourly wage growth using the lagged area share of minimum wage workers and controlling for area wage level (model corresponding to Model 1 Table 1).

	Coefficient	SE	*p*	95% CI	
Female	−0.028	0.021	0.186	−0.069	0.014
Age	−0.001	0.005	0.861	−0.010	0.008
Age square	0.000	0.000	0.843	0.000	0.000
Education					
Other higher degree	−0.053	0.042	0.208	−0.136	0.030
A-level, etc.	−0.075	0.038	0.051	−0.149	0.000
GCSE, etc.	−0.095	0.035	0.007	−0.164	−0.027
Other qualification	−0.097	0.049	0.048	−0.193	−0.001
No qualification	−0.116	0.038	0.002	−0.192	−0.041
Has child under 5	−0.012	0.015	0.442	−0.041	0.018
Number of children					
1	0.001	0.009	0.919	−0.017	0.019
2	0.002	0.010	0.818	−0.018	0.022
3	0.016	0.012	0.163	−0.007	0.040
Self-reported health status	−0.010	0.014	0.468	−0.038	0.018
Ethnic minority (0/1)	−0.017	0.028	0.548	−0.070	0.037
Immigrant (0/1)	−0.011	0.027	0.691	−0.063	0.042
Has previous unemployment spell (0/1)	−0.022	0.077	0.772	−0.173	0.129
Firm size (logged)	0.004	0.006	0.457	−0.007	0.016
Public sector	0.049	0.023	0.036	0.003	0.095
Temporary contract	0.043	0.032	0.187	−0.021	0.106
Part-time work	−0.035	0.025	0.157	−0.084	0.014
Industry					
Manufacturing-food, beverages, textile	−0.043	0.029	0.142	−0.100	0.014
Manufacturing-basic industrial	0.018	0.035	0.610	−0.050	0.086
Manufacturing-complex industrial	0.006	0.033	0.854	−0.058	0.070
Construction and gas, electricity and water services	0.050	0.048	0.297	−0.044	0.144
Wholesale and retail trade	−0.013	0.025	0.619	−0.062	0.037
Transportation and storage	0.011	0.032	0.721	−0.051	0.074
Accommodation and food services	−0.026	0.027	0.341	−0.079	0.027
Information and communication	0.187	0.108	0.083	−0.025	0.398
Finance and insurance and real estate	0.098	0.054	0.068	−0.007	0.204
Professional, scientific, and technical services	0.127	0.054	0.018	0.022	0.233
Administrative and support services	0.000	0.025	0.996	−0.049	0.049
Public administration, education, health and social work	−0.009	0.027	0.741	−0.062	0.044
Arts and other	0.004	0.029	0.884	−0.053	0.061
Region					
North West	0.030	0.046	0.520	−0.061	0.120
Yorkshire and the Humber	0.020	0.022	0.374	−0.024	0.063
East Midlands	0.029	0.031	0.362	−0.033	0.090
West Midlands	0.004	0.026	0.865	−0.046	0.055
East of England	0.017	0.026	0.512	−0.034	0.068
London	0.071	0.061	0.246	−0.049	0.191

(Continues)

TABLE A5 | (Continued)

	Coefficient	SE	*p*	95% CI	
South East	0.056	0.032	0.077	−0.006	0.119
South West	0.017	0.029	0.558	−0.039	0.073
Wales	0.004	0.024	0.853	−0.043	0.052
Scotland	0.004	0.026	0.875	−0.048	0.056
Year					
2011	−0.026	0.053	0.627	−0.129	0.078
2012	−0.051	0.043	0.235	−0.134	0.033
2013	−0.079	0.052	0.134	−0.181	0.024
2014	−0.057	0.044	0.193	−0.143	0.029
2015	0.004	0.040	0.921	−0.074	0.081
2016	0.007	0.048	0.876	−0.086	0.101
2017	−0.064	0.046	0.157	−0.154	0.025
2018	−0.073	0.042	0.085	−0.156	0.010
2019	0.022	0.057	0.701	−0.090	0.134
Inverse Mills ratio	−0.054	0.389	0.889	−0.816	0.708
Lagged share of min wage workers	−0.006	0.009	0.540	−0.023	0.012
Lagged share of min wage workers# Year					
2011	0.004	0.011	0.742	−0.018	0.025
2012	0.007	0.010	0.523	−0.014	0.027
2013	0.016	0.015	0.275	−0.013	0.046
2014	0.009	0.010	0.365	−0.010	0.028
2015	−0.004	0.010	0.728	−0.023	0.016
2016	0.001	0.011	0.916	−0.020	0.022
2017	0.008	0.009	0.422	−0.011	0.026
2018	0.006	0.009	0.515	−0.012	0.024
2019	0.001	0.010	0.921	−0.019	0.021
Median TTWA wage level	0.000	0.000	0.045	0.000	0.000
Month of the interview					
2	0.020	0.019	0.276	−0.016	0.057
3	−0.003	0.010	0.754	−0.023	0.017
4	0.007	0.010	0.478	−0.012	0.027
5	0.008	0.012	0.469	−0.014	0.031
6	0.008	0.010	0.435	−0.012	0.028
7	0.007	0.011	0.495	−0.014	0.028
8	−0.006	0.009	0.465	−0.023	0.011
9	−0.003	0.009	0.780	−0.021	0.016
10	−0.012	0.010	0.245	−0.032	0.008
11	0.012	0.010	0.255	−0.008	0.032
12	−0.005	0.011	0.681	−0.027	0.017
Number of months in-between interviews	0.003	0.002	0.096	−0.001	0.006
Constant	0.165	0.168	0.325	−0.164	0.495
$N = 3987$					

Note: Coefficients from the second step of a two-step Heckman regression, where the hazard of leaving the labor market is estimated using the same variables, plus household nonlabor income, gross labor income from other household members, and age of youngest child interacted with gender.

Source: Authors' calculations based on UKHLS, Waves 1–10 and ASHE 2009–2019.

TABLE A6 | Coefficients from a model of log hourly wage growth using the area share of minimum wage workers in 2009 interacted with the lag of the minimum wage at the national level, and controlling for the area median wage level (model corresponding to Model 2 Table 1).

	Coefficient	SE	*p*	95% CI	
Female	−0.028	0.022	0.201	−0.070	0.015
Age	−0.001	0.005	0.865	−0.010	0.008
Age square	0.000	0.000	0.846	0.000	0.000
Education					
Other higher degree	−0.055	0.042	0.199	−0.138	0.029
A-level, etc.	−0.075	0.038	0.048	−0.150	−0.001
GCSE, etc.	−0.096	0.035	0.006	−0.165	−0.027
Other qualification	−0.098	0.049	0.047	−0.195	−0.001
No qualification	−0.117	0.038	0.002	−0.192	−0.041
Has child under 5	−0.012	0.015	0.436	−0.041	0.018
Number of children					
1.00	0.001	0.010	0.946	−0.018	0.019
2.00	0.002	0.010	0.838	−0.018	0.022
3.00	0.017	0.012	0.153	−0.006	0.040
Self-reported health status	−0.011	0.014	0.460	−0.038	0.017
Ethnic minority (0/1)	−0.016	0.028	0.565	−0.071	0.039
Immigrant (0/1)	−0.011	0.027	0.688	−0.063	0.041
Has previous unemployment spell (0/1)	−0.022	0.077	0.778	−0.173	0.130
Firm size (logged)	0.004	0.006	0.462	−0.007	0.016
Public sector	0.049	0.023	0.037	0.003	0.094
Temporary contract	0.044	0.032	0.175	−0.019	0.107
Part-time work	−0.035	0.025	0.160	−0.085	0.014
Industry					
Manufacturing-food, beverages, textile	−0.039	0.029	0.173	−0.095	0.017
Manufacturing-basic industrial	0.020	0.035	0.568	−0.048	0.087
Manufacturing-complex industrial	0.009	0.032	0.782	−0.054	0.072
Construction and gas, electricity and water services	0.054	0.048	0.256	−0.039	0.147
Wholesale and retail trade	−0.011	0.025	0.671	−0.060	0.039
Transportation and storage	0.012	0.031	0.693	−0.049	0.073
Accommodation and food services	−0.024	0.027	0.380	−0.076	0.029
Information and communication	0.183	0.106	0.083	−0.024	0.390
Finance and insurance and real estate	0.095	0.054	0.080	−0.011	0.202
Professional, scientific, and technical services	0.126	0.054	0.020	0.020	0.231
Administrative and support services	0.003	0.025	0.909	−0.046	0.052
Public administration, education, health and social work	−0.007	0.027	0.803	−0.059	0.046
Arts and other	0.006	0.029	0.824	−0.050	0.063
Region					
North West	0.028	0.045	0.539	−0.061	0.116
Yorkshire and the Humber	0.017	0.022	0.441	−0.026	0.061

(Continues)

TABLE A6 | (Continued)

	Coefficient	SE	*p*	95% CI	
East Midlands	0.025	0.031	0.416	−0.035	0.085
West Midlands	0.004	0.026	0.867	−0.046	0.055
East of England	0.012	0.025	0.614	−0.036	0.061
London	0.073	0.062	0.236	−0.048	0.194
South East	0.052	0.031	0.093	−0.009	0.114
South West	0.014	0.028	0.618	−0.041	0.069
Wales	0.005	0.024	0.837	−0.042	0.052
Scotland	0.000	0.027	0.991	−0.053	0.053
Year					
2011	−0.015	0.037	0.683	−0.087	0.057
2012	−0.025	0.026	0.334	−0.077	0.026
2013	−0.011	0.049	0.826	−0.107	0.086
2014	−0.022	0.032	0.483	−0.085	0.040
2015	−0.009	0.025	0.713	−0.058	0.040
2016	0.017	0.031	0.583	−0.043	0.077
2017	−0.008	0.036	0.827	−0.078	0.062
2018	−0.021	0.039	0.588	−0.096	0.055
2019	0.045	0.049	0.361	−0.051	0.141
Median TTWA wage level	0.000	0.000	0.194	0.000	0.000
Inverse Mills ratio	−0.059	0.391	0.881	−0.824	0.707
Share of minimum wage workers in 2009	−0.021	0.036	0.558	−0.093	0.050
Lagged bite of the minimum wage at the national level	−0.005	0.004	0.190	−0.013	0.003
Share of min wage workers# Lagged national bite	0.000	0.001	0.644	−0.001	0.002
Interview month					
2	0.020	0.019	0.302	−0.018	0.057
3	−0.003	0.010	0.776	−0.023	0.017
4	0.008	0.010	0.416	−0.012	0.028
5	0.012	0.012	0.338	−0.012	0.035
6	0.010	0.011	0.366	−0.012	0.031
7	0.009	0.011	0.418	−0.013	0.031
8	−0.003	0.010	0.759	−0.022	0.016
9	0.001	0.010	0.907	−0.018	0.021
10	−0.007	0.011	0.521	−0.030	0.015
11	0.017	0.011	0.123	−0.005	0.038
12	0.000	0.012	0.976	−0.024	0.025
Number of months in-between interviews	0.003	0.002	0.144	−0.001	0.006
Constant	0.478	0.260	0.066	−0.031	0.987
$N = 3964$					

Note: Coefficients from the second step of a two-step Heckman regression, where the hazard of leaving the labor market is estimated using the same variables, plus household nonlabor income, gross labor income from other household members, and age of youngest child interacted with gender.
Source: Authors' calculations based on UKHLS, Waves 1–10 and ASHE 2009–2019.

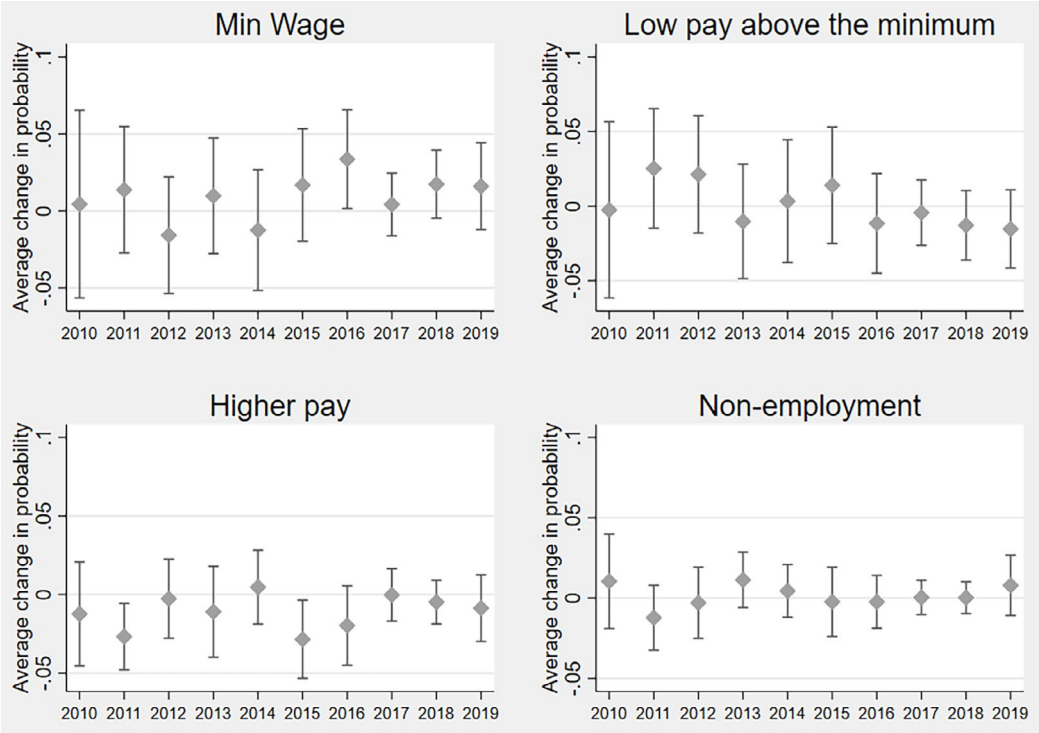

FIGURE A6 | Average marginal effects (and 95% confidence intervals) of the lagged share of minimum wage workers by year; four-state model. Minimum wage jobs are defined as having an hourly pay less than the adult rate minimum wage level plus 5p; Standard errors are computed using bootstrapping with 100 replications. *Source:* Authors' calculations based on UKHLS, Waves 1–10 and ASHE 2009–2019. [Color figure can be viewed at wileyonlinelibrary.com]