The NMW/NLW and progression out of minimum wage jobs in the UK

Interim report

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Executive Summary

This report presents preliminary analysis looking into the wage progression of minimum wage job holders between 2009 and 2016. Our aims are i) to examine whether the substantial increases in the minimum wage rate during this period affected progression out of minimum wage jobs and ii) to investigate which individual and job characteristics are associated with progression out of minimum wage jobs.

Between 2008 and 2017, the adult minimum wage rate in the UK increased significantly relative to median hourly pay. In 2017, it was 54% of median hourly pay compared to 48% in 2008. During this period, the proportion of workers covered by the minimum wage also increased from 4% in 2008 to 7% in 2017. The proportion of low paid workers (i.e. workers paid less than 2/3 of median hourly pay) however fell considerably from around 21.5% in 2008 to 18.4% in 2017[1].

A priori, it is not clear if and how minimum wage increases should affect the wage progression of minimum wage job holders. If minimum wages increases squeeze pay differentials at the bottom as indicated by higher coverage, incentives to progress might be lowered. To deal with costs, employers might also forego investment (including human capital investment) that can be expected to lead to higher wages later on. On the contrary, if higher minimum wages encourages skill acquisition and/ or other production changes then lead to productivity increases, they may facilitate wage progression in the long-run.

We use the UK Longitudinal Household Survey (UKHLS) to examine transitions out of minimum wage employment. At the time of writing, the UKHLS provides a seven year panel covering 2009-2016. We investigate transitions to three possible destinations i) employment paid above the minimum but less than two thirds of median hourly pay (low paid employment), ii) employment paid above two thirds of median hourly pay ('high' paid employment), and iii) non-employment. We focus on working age individuals who were entitled to the adult pay rate throughout the period, i.e. men aged 25-64 and women aged 25-59.

We estimate the effect of minimum wages by comparing transition probabilities out of minimum wage jobs over time in areas with low and high median wages. If minimum wage hikes do have an effect on wage progression, we expect transition probabilities to be more affected in low wage areas than in high wage areas. We measure the wage area level using travel-to work areas (TTWA) median hourly pay levels measured in 2009 from NOMIS which we merge into our UKHLS dataset.

We find that approximately one half of minimum wage job holders succeed in finding better paid employment within a year. Of these, four fifths progress to low paid employment and a fifth succeed in moving to 'high' paid employment. Transition rates measured over three years are only slightly higher. Minimum wage workers are more likely to transition to 'high'

[1] ONS, Low and high pay in the UK 2018, https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/lowandhighpayuk/2018

paid employment in areas with higher median wages, although this difference does not account for different worker characteristics across areas.

Once we control for individual and job characteristic, we find no evidence of minimum wage increases affecting progression probabilities out of a minimum wage job. In our preferred specification, the minimum wage bite lagged by 1 year - our measure of interest - is not significant. Moreover, we could not find a differential effect of the bite of the minimum wage across areas with different wage levels in any of our specifications. While we have a relatively low sample size and thus our research design is somewhat underpowered, our policy estimates are not only statistically insignificant but also very close to zero.

We find that more educated individuals, working in the public sector or in large firms are more likely to transition to 'high' pay. Women, individuals with a history of unemployment, part-time workers, and workers in accommodation and food services and food, beverages and textile manufacturing have lower chances of moving to 'high' paid employment. We also find that the longer one spends in a minimum wage job, the lower the chances of finding better paid employment. This could be due to unobserved lower productivity of those remaining in minimum wage jobs or to 'true' persistence. The latter is consistent with a significant body of literature that finds scarring effects of low pay in general.

1. Introduction and background

Introduced in 1999 at a low rate, the minimum wage in the UK has increased substantially since. In a context of stagnant real earnings, the minimum wage has increased from 48% of median full time hourly earnings in 2008 to 54% in 2017. Since 2008, the minimum wage rate has increased faster than average earnings, inflation or GDP. The growth of the minimum wage rate has accelerated after 2016 when the Government introduced the National Living Wage (NLW) and set for it a target of 60% of median earnings by 2020 subject to sustained economic growth. Thus, significant increases of the minimum wage rate are likely to continue.

A large economic literature has been concerned with the effects of minimum wages on the employment of less productive workers. Whereas some US studies do find negative effects (Neumark and Wascher, 2007), in the UK there is no evidence that the minimum wage has had any negative impact on employment (Metcalf, 2008, Dolton et al., 2012, Stewart, 2002a, Stewart, 2004, Manning, 2012). On the contrary, the minimum wage did have a significant effect on the distribution of wages, reducing inequality in its lower part (Dickens and Manning, 2004, Dickens and Manning, 2002, Stewart, 2012).

As the minimum wage has increased faster than median earnings, one consequence has been a substantial increase in the share of workers that are covered. Whereas in 2008 less than 4% of workers were covered by the minimum wage, this has increased to nearly 8% in 2017 and is projected to reach 12% in 2020 as the NLW continues to increase (Low Pay Commission, 2017). The share is much higher in low paying sectors and can exceed 50% in some areas. While reducing wage inequality at the bottom, the increased 'bunching' around the minimum wage has the potential to squeeze pay differentials and limit the opportunities for wage progression. This project examines the patterns of progression out of minimum wage jobs and seeks to provide evidence on the extent to which recent NMW/NLW increases have affected wage progression out of minimum wage jobs.

Understanding if and how the level of the minimum wage affects wage progression is important for designing and adapting minimum wage policy. Theories of human capital emphasize low individual productivity as the main explanation for low pay. Low productivity may also partly be the result of employer choices regarding work organization, capital investments, work incentives and reliance on low cost rather than high value added. As a result, the expected impact of increases in the NMW/NLW on wage progression is unclear. Employers may react to the cost of a higher minimum wage by reducing real pay growth for employees paid above the minimum. In the short term, they may also forgo investment in technology and/or human capital that would be expected to be accompanied by higher pay in the long-term. Greater bunching and squeezed wage differentials may reduce incentives to progress. Finally, if high minimum wages increase unemployment and unemployment is scarring (Arulampalam, 2001, Gregg and Tominey, 2005), then low skilled workers may be doubly impacted. They are more likely to become unemployed as a result of the minimum wage and their unemployment experience will decrease their wages long-term. A higher

minimum wage may also have a positive effect on wage progression if it induces employers to shift from competing on cost to competing on increased productivity and high value added. In turn, higher productivity can support higher wages. Such a shift however is likely to occur only in the medium and long-term.

Unlike employment and wage growth, there is little evidence as to whether minimum wages impact on wage progression and the direction of the effects. A series of research reports commissioned by the Low Pay Commission have produced descriptive evidence on transitions into and out of minimum wage jobs. Using data from British Household Panel Survey (BHPS) covering 1999-2004, Bryan and Taylor (2006) find that moves into and out of minimum wage jobs are frequent but most are associated with short range upward mobility (jobs paid only slightly above the minimum) or with non-employment. In general, minimum wage workers appeared to exhibit less upward wage mobility compared to other workers, and more mobility into non-employment, although such patterns are frequently associated with low paid jobs (Stewart, 2007, Cappellari and Jenkins, 2008, Cappellari, 2002). Similar findings are reported by Jones et al (2004) who used the Labour Force Survey (LFS) to examine transitions in and out of minimum wage jobs between 1999 and 2002. They found that around half of minimum wage earners transitioned to a better paid job within 12 months. Low qualifications, having a disability, being employed in a small firm, working part-time, being a renter and being employed in the private sector were all associated with a lower propensity to progress to employment paid above the minimum. Using LFS data, Stewart (2002b) finds that after the introduction of the minimum wage in 1999, the probability of remaining in a low paid job or transitioning to one from unemployment decreased while the probability to remain inactive (but wanting to work) increased. Of course, these changes may have been driven by factors other than the introduction of the minimum wage. In a study examining the timing of wage growth among low paid workers, Swaffield (2014) finds that employers tend to comply with minimum wage laws but hold down or offset wage growth during periods with relatively low minimum wage hikes. This results in wage growth at the bottom being strongly dependent on the size of the minimum wage hike.

The literature trying to identify the influence of minimum wages on wage progression is far more sparse. To our knowledge, there are only two studies that aim to quantify these effects for the UK. Cai et al (2018) analyse low pay dynamics between 1991 and 2008 and test whether these changed after the introduction of the minimum wage in 1999. They find that patterns of progression in and out of low pay have remained the same and conclude that the introduction of the minimum wage has not had an effect on transitions out of low pay. Jones et al. (2013) use regional and temporal variation in the bite of the minimum wage to model the impact of minimum wage changes on flows in and out of minimum wage jobs. They find that an increased bite is weakly associated with higher inflows into minimum wage jobs, as would be expected, but not with outflows from these jobs. They also find a strong connection between the strength of the local economy and the coverage of the minimum wage. Areas with a slacker economy experienced increasing coverage whereas the proportion of workers affected by the minimum wage decreased in busier areas. In a different setting, Rinz and Voorheis (2018) use US administrative data to examine the effect of minimum wages on income mobility. They find that raising the minimum wage increases earnings mobility for

those at the bottom of the wage distribution. In an older piece of research using data from the 1970s and 1980s, Neumark and Nizalova (2007) conclude that exposure to higher minimum wages at young ages (teens and early twenties) depresses earnings at older ages, mainly due to negative effects on training, schooling and labour market experience.

In this project, we seek to shed light on the extent to which the minimum wage has influenced low pay progression in the UK post-recession (2009-2016). We examine transitions out of minimum wage jobs by destination and use geographical and time variation in the minimum wage bite to estimate policy effects. The next section describes the data we use and the characteristics of our sample. The estimation methodology is detailed in section 3. Section 4 presents our main results and section 5 concludes.

2. Data

The analysis of pay dynamics requires longitudinal data. In this study, we make use of **Understanding Society**, the UK Longitudinal Household Study (UKHLS). Established in 2009, it is the largest UK longitudinal survey following approximately 40000 households. It also collects rich information about individual characteristics, their previous work history (including periods out of work), as well as information about their current job and employer. Seven waves are currently available to use, covering the period 2009-2016.

Longitudinal surveys are subject to attrition. Attrition represents a problem if individuals who drop out of the study are systematically different from those who continue to answer the survey questions. In this case, low paid workers may be more mobile and thus more likely to drop out. This could potentially bias our estimates of wage progression. Attrition in Understanding Society is significant. Approximately 52% of the initial sample is still participating after 6 years[2] (see the Understanding Society User Guide: https://www.understandingsociety.ac.uk/sites/default/files/downloads/documentation/mainstage/user-guides/mainstage-waves-1-7-user-guide.pdf). To account for this, we will use the longitudinal weights provided by Understanding Society which are specifically designed to account for differential attrition.

2.1 Sample Selection and Exclusion Criteria

Following ONS official estimates and previous studies on the impact of the NMW on earnings, we focus on employees entitled to the adult rate. The age at which workers become entitled to the adult pay rate has changed during the period we study. To ensure consistency, we focus on individuals aged 25 and older who were entitled to receive the adult rate throughout the years covered by our data. To avoid having to deal with complications raised by partial retirement, we focus exclusively on the working age population. We thus exclude men aged 65 and over and women aged 60 and over. On the one hand, the probability of progressing to higher wages is likely to be low for these groups for reasons unrelated to the

[2] Most of the attrition however occurs between waves 1 and 2 and is typical of panel surveys.

minimum wage while, on the other, access to significant sources of non-employment income such as state and private pensions potentially changes the earnings dynamics.

Our restrictions leave us with an unbalanced sample consisting of 34,148 individuals and 127,318 person-year observations. Out of these, there are 4,278 observations where the person is observed to be in a minimum wage job corresponding to 2,671 individuals. We observed 1,027 transitions to low pay, 260 transitions to 'high' pay and 152 transitions to non-employment. In our full specification, we lose some observations due to missing values on the covariates and are left with 2,327 individuals, 1,006 transitions to low pay, 258 transitions to 'high' pay and 148 transitions to non-employment.

2.2 Hourly Wages

The minimum wage is defined at the hourly pay level. To establish whether someone is paid at or above the minimum, we thus need to calculate nominal hourly wages. Average hourly earnings are not directly available in the UKHLS, except for a subsample of respondents who are paid by the hour. We thus use an imputation procedure to derive an hourly pay measure for the remainder of the sample. This is important not only to increase the sample size (only about a third of employees report an hourly pay figure) but to correct for bias coming from hourly paid employees being disproportionately likely to be low paid.

For all workers in our sample we have information about the usual monthly pay and the usual hours worked. We use these data to construct a derived measure which we term the '**implicit**' hourly wage. For cases where the usual monthly pay is missing, we use the total individual gross labour income measure, imputed by the UKHLS team. Both pay and hours measures include overtime work. The exclusion of reported overtime paid hours makes little difference. We have capped our measure of total weekly hours at 80 before computing our measure of *implicit* hourly pay. Finally, to avoid estimates being affected by implausibly large values, we have capped the implicit hourly pay measure at the largest observed direct measure. This affects less than 20 observations.

While convenient and easy to calculate, it is well known that implicit hourly pay measures derived from survey data tend to contain significant amounts of measurement error resulting in some implausibly small values and well as a general overestimation of the proportion of low paid workers (Stewart and Swaffield, 2002, Skinner et al., 2002). In comparison with the **direct** measure of hourly pay, the implicit measure tends to be too smooth and to underestimate 'bunching' at the minimum wage. Fig 1 shows the distribution of hourly pay using the direct and implicit measures for the subsample that report a direct measure. The implicit measure overestimates the proportion of individuals with very low values of hourly pay. In contrast, the distribution of the direct measure is much closer to what we would expect: there are virtually no individuals paid below the minimum while the spike at the minimum is much more striking.

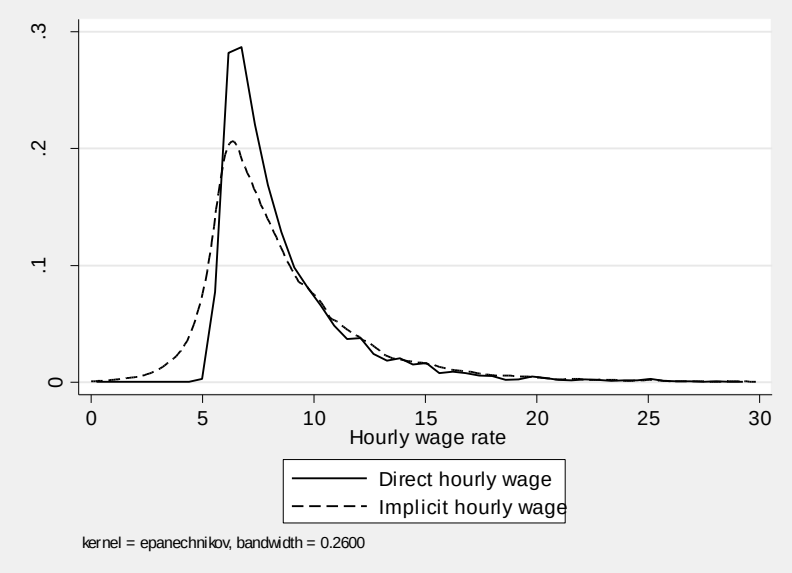


Fig 1: Density the nominal hourly wage distribution using the direct and implicit hourly wage measures, 2009-2016

As our analysis focuses on low paid individuals and in particular on individuals paid the minimum wage, it is important to have an hourly pay measure as accurate as possible. To address this issue, we adapt an imputation procedure developed by Skinner, Stuttard et. al. (2002). The procedure assigns an imputed value to observations missing the direct hourly pay measure 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 (6 categories), region, marital status, the number of children aged under 5, occupation (3-digit SOC codes), industry (2 digit SIC codes), firm size, public sector, part-time employment and year. We then use this regression to predict the hourly wage for all the individuals who are in our sample of interest (employed men aged 25-64 and employed women, aged 25-59) and have non-missing values on the predictor variables. Next, 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 ten nearest '*neighbours*'. A neighbour is defined as an observation with a value of the predicted hourly wage within +/50p of the target's predicted hourly wage. For each observation we wish to impute a value, we first select the ten neighbours whose predicted hourly wage is closest to the target observation's predicted hourly wage (if they exist). We then randomly choose one among the 10 (or less if ten neighbours do not exist) and assign its value to the missing observation. To avoid outliers potentially 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, Stuttard et. al. (2002) and repeat the imputation 20 times. Our final imputed values are the means of the twenty imputations. We carry out the imputation separately for each year (note that a year usually straddles two waves in the UKHLS data).

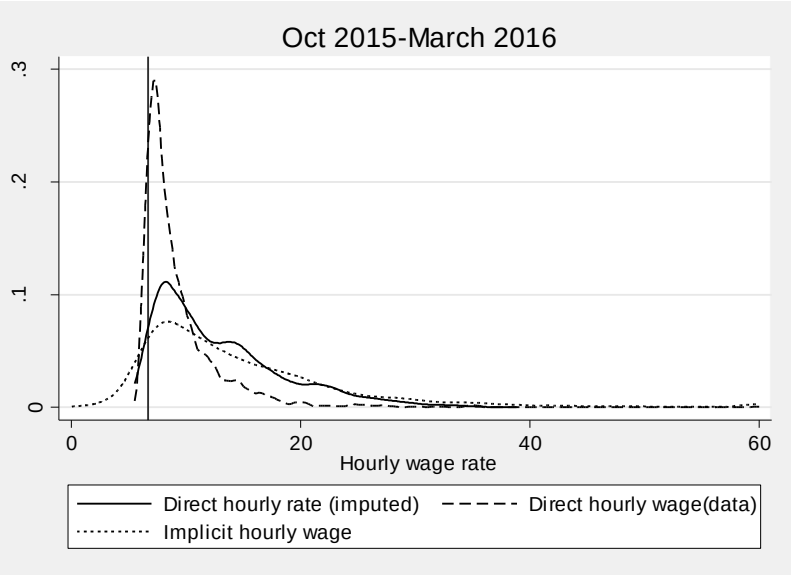


Figure 2: Hourly pay distribution according to three measures: 'direct', 'implicit', and 'direct' + imputed values

Figure 2 shows the distribution of hourly pay according to three measures: direct, implicit and direct plus imputed between October 2015 and March 2016 as well as the value of the minimum wage during this period (the vertical black line). 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. The spike however is much smaller than that of the direct measure and more in line with estimates obtained from administrative data. Similar results are obtained for all the years in our data (see Fig A1 in the Appendix).

A different way of assessing the quality of the imputation is to examine the share of workers covered by the minimum wage according to the three hourly pay measures. Figure 3 shows that both the direct and the implicit measures overestimate the coverage of the minimum wage significantly, the latter due to measurement error and the former due to bias from overrepresentation of low paid workers. In contrast, the imputed hourly pay measure gives estimates that are much closer to official statistics if still a little too high. Official estimates based on the Annual Survey of Hours and Earnings (ASHE) range between around 4% in 2009 to around 7% in 2017. Further analysis has shown that the overestimation is due to a too high share of low paid workers in the observed direct hourly wage data rather than in the imputed data.

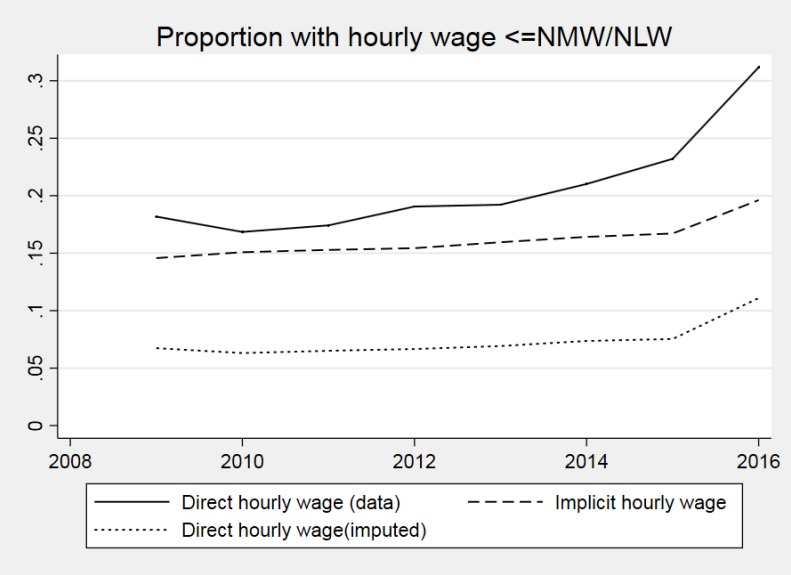


Figure 3: Proportion of workers with an hourly pay below or at the NMW/NLW level

In the UKHLS, we are unable to accurately identify cases where individual pay has been affected by absences or other factors that might legitimately depress the observed hourly rate below the minimum in force. However, we use information about 'usual pay' and hours of work, rather than pay over a fixed period, to determine hourly wages. This variable should be less sensitive to temporary drops in the observed wages. Ideally, we also want to avoid including workers whose pay period is partly covered by the old NMW/NLW. As the UKHLS is collected throughout the year, there is a chance that the pay period for some workers straddles the introduction/uprating of the NMW/NLW. The UKHLS does not record exact information about the start of the pay period, so we cannot exclude individuals whose pay might refer to a period where two levels of the minimum wage have been in force. However, as a sensitivity test, we re-estimate our models excluding individuals interviewed in the month when the minimum wage changes (October before 2016 and April thereafter).

2.3 Transitions between minimum wage, low paid and 'high' paid employment

Based on the hourly pay rate, we define four mutually exclusive states: minimum wage employment, low paid employment, 'high' paid employment and non-employment. **Minimum wage employment** is defined as all those workers who have an hourly pay rate at or below the NMW/NLW rate in force at the time of their interview. **Low paid** employment is defined as employment that pays an hourly wage higher than the NMW/NLW but less than the low pay threshold. We follow the literature and define the low pay threshold to be two thirds of median pay (Cappellari and Jenkins, 2008, D'Arcy and Finch, 2017). Because our median hourly pay is somewhat lower than official estimations, we use the official estimate of median pay based on the Annual Survey of Hours and Earnings (ASHE) when computing

our low pay threshold. **High paid employment** is defined as having an hourly pay above the low pay threshold.

We define **transitions** between minimum wage pay, low, and high pay to occur when workers move between these categories. 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 et al. (2012). In future work, we will test the sensitivity of our results to the choice of threshold by checking our estimates hold when using both a lower (0p) and higher (10p) threshold.

2.4 Local area indicators of economic activity

We wish to use geographical variation to estimate the impact of the minimum wage on the probability of moving out of a minimum wage job. In the UK, the minimum wage is set at the national level so the bite effectively only varies over time. However, the proportion of workers affected by the minimum wage and its increases will vary not only over time but also geographically, depending on the strength of the local economy. In this study, we have opted to use travel to work areas (TTWA) as the local geographical indicator. Other geographical units could be used (for example, local authority districts) but we believe TTWAs are closest in approximating local labour markets. TTWAs are constructed geographical units satisfying two criteria - at least 75% of the resident economically active population works in the area and at least 75% of the actively working population resides in the area (Prothero, 2016). TTWAs have been constructed based on commuting flows data in the 2001 and 2011 censuses. There are 243 TTWAs based on the 2001 census and 228 based on the 2011 census.

UKHLS provides 2001 based TTWA indicators for the first six waves (covering 2009-2015) and 2011 based indicators for wave 7 (covering 2015 and 2016). We use these indicators to match information on median wages at the TTWA level from 2009 to 2016 from NOMIS (https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/workbasedtraveltoworkareaashetable11). TTWA median wages calculated based on ASHE are provided for Great Britain only. Furthermore, NOMIS provides 2001 TTWA measures for the period 2009-2013 and 2011 based TTWA measures thereafter. Thus, we have a mismatch of coding affecting our 2014 and half of our 2015 samples (i.e. individuals interviewed in wave 6). Only a handful of TTWAs remained the same after re-coding based on the 2011 census. Thus, there is not a one to one correspondence between 2001 TTWA codes and 2011 ones. To get around this problem, we have loosely matched 2001 TTWA codes to 2011 ones based on maximizing the overlap area between the two. We were then able to assign median hourly wage levels for all the individuals in our UKHLS sample who live in Great Britain. Our analysis thus excludes respondents residing in Northern Ireland. In further work, we plan on recalculating our estimates using the share of workers covered by the minimum wage at the TTWA level rather than the median wage. This measure should be better able to capture geographical variation in the impact of the minimum wage. However, since it is not provided as a public resource by the ONS it was not available at the time this

analysis was carried out. Instead, we will compute this measure directly from ASHE data for the 2009-2016 period.

3. Estimation strategy

Our aim is to examine transitions out of NMW/NLW jobs and the extent to which transition probabilities have been affected by changes in the minimum wage. We are also interested in probing which individual and job characteristics are associated with a higher probability to progress to better paid employment.

We first produce descriptive statistics on: (i) trends in minimum wage jobs and low pay over the period we study (2009-2017); (ii) transitions between pay states over time; and (iii) regional variations in low pay and transitions out of minimum wage jobs.

We then use transition matrices and a competing risks discrete time model to carefully look at wage progression out of minimum wage jobs. We define transitions out of minimum wage jobs over a single year; as well as over a longer period (3 years). Note that given we only have data up to 2016, we are able to examine the impact of the National Living Wage (NLW) introduced in April 2016 only on short-term (1 year) transitions. Note also that our sample of individuals affected by the NLW is low so any results should be interpreted with caution[3] .

3.1 Competing risks discrete time model

To examine patterns of wage progression in more detail, we examine exit probabilities to three potential destination states: low paid employment, 'high' paid employment and non-employment. Low paid employment is defined as employment paying an hourly wage above the minimum but below the low pay threshold (defined as two thirds of median hourly earnings); 'high' paid employment is defined as employment paying above the low pay threshold. By differentiating between exits to low paid and high paid employment, we quantify the extent of short range versus long range mobility for minimum wage earners.

A first indication of the likely impact of the NMW/NLW increases on transition probabilities out of minimum wage jobs can be gained by examining changes across years. If years following relatively high increases in the NMW/NLW show lower/higher probabilities of wage progression, this suggests that wage progression might be affected by the uprating of the NMW/NLW. Obviously, concurrent economic changes and/or public policies will affect these transition probabilities and so yearly differences cannot be interpreted as a causal effect.

To get closer to a causal effect, we compare changes in transition probabilities, following changes in the minimum wage, across local areas. If increases in the NMW/NLW affect wage progression, areas with a higher incidence of minimum wage jobs and lower median wages should be affected more in periods when the relative minimum wage is higher. This strategy assumes that, absent NMW/NLW changes, changes in wage progression probabilities across regions would be the same.

[3] We will have a larger sample size once we are able to add wave 8.

Formally, we estimate models of the following type:

$$(1)\ h_{st} = \frac{\exp(\alpha_{st}+\beta_s X_{it}+\delta_s W_{it}+\gamma_s LMWage_{a,2009} MWBite_{t-1})}{(1+\sum_{ss=1}^{S}\exp(\alpha_{sst}+\beta_{ss}X_{it}+\delta_{ss} W_{it}+\gamma_{ss} LMWage_{a,2009} MWBite_{t-1}))}$$

where h_{st} is the hazard of leaving a minimum wage job at time *t* for destination *s*. s takes one of three possible values: low paid employment, 'high' paid employment and non-employment. X_{it} represents a vector of individual level characteristics measured at time *t* and W_{it} represents a vector of employer level characteristics measured at time *t*. $LMWage_{a,2009}$ is the median hourly wage in area (TTWA) *a* in 2009 and $MWBite_{t-1}$ represents the 'bite' of the minimum wage (i.e. the ratio between the NMW/NLW and median hourly earnings) at the national level in year *t-1*.We measure local wage levels in 2009 *before* any of the minimum wage hikes we study take place. We thus ensure that the area wage levels indicator is not contaminated by the policy changes we study. The minimum wage bite variable is measured at the national level and is entered lagged. Given that it may take some time for minimum wage policies to affect transition probabilities, we believe that entering the lag of the minimum wage bite is the most appropriate. However, entering the contemporaneous minimum wage bite yields very similar results. It is possible that more than one year is needed for minimum wage levels to affect transition probabilities. Unfortunately, our sample size and panel length do not allow for the inclusion of more than one lag.

Since the bite of the minimum wage is calculated as the ratio between the minimum and median hourly earnings, it is possible any potential effects are driven by changes in the median rather than by changes in the minimum. For example, if median wages were to rise while the minimum wage is held constant, the bite would fall. Higher median wages could also increase the probability to transition to 'high' pay inducing thus a negative correlation between the 'bite' and transition probabilities. In the period we study, median wages have been relatively stagnant whereas the minimum wage increased considerably. Thus, the increase in the bite of the minimum wage observed during this period is due to changes in the NMW/NLW itself rather than changes in the median.

The specification we employ is essentially a competing risks discrete time model with minimum wage employment as the origin and three possible destination states: low paid employment, high paid employment and non-employment. The set of coefficients γ_s, s=1,2,3 identify the impact of the minimum wage on the probability of transitions to low-paid, high-paid and non-employment if the identifying assumption holds. We allow for multiple spells per individual, i.e. individuals who exit minimum wage employment but re-enter subsequently will have more than one spell in the data.

Discrete time models are especially suited to our case as we have yearly observations on the type of employment individuals hold. They have the advantage they can account for dependence on time spent in state in a flexible way, can easily accommodate time varying co-variates, are relatively robust to time-invariant individual specific unobserved heterogeneity,

and are easy to estimate using standard software (Nicoletti and Rondinelli, 2010, Jenkins, 1995, Allison, 1982).

One drawback of discrete time competing risks models is that they impose the assumption of independence of irrelevant alternatives (IIA). The IIA assumption is quite strong requiring that the processes governing transitions to the various destination states be independent. While in theory we can relax this assumption by including time invariant individual specific random effects and allowing the random effects to be correlated across equations for different destination states, in practise we are not able to estimate this model due to data constraints. The estimation of random effects requires a significant number of individuals experiencing a given transition more than once (so that a person level effect can be estimated). In addition to our sample size being relatively small, we have a relatively short panel and so the number of individuals with multiple spells is by necessity very limited.

It could be argued that duration models are inappropriate if the data does not collect accurate measures of employment spell duration (see, for example, Jones et al., 2004). We believe that duration measurement would indeed be a problem for our estimates if individuals switch employers very often. If this was the case, the annual data collection may miss some periods of employment and their associated hourly wages. However, previous studies have found that the average job tenure (of complete and incomplete job spells) is over five years and that low skilled workers are no more mobile than average (Mumford and Smith, 2004). As a result, we believe that this in unlikely to be a problem. Moreover, the UKHLS collects detailed information about employment spells in-between interview dates. As a robustness check, we will in future work use this information to eliminate from the analysis individuals who experience more than one transition between two consecutive waves and check whether results are affected.

3.1 Covariates: Individual and employer characteristics

In addition to local area wage levels and the minimum wage bite, our preferred specification includes a number of individual and job level characteristics. We include these variables with a twofold aim. First, in estimating policy effects we compare changes in transition probabilities over time and over areas. However, if wage progression patterns are different in high and low wage areas due to different characteristics of their workforce or jobs, this will bias our estimates. Thus, it is important to control for compositional differences across areas both in the types of jobs and in the types of workers. Second, we are interested in the effects of individual and job level characteristics on wage progression probabilities themselves. We include a rich set of co-variates: gender, age, qualifications, household composition (including the presence of children and very young children), health status, ethnicity, immigration status, and previous experience of unemployment, and region. These variables are intended to capture either low human capital (qualification, occupation, previous unemployment etc.) or the presence of barriers to employment that may lead to lower productivity such as health status or caring responsibilities. On the employer/workplace level, we include industry, sector, and firm size. Together, these variables capture both personnel

policies and some other important channels that may affect wage progression (e.g. unionisation).

4. Results

4.1 Descriptive results

We start by looking at trends in minimum wage and low pay. Figure 4 shows that between 2009 and 2016, the share of workers paid at (or below) the minimum has increased whereas the share of workers paid at or below the low pay threshold (including minimum wage workers) has fallen significantly. The share of workers paid at or below the minimum has climbed from around 4-4.5% 2009/2010 to 7% in 2016. The share of low paid workers on the other hand fell from around 24% in 2009 to around 20% in 2016. The trends in our data are consistent with official estimates based on ASHE, albeit the levels are slightly higher than the corresponding ASHE based measures. Figure 5 illustrates the considerable regional variation in the proportion of minimum wage and low paid workers. Over the period we study, the share of workers in minimum wage employment varied from less than 2% in London to over 6% in Northern Ireland. Similarly, the share of low paid workers ranged from less than 10% in London to 29% in Wales. Generally, regions with a higher share of minimum wage workers also have a higher share of low paid workers suggesting that the share of minimum wage workers is strongly connected to the strength of the local economy and its industrial/occupational composition.

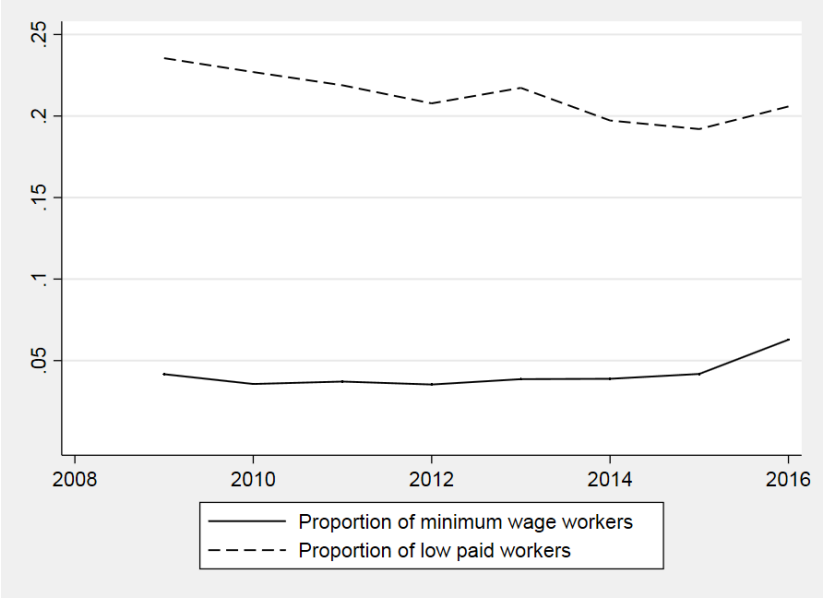


Fig 4: Proportion of workers who are paid at/below the minimum and proportion of workers paid at or below the low paid threshold by year

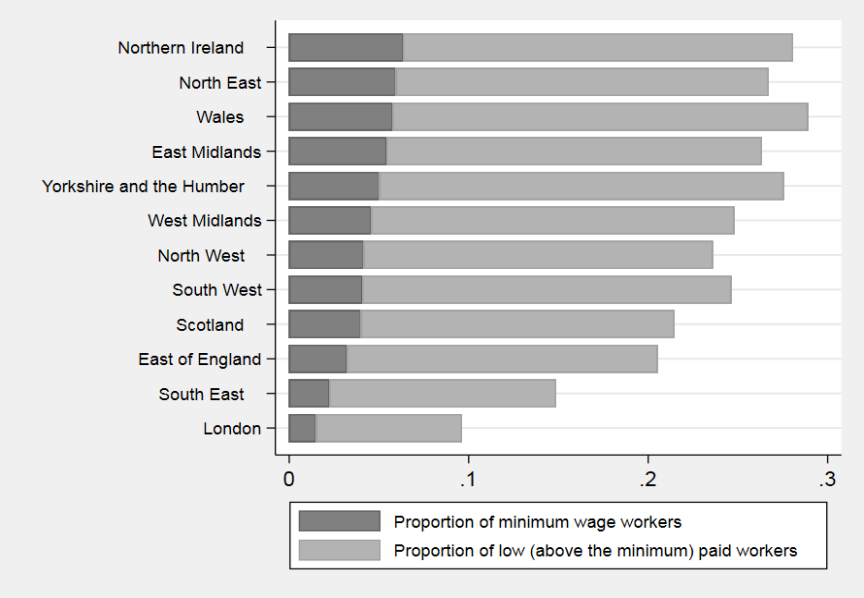


Fig 5: Proportion of workers who are paid at/below the minimum and proportion of workers paid at or below the low paid threshold by region

Next, we examine transition probabilities out of minimum wage jobs and the way they vary across time and across areas. Figure 6 shows average 1-year unadjusted transition probabilities to low (but above minimum) paid employment, 'high' paid employment and non-employment for each year between 2010 and 2006. For each year we calculate, from the stock of workers in minimum wage jobs in the previous year, the proportion that are still in a minimum wage job in the current year and the proportions transitioning to the three other states.

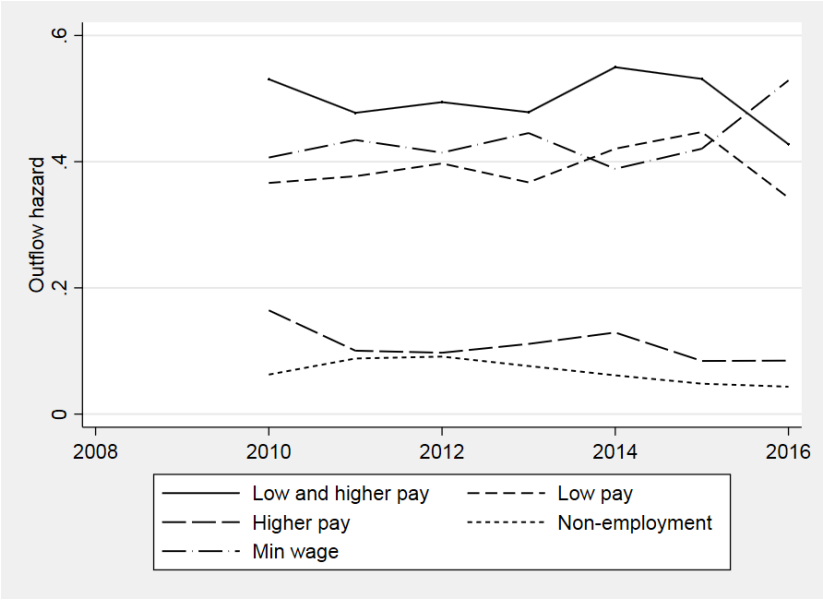


Fig 6: One-year transition probabilities to minimum wage, low paid, 'high' paid and non-employment by year

Every year, around half of minimum wage workers transition to a better paid job while between 5% and 10% transition to non-employment. The proportion of workers finding a better paid job after 1 year increased slightly after 2012 but fell again in 2016. The proportion of minimum wage workers moving to non-employment fell during the same period. Both trends are consistent with macro indicators showing economic growth resuming after 2012.

Among those transitioning to a better paid job, approximately four fifths remain in low paid employment (paid above the minimum). Only around 10% of minimum wage workers succeed in securing a 'high' paid job in 12 months and this proportion is relatively stable over time. It is possible that minimum wage workers succeed in transitioning to 'high' paid employment over longer periods of time. To investigate this possibility, we have computed 3 year transition probabilities to low paid, 'high' paid and non-employment. These are calculated as the proportion of individuals who are low paid, 'high' paid or in non-employment in the current year out of those who have been in a minimum wage job in any of the previous three years in *(t-1,t-2* and *t-3*). Figure 7 plots these three year transition probabilities. They show a very similar pattern to one year transition probabilities: a substantial minority of minimum wage job holders manage to obtain better pay but the vast majority of transitions are to low paid jobs. In fact, the proportion of individuals succeeding in securing 'high' paid employment is very similar whether we use one or three-year transition probabilities. This finding suggests that most individuals moving to low pay from a minimum wage job are not successful in moving to 'high' pay in the short-term.

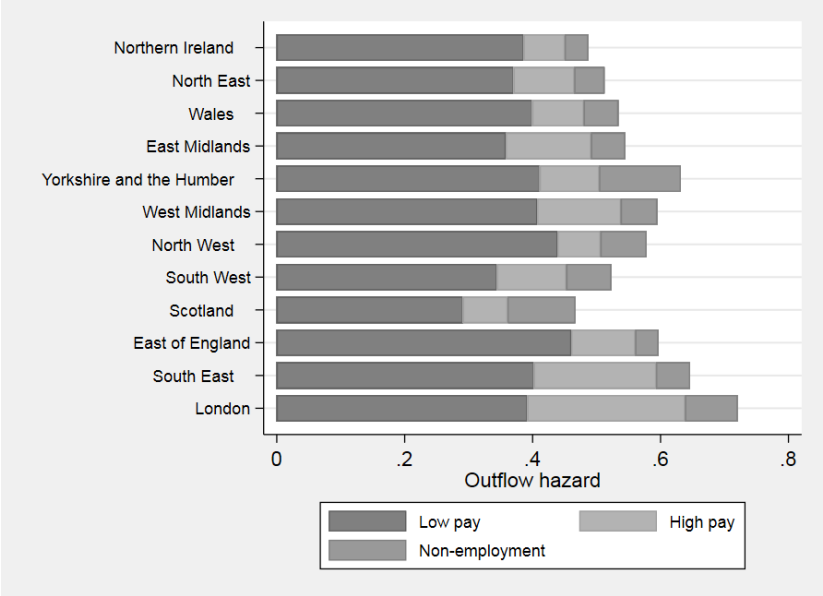


Fig 7: Three-year transition probabilities to minimum wage, low paid, 'high' paid and non-employment by year

We next examine how transition probabilities out of minimum wage jobs vary geographically. Average one-year transition probabilities to low pay, 'high' pay and non-employment by region are displayed in Figure 8. Unfortunately, low sample sizes prevent us from looking at temporal and spatial variation at the same time so we show averages over the

entire period only. London and the South East have the largest transition probabilities to 'high' paid employment: 25% and 19% respectively. At the opposite end, Northern Ireland and the North West have the lowest probabilities - around 6-7%. To check how transition probabilities vary with the local area economy, we have grouped all TTWAs into ten groups (deciles) based on their median wage in 2009. We then plotted *unconditional* transition probabilities for these ten groups in Figure 9. The probability to transition from a minimum paid job to better paid employment clearly increases as the average wage of the area goes up. Notably, differences are strongest for transitions to 'high' paid employment. While the probability of moving from a minimum wage job to a low paid job is relatively constant, the probability of transitioning to a 'high' paid job increases significantly in areas where wages are higher (in the top five deciles). Conversely, the probability of moving into non-employment falls. This pattern suggests that chances of finding 'high' paid employment may be strongly linked to the structure of the local economy. Note however that these differences are unconditional and do not account for possible differences in worker characteristics across areas with low and high wages.

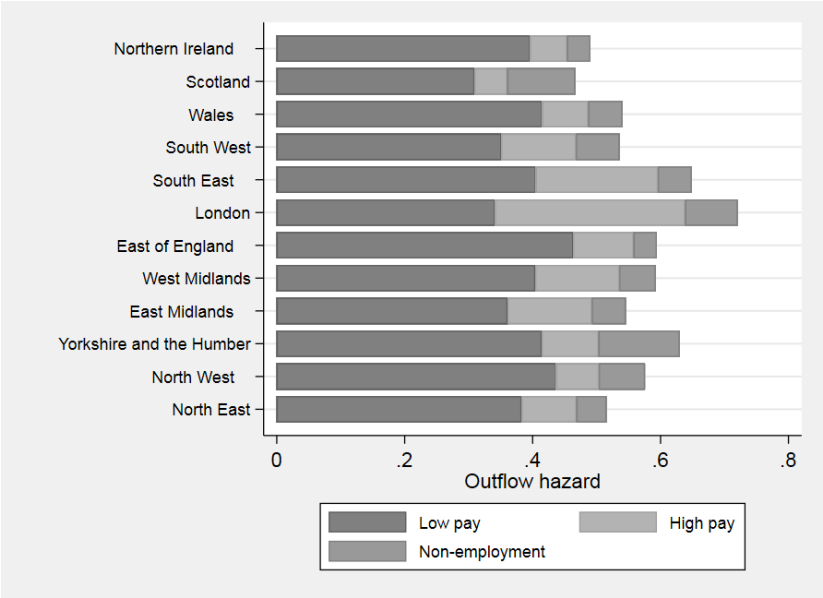


Fig 8: One-year transition probabilities to minimum wage, low paid, 'high' paid and non-employment by region

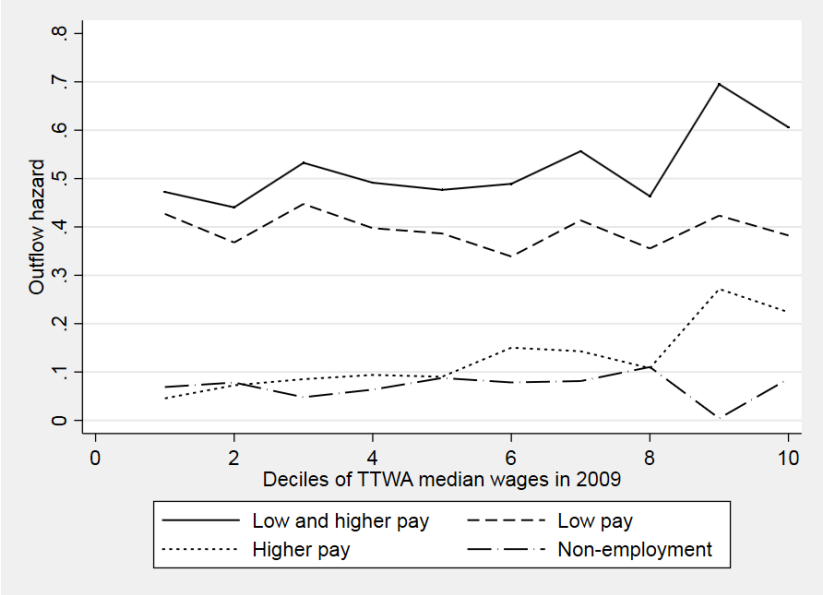


Fig 9: One-year transition probabilities to minimum wage, low paid, 'high' paid and non-employment by decile of TTWA median wages

4.2 Minimum wage effects on wage progression

To investigate potential minimum wage effects on transition probabilities out of minimum wage jobs, we have estimated a discrete time competing risks model with four states: minimum wage employment, low paid employment above the minimum, 'high' paid employment and non-employment. Each year, minimum wage job holders are 'at risk' of leaving their minimum wage job for one of the other three states. If a high minimum wage discourages wage progression, we would expect that the probability of leaving a minimum wage job for better paid employment to fall as the bite of the minimum wage increases. Moreover, we would expect lower wage areas to be more affected than 'high' wage areas. Looking at variation across areas is important because the bite of the minimum wage only varies over time. As such, its effects may be confounded by other concurrent economic or policy changes.

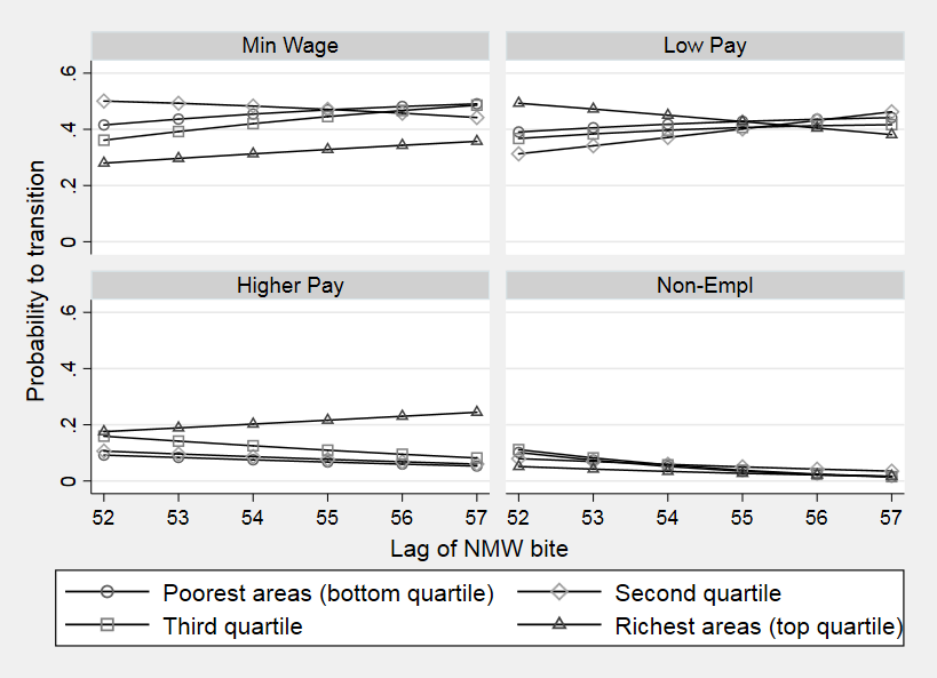


Fig 10 Predicted probabilities to remain and move out of a minimum wage job by lag of minimum wage bite and area's median wages

Figure 10 presents how the predicted probabilities of remaining in a minimum wage job (top left); transitioning to low paid employment (top right); to 'high' pay (bottom left); and to non-employment (bottom right) vary with the bite of the minimum wage (lagged by one years). If the minimum wage has an adverse effect on wage progression, we would expect the probability of remaining in a minimum wage job to be increasing, and the probabilities to transitioning to 'high' pay to be decreasing, with the minimum wage's bite (represented on the X axis). Moreover, we would expect the lines to be steeper for poorer areas (represented by a circle) compared to richer areas (represented by a triangle). Figure 10 shows that these expectations are not borne out by the data. While there is a slightly downward trend in the probability to transition to 'high' paid employment, the effects are small and there is no difference between areas in the first three quartiles of the distribution. Similarly, while there seems to be a positive relationship between the bite of the minimum wage and the probability to remain in a minimum wage job in high wage regions, there is no relationship in the other three groups.

A different way of examining our results is to see by how much the probability of transitioning changes if the bite increases by 1 percentage point in areas with different wage levels.

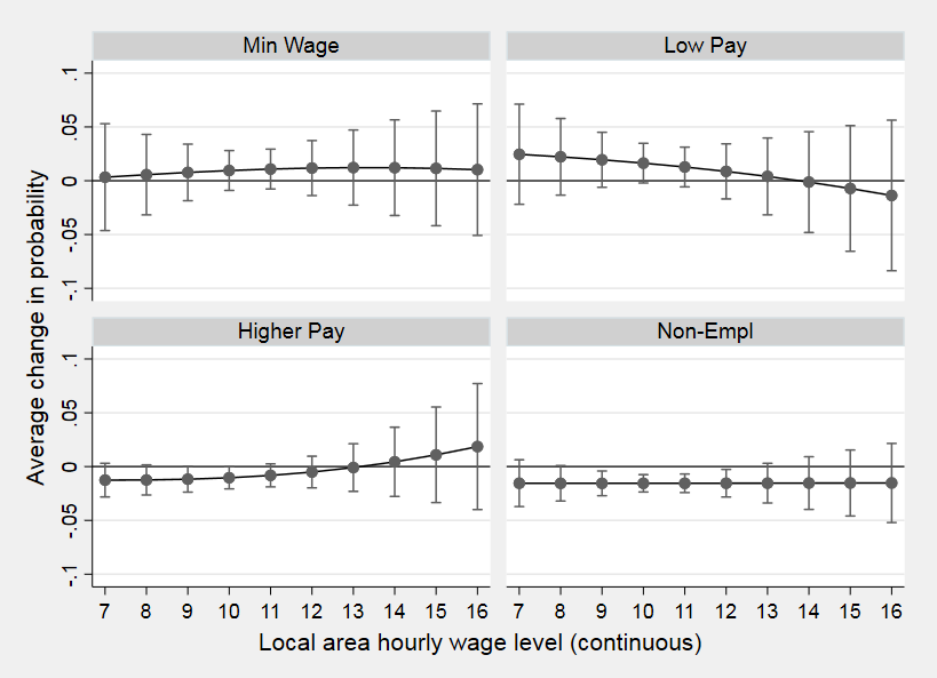


Fig 11: Average marginal effects of the minimum wage bite across areas with different wage levels

Figure 11 plots the size of these changes (called average marginal effects) as well as the standard errors of our estimates. It shows that with the exception of transitions to non-employment, we cannot rule out a zero effect of the minimum wage bite irrespective of the area wage level. Furthermore, we do not find more negative effects in low wage regions compared to high wage ones. In fact, effects in almost all cases are statistically indistinguishable from zero and are very similar across TTWA areas. Whereas our small sample size means that our estimates are somewhat underpowered, we would like to stress that the lack of statistical significance is primarily due to the point estimates themselves being very close to zero.

We conclude that there is no evidence to suggest that minimum wage hikes had any impact on wage progression probabilities for minimum wage workers between 2009 and 2016. Albeit our estimation strategy is somewhat underpowered, our estimates of the impact of the minimum wage bite are close to zero and the geographical variation in the size of the effects is minimal.

4.3 Individual and job level determinants of progression out of minimum wage jobs

As part of our estimation strategy, we quantify the effects of several individual and job characteristics on the probability of moving out of a minimum wage job. We focus on two transitions: to low paid (but above the minimum wage) employment and to 'high' paid jobs.

Our estimates (see Table A1 in the Appendix) indicate that only a few predictors are significantly associated with the probability to transition to low paid employment: having no qualifications, having a previous history of unemployment, and working in a part-time job reduce the probability of moving to low paid employment. In contrast, working in the public sector or in a large firm increases the likelihood of moving to a low paid job. Figure 12 shows the magnitude of these effects. They can be interpreted as the average change in the transition probability from a minimum wage job to low paid employment associated with a 1 unit change in the predictor.

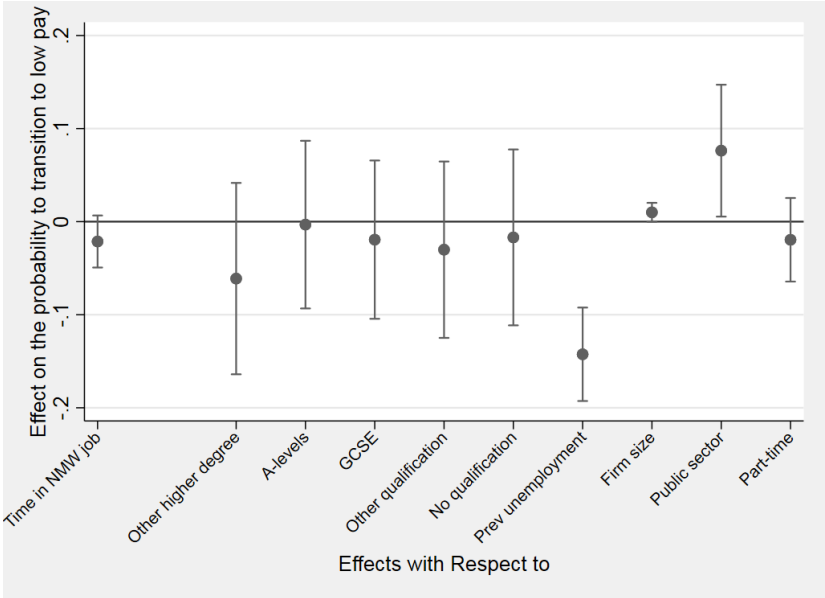


Fig 12: Average marginal effects (and 95% confidence intervals) on the probability to transition to low pay.

Additional predictors turn out to be significantly correlated with the probability of transitioning to 'high' pay. Generally, as the level of qualifications held by an individual increases, the probability to transition also increases, with the premium being especially high for degree holders. Working part-time and having a history of unemployment are associated with a lower probability of moving into a 'high' paying job. In contrast, working in the public sector or in a larger firm increases the probability to transition to 'high' pay. Women have a lower probability of moving into 'high' paid employment from a minimum wage job even controlling for part-time work and the number of children they have. Finally, working in manufacturing of food, beverages and textiles and in accommodation and food services is associated with a significantly lower probability of transitioning to 'high' pay. On the contrary, working in information and communication, professional, scientific and technical, or financial and insurance services is associated with a larger probability of moving to 'high' pay, although estimates are not statistically significant in these cases due to low sample sizes. Figure 13 shows the magnitude of the effects (calculated as average marginal changes in the probability to transition into 'high' pay). Having no qualifications has the strongest negative impact while working in the public sector has the strongest positive effect.

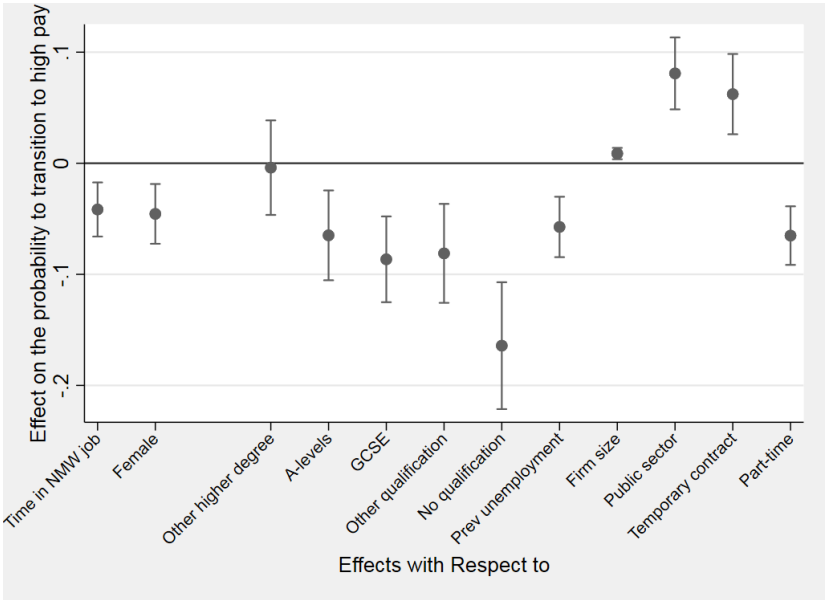


Fig 13: Average marginal effects (and 95% confidence intervals) on the probability to transition to 'high' pay.

5. Conclusions

Using the UKHLS, we examine progression out of minimum wage jobs in the UK between 2009 and 2016. During this period, the minimum wage increased considerably relative to median pay. Consequently, the share of workers covered by the minimum also increased substantially from around 4% to 7%. Conversely, the share of workers paid below the low pay threshold (defined as paying an hourly rate less than two thirds of the median hourly wage) decreased. We find that in any given year, approximately half of minimum wage workers transition to higher pay but that the vast majority of these transitions (approximately four fifths) are to low paid employment. These findings are consistent with previous work that has examined transitions out of minimum wage employment in the noughties (Bryan and Taylor, 2006, Jones et al., 2004). We also find considerable geographical variation in the transition rates out of minimum wage jobs. Whereas transition probabilities to low paid employment are relatively constant across areas with different wage levels, the probability to transition to a 'high' paid job (defined a paying more than 2/3 of median hourly pay) increases as the area wage level increases. However, these are unconditional probabilities that do not account for possible differences in the characteristics of workforces in areas with different wage levels.

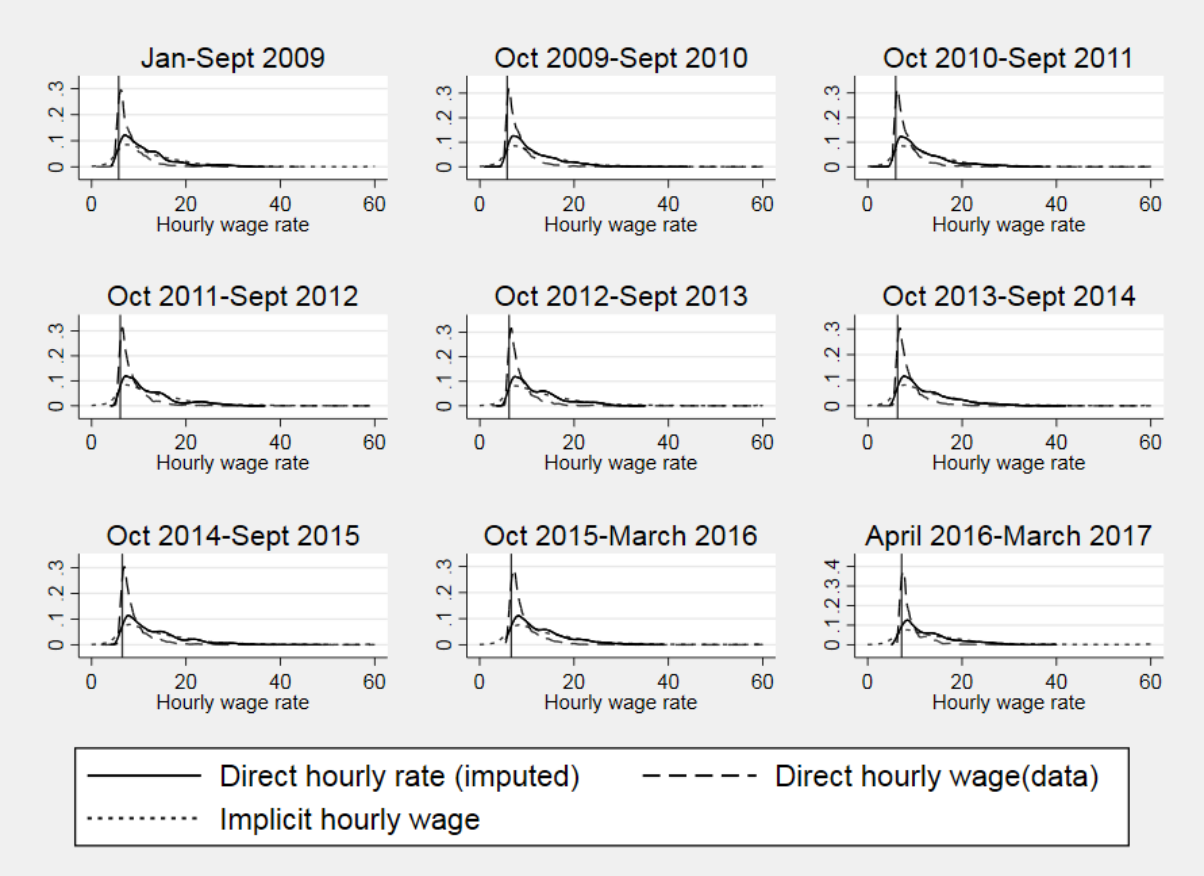
We use a competing risks discrete time model to estimate the effect of minimum wage changes on the probabilities of moving out of a minimum wage job. We compare how transition probabilities change as the minimum wage bite increases in high and low wage areas. If minimum wage increases do affect wage progression probabilities, we would expect

low wage areas to be more affected than high wage ones. We do not, however, find that transition probabilities in low wage areas react differently to changes in the minimum wage 'bite' than those in high wage areas. We thus conclude that there is no evidence to support the hypothesis that minimum wage hikes affected wage progression in the period we study. Our results are in line with two other studies (Cai et al., 2018, Jones et al., 2013) that examined low pay dynamics using different datasets and have similarly found no effects of the minimum wage on transition probabilities.

Individual and job characteristics are important determinants of the probability of moving out of a minimum wage job. 'High' educational qualifications, working in the public sector, working in a large firm and working on a temporary contract all increase the probability to transition to 'high' pay. Working part-time, having a history of unemployment spells, being a woman, and working in accommodation and food services or in food, beverages and textile manufacturing depress the probability to move to 'high' pay. We also found the chance to transition to 'high' pay decreases the longer one spends in a minimum wage job suggesting that there may be persistence in minimum wage jobs. Again, this finding is consistent with results from a previous study that focuses on the early noughties (Bryan and Taylor, 2006) and with the literature on low pay dynamics more generally (Cappellari and Jenkins, 2008, Stewart, 2007). Having no qualifications, working part-time and longer durations also decreased the probability of moving to a low paid job (paid above the minimum), whereas working in the public sector or in a large firm increased it. Thus, the individual and job characteristics associated with moves to low and 'high' paid employment are relatively similar.

Appendix

Fig A1: Hourly pay distributions according to three measures: 'direct', 'implicit', and 'direct' + imputed values between 2009 and 2016



Note: 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: Author's calculations based on UKHLS

Table A1:Estimated log odds ratios of transitioning from a minimum wage job to low pay, 'high' pay and non-employment respectively

	Low pay	'high' pay	Non-employment
Time spent in NMW job (years)	-0.208*** (0.061)	-0.683*** (0.168)	-0.324* (0.168)
Female	0.007 (0.122)	-0.614** (0.197)	-0.106 (0.254)
Age (years)	-0.062 (0.046)	-0.039 (0.077)	-0.128 (0.103)
Age ^2	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
Education (base=degree)			
Other 'high' degree	-0.313 (0.255)	-0.204 (0.329)	-0.053 (0.586)
A-levels	-0.168 (0.225)	-0.926** (0.312)	-0.088 (0.498)
GCSE	-0.364 (0.213)	-1.334*** (0.297)	-0.526(0.469)

Other qualification	-0.394 (0.235)	-1.314*** (0.340)	-0.482 (0.515)
No qualification	-0.552* (0.230)	-2.520*** (0.418)	-0.302 (0.496)
Has children under 5	-0.002 (0.158)	-0.291 (0.288)	0.508 (0.415)
Number of dependent children under 16			
1	0.024 (0.141)	-0.178 (0.259)	0.346 (0.330)
2	0.152 (0.155)	0.519* (0.257)	-0.234 (0.397)
3 or more	0.113 (0.199)	-0.083(0.370)	-0.385(0.484)
Poor health	-0.195 (0.106)	-0.318 (0.186)	0.191(0.232)
Ethnic minority member	-0.118 (0.242)	0.207 (0.409)	0.099(0.623)
Immigrant	-0.072 (0.236)	-0.569(0.421)	0.353 (0.603)
Previous unemployment	-0.2786* (0.119)	-0.627** (0.224)	6.400***(1.021)
Firm size	0.063* (0.025)	0.147*** (0.038)	-0.100 (0.058)
Public sector	0.686*** (0.179)	1.487*** (0.252)	0.813 (0.437)
Temporary contract	0.209 (0.205)	1.005*** (0.279)	0.694*(0.323)
Part-time	-0.285** (0.109)	-1.035*** (0.192)	-0.212 (0.246)
Industry (base category=Manufacturing, basic industries)			
Agriculture and mining	0.622(0.710)	-0.160(1.228)	-
Manufacturing- food, beverages and textile	-0.298(0.397)	-1583* (0.680)	0.895 (0.921)
Manufacturing-complex industries	-0.527(0.535)	0.475 (0.597)	-0.429 (1.355)
Construction, gas, electricity and water services	-0.152 (0.672)	0.693 (0.713)	1.064 (1.215)
Wholesale and retail trade	0.029 (0.327)	-0.815(0.444)	0.454 (0.824)
Transportation and storage	-0.161 (0.403)	-0.937 (0.566)	1.985* (0.928)
Accommodation and food services	-0.177 (0.333)	-1.212**(0.464)	0.676 (0.835)
Information and communication	1.269 (1.169)	1.36 (1.307)	4.574*(1.910)
Finance, insurance and real-estate services	0.550 (0.776)	0.703 (0.863)	-
Professional, scientific and technical services	-0.020 (0.604)	1.117(0.681)	0.442 (1.542)
Administrative and support services	-0.056(0.354)	-0.348(0.482)	0.765 (0.842)
Public administration, education and health	-0.275 (0.337)	-0.638(0.452)	-0.033 (0.873)
Arts and other	-0.228 (0.367)	-0.673(0.512)	1.329 (0.894)
Minimum wage bite	-0.066 (0.266)	-0.193 (0.424)	-0.570 (0.786)
TTWA median wage level	0.007 (1.385)	-0.012 (2.114)	-1.045 (4.062)
Minimum wage bite X Local wage level	0.001 (0.025)	0.006(0.039)	0.020 (0.075)
N	2311		

Note: Coefficients represent log odds ratios; standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001; values missing when estimate is very unreliable

Source: Authors' calculations based on UKHLS 2009-2016

References

ALLISON, P. D. 1982. Discrete-Time Methods for the Analysis of Event Histories. *Sociological Methodology,* 13**,** 61-98.

ARULAMPALAM, W. 2001. Is Unemployment Really Scarring? Effects of Unemployment Experiences on Wages. *The Economic Journal,* 111**,** F585-F606.

BRYAN, M. L. & TAYLOR, M. 2006. Identifying and Explaining Pattern of NMW Receipt in Britain, 1999-2004. *Report for the Low Pay Commission*

CAI, L., MAVROMARAS, K. & SLOANE, P. 2018. Low Paid Employment in Britain: Estimating Stqate-Dependence and Stepping Stone Effects. *Oxford Bulletin of Economics and Statistics,* 80**,** 283-326.

CAPPELLARI, L. 2002. Do the 'Working Poor' Stay Poor? An Analysis of Low Pay Transitions in Italy. *Oxford Bulletin of Economics and Statistics,* 64**,** 87-110.

CAPPELLARI, L. & JENKINS, S. P. 2008. Estimating Low Pay Transition Probabilities Accounting for Endogeneous Selection Mechanisms. *Applied Statistics,* 57**,** 165186.

D'ARCY, C. & FINCH, D. 2017. The Great Escape? Low Pay and Progression in the UK's Labour Market. Resolution Foundation.

DICKENS, R. & MANNING, A. 2002. Has the National Minimum Wage Reduced UK Wage Inequality? *Journal of the Royal Statistical Society,* 167**,** 613-626.

DICKENS, R. & MANNING, A. 2004. Spikes and Spillovers:The Impact of the National Minimum Wage on the Wage Distribution in a Low-Wage Sector. *The Economic Journal,* 114**,** C95-C101.

DOLTON, P., BONDIBENE, C. R. & WADSWORTH, J. 2012. Employment, Inequality and the UK Minimum Wage over the Medium-Term. *Oxford Bulletin of Economics and Statistics,* 74**,** 78-106.

GREGG, P. & TOMINEY, E. 2005. The Wage Scar form Male Youth Unemployment. *Labour Economics,* 12**,** 487-509.

JENKINS, S. P. 1995. Easy Estimation Methods for Discrete-Time Duration Models. *Oxford Bulletin of Economics and Statistics,* 57**,** 129-138.

JONES, M. K., JONES, R. J., LATREILLE, P. L., MURPHY, P. D. & SLOANE, P. J. 2013. A regional analysis of flows into and out of the UK National Minimum Wage. *Applied Economics,* 45**,** 03074-3087.

JONES, M. K., JONES, R. J., MURPHY, P. D. & SLOANE, P. J. 2004. The Analysis of Flows Into and Out of The National Minimum Wage. *Report for the Low Pay Commission.*

LOW PAY COMMISSION 2017. National Minimum Wage. Low Pay Commission Report 2017. Low Pay Commission.

MANNING, A. 2012. Minimum Wage: Maximum Impact. *In:* FOUNDATION, R. (ed.).

METCALF, D. 2008. Why Has the British National Minimum Wage Had Little or No Impact on Employment? *Journal of Industrial Relations,* 50**,** 489-512.

MUMFORD, K. & SMITH, P. N. 2004. Job Tenure in Britain: Employee Characteristics vs. Workplace Effects. *The University of York Discussion Papers in Economics,* 2004/06.

NEUMARK, D. & NIZALOVA, O. 2007. Minimum Wage Effects in the Longer Run. *Journal of Human Resources,* 42**,** 435-452.

NEUMARK, D. & WASCHER, W. L. 2007. Minimum Wages and Employment. *Foundations and Trends in Microeconomics,* 3**,** 1-182.

NICOLETTI, C. & RONDINELLI, C. 2010. The (Mis)specification of Discrete Duration Models with Unobserved Heterogeneity: A Monte Carlo Study. *Journal of Econometrics,* 159**,** 1-13.

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

RINZ, K. & VOORHEIS, J. 2018. The distributional effects of minimum wages: Evidence from linked survey and administrative data. *CARRA Working Paper Series,* 2018-02.

SKINNER, C., STUTTARD, N., BEISSEL-DURRANT, G. & JENKINS, J. 2002. The Measurement of Low Pay in the UK Labour Force Survey. *Oxford Bulletin of Economics and Statistics,* 64**,** 653-676.

STEWART, M. B. 2002a. Estimating the Impact of the Minimum Wage Using Geographical Wage Variation. *Oxford Bulletin of Economics and Statistics,* 64**,** 583-605.

STEWART, M. B. 2002b. The National Minimum Wage and Labour Market Transitions. *Report for the Low Pay Commission.*

STEWART, M. B. 2004. The Impact of the Introduction of the UK Minimum Wage on the Employment Probabilities of Low Wage Workers. *Journal of the European Economic Association,* 2**,** 67-97.

STEWART, M. B. 2007. The Interrelated Dynamics of Unemployment and Low Wage Employment. *Journal of Applied Econometrics,* 22**,** 511-531.

STEWART, M. B. 2012. Wage Inequality, Minimum Wage Effects, and Spillovers. *Oxford Economic Papers,* 64**,** 616-634.

STEWART, M. B. & SWAFFIELD, J. K. 2002. Using the BHPS Wave 9 AdditionalQuestions to Evaluate the Impact of the National Minimum Wage. *Oxford Bulletin of Economics and Statistics,* 64**,** 633-652.

SWAFFIELD, J. K. 2014. Minimum Wage Hikes and the Wage Growth of Low-Wage Workers. *Bulletin of Economic Research,* 66**,** 384-405.